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Description of *Onyx balochiensis* n. sp. (Nematoda: Chromadorida) with a compendium of the genus *Onyx* Cobb, 1891 from Pakistan

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Specimens of a new species of the genus *Onyx* Cobb, 1891 were isolated from the sediments of the Sonmiani beach of Balochistan, Pakistan and described and illustrated. A compendium of the genus *Onyx*, based on the characters: body length, dorsal tooth, oesophageal bulb and spicules length, number of supplements, ratios a, b, c and vulva percentage, is presented. These allometric and morphometric characters are derived from the original descriptions. The new species *Onyx balochiensis* is characterized by relatively longer body, more posteriorly located vulva, longer oesophageal bulb and spicules, presence of epiptygma and in the presence of two groups of setae anterior to spicules. The new species *Onyx balochiensis* comes close to *O. perfectus* Cobb, 1891 but differs from it in dorsal tooth, oesophageal bulb and spicules length, in the number of supplements, more posteriorly located vulva and in the presence of two groups of setae anterior to spicules (dorsal tooth= 32-36 vs 52 μ m; oesophageal bulb = 84-100 vs 90 μ m; spicules= 45-50 vs 43 μ m; number of supplements= 15-23 vs 14; V%= 58-66 vs 57; presence of two groups of setae anterior to spicules vs absence of groups of setae). The new species also comes close to *O. sagittarius* Gerlach, 1950, but differs from it in body length; spicules and oesophageal bulb length, more posteriorly located vulva and in the presence of two groups of setae anterior to spicules (L=1240-1640 vs 1100 μ m; spicules= 45-50 vs 35 μ m; oesophageal bulb= 84-100 vs 57-73 μ m; V%= 58-66 vs 55; presence of groups of setae anterior to spicules vs absence of two groups of setae).

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Pathogenicity of *Xenorhabdus nematophila* (strain ham-10) against wax moth larvae and vine mealy bug in Pakistan

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Cell suspensions of *Xenorhabdus nematophila* and its metabolites from *Steinernema pakistanense* (strain HAM-10) were lethal to *G. mellonella* larvae and vine mealy bug. Different experiments on penetration of cells, time of exposure, cell suspension in broth and water and serial dilutions of bacterial cell were conducted. *X. nematophila* suspension containing 4.0×10^4 bacterial cell/ml showed penetration power within 6 min in *G. mellonella* and vine mealy bug. Cell in broth was more effective than cell in water suspension. At different time interval maximum mortality 97% and 95% was assessed after 24-48 h exposure of cell in broth and water suspension against *G. mellonella* and 95% and 77% in vine mealy bug. The supernatant and residue + water also showed similar lethal effects. The LD 50 value of different doses of bacterial concentration was found to be 4.02, 19.135 bacterial cell /ml, while probit regression equation were calculated as $3.98 + 0.41 x$, $4.7 + 0.22 x$ against *G. mellonella* and vine mealy bug, respectively. The LT50 value of different time interval of bacterial concentration was found to be 0.377 h and 11.8 h against *G. mellonella* and vine mealy bug, respectively.

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Pakistani strains of entomopathogenic nematode as a biological control agent against stored grain pest, *Tribolium castaneum*

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Seven indigenous entomopathogenic nematodes viz., *S. pakistanense* Shahina, Anis, Reid & Maqbool (Ham 10 strain); *S. asiaticum* Anis, Shahina, Reid & Rowe (211 strain); *S. abbasi* Elawad, Ahmad & Reid (507 strain); *S. siamkayai* Stock, Somsook & Reid (157 strain); *S. feltiae* Filipjev (A05 strains), *H. bacteriophora* Poinar (1743 strain) and *H. indica* Poinar, Karunakar & David (HAM-64 strain) were examined against adult and larval stage of *Tribolium castaneum* in laboratory bioassays. The activity of the strains was determined at four different concentrations in Petri dish and concrete container. Mortality of adult and larval stage red flour beetle was higher in the nematode treatments than in the control.

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Biopesticidal affect of *Photorhabdus luminescens* against *Galleria mellonella* larvae and subteranean termite (Termitidae: *Macrotermis*)

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Photorhabdus luminescens was isolated from the haemolymph of *Galleria mellonella* larvae infected with *Heterorhabditis bacteriophora* isolate 1743. Different experiments on penetration of cells, time of exposure, cell suspension in broth and different doses of bacterial cell were conducted. *P. luminescens* symbiotic bacterial suspension containing 4.0×10^4 bacterial cell/ml showed penetration power within 9 and 12 min in *G. mellonella* and *Macrotermis* spp., respectively. Suspension of *P. luminescens* in broth at different doses caused 95 and 98 % mortality of *G. mellonella* and *Macrotermis* spp., respectively. The LD₅₀ value of bacterial doses was found to be 190.4, 27.4 bacterial cell /ml, while probit regression equation were calculated as $3.42 + 0.72x$, $3.69 + 0.74x$ against *G. mellonella* and *Macrotermis* spp., respectively. The LT₅₀ value of *G. mellonella* on bee hives was found to be 24 hrs. In case of *Macrotermis* spp., the LT₅₀ value was calculated as 17.1 hrs. Maximum mortality (after 24hrs) of cell free suspension was 65 and 80% while bacterial pallets showed 97 % mortality of *G. mellonella* and *Macrotermis* spp., respectively.

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Trend of mango sudden death syndrome (MSDS) in relation to fungal microflora and nematodes fauna in Punjab, Pakistan

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Mango Sudden Death Syndrome (MSDS) reported from Brazil, Oman and Pakistan has gained much importance in Pakistan. A lot of research has been done on fungi associated with MSDS but the role of nematodes has been sparsely studied. This particular study was done to observe the trend of Mango Sudden Death Syndrome (MSDS) in relation to fungal microflora and nematodes fauna in selected four districts of Punjab, Pakistan. It was observed that the maximum disease incidence 28% and severity rating 4 (31-50%) was recorded in Multan where combination of different fungi was present and thus there was an increased population of fungal eater nematodes. Following Multan disease incidence (20%) was found in Bahawalpur, Faisalabad (18%) and Jhang (10%) with disease severity 3 (21-30%), 2 (11-20%) and 1 (1-10%), respectively.

It is very interesting to note that the disease incidence and severity has similar trend and are directly proportional to each other in the observed locations. The fungus *Ceratocystis fimbriata* alone as well as in combination contribute towards the disease incidence as in Multan and Bahawalpur. However fungi such as *Fusarium solani* and *Nattrassia mangiferae* seem to contribute much low towards the disease incidence.

Nematodes such as *Xiphinema* sp., *Hoplolaimus* sp., *Longidorus* sp. and *Hemicriconemoides* sp. are present in combinations at every location wherever there are fungi in combination. This study opens the way forward that why nematodes populations are higher where there is high fungal frequency! Do they contribute towards the disease development or they try to feed on fungal population and act as natural enemies.

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Plant parasitic nematodes associated with diseased betelvine conservatories in Karachi, Thatta, Hub area and Ketty bunder

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The present study conducted for the investigation of betelvine crop which was attacked by plant-parasitic nematodes. Surveys of the betelvine conservatories, carried out in Karachi, Thatta, Hub area and Ketty Bunder, showed that betelvine crop was attacked by nematodes. It was observed that the use of various mixtures of fertilizer and nematicide decrease the nematode population in betelvine conservatories, while the population of fungi increased the betelvine crop for a short time and later nematode population increased. The rotation of crops can be selected in nematode infested soil.

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Invasion and development of *Meloidogyne incognita* race 1 in different tomato cultivars

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Five varieties viz., Calmart VFN, Roma, UAE-1, Samrutt and Moneymaker were subjected for the invasion and development of *Meloidogyne incognita* race 1. All the varieties showed variability in their response to *M. incognita* infestation. Maximum invasion and development of nematodes was recorded in Moneymaker followed by Samrutt, UAE1 and Roma. Minimum invasion and development was recorded in Calmart VFN. Root weight has direct relationship with the number of developing *M. incognita*.

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Tylenchid nematodes associated with watermelon growing in Diyarbakir province, Turkey

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Plant parasitic nematodes (Tylenchida: Nematoda) found on watermelon (*Citrullus lunatus* Thunb (Mansf.) growing in the Diyarbakir province of Turkey were examined faunistically and taxonomically. This study was carried out in four towns (Çınar, Ergani, Silvan, Central) important for the cultivation of watermelon during the summer of 2001-2002. Samples were taken from 16 different watermelon fields and examined in the laboratory. By the end of our research twenty-five species were identified. One of these species (*Pratylenchus fallax* Seinhorst, 1968) is a new record for Turkey. Its identification, distribution in Diyarbakir and morphological and morphometric characteristic are given. This is the first report of plant parasitic nematodes

associated with water melon cultivation areas in Diyarbakir province. Other common species found were: *Filenchus cylindricauda* (Wu, 1969) Siddiqi 1986, *Pratylenchus fallax* Seinhorst (1968), *Boleodorus* (*B.*) *thyllactus* Thorne (1941), *Ditylenchus destructor* Thorne (1945) and *Merlinius nanus* (Allen, 1955) Siddiqi, 1970.

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Distribution and association of plant parasitic nematodes with some oil crops in Egypt

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Thirteen genera of plant parasitic nematodes associated with rapeseed, peanut, soybean and sunflower oil crops were recovered from ten governorates in Egypt during the 2000-2003 growing seasons. *Helicotylenchus*, *Hoplolaimus*, *Meloidogyne* and *Pratylenchus* were found occurring with high population densities, frequency of occurrence and prominence values. Other nematode genera as *Criconeoides*, *Heterodera*, *Hemicyclophora*, *Longidorus* and *Rotylenchulus* differed in the previous parameters in the different surveyed localities. Most of the surveyed peanut and sunflower fields had populations of over 200 individuals of *Meloidogyne* spp., the main pest of these crops, per 200 g soil. Identification of *Meloidogyne* spp., indicated that only *Meloidogyne javanica* was the dominant species from all peanut root samples collected from three Governorates in Egypt. The differences in nematode parameters in different surveyed localities are discussed here.

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Evaluation of some sugar beet varieties for *Meloidogyne incognita* resistance as induced by gamma-irradiation

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The main objective of this study was to evaluate the effect of irradiation against 28 varieties of sugar beet seeds with 100 Gy-dose for inducing the plant resistance to root-knot nematode, *Meloidogyne incognita* infection through measuring some morphological parameters, biochemical components, root characteristics and host susceptibility rating. Results of the study cleared that, relative to control plants (non irradiated seeds and soil not infected with nematode), root-knot nematode significantly reduced plants shoot height, number of leaves, leaf area index, root length, root diameter and root weight, while increased the activity of peroxidase and polyphenol oxidase in addition to decrease in the number of juveniles (J_2) in the soil, and number of galls, gall index, gall size and gall area. However, plants grown from irradiated seeds showed significantly different values between control and infected plants and hence, 100 Gy dose can increase sugar beet tolerance to nematode where, 7 varieties changed from highly susceptible to moderately resistant, one variety changed from highly susceptible to susceptible and 12 varieties changed from susceptible to moderately resistant.

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Varietals screening in *Brassica campestris* and *B. napus* infected with root-knot nematode in Egypt

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Under greenhouse conditions, 14 imported oilseed-rape cultivars were screened for their relative susceptibility to *Meloidogyne incognita* root-knot nematode. The degree of susceptibility was based on number of galls and

gall rating per root system of each cultivar. Semu 235/84, Loras, Sedo and AD 201/GRI were rated as moderately resistant hosts against the nematode infection and seven cultivars viz., Candle, Hanna, PF 2/85, Semu DNK, Tower, Duplo and Global were categorized as susceptible cultivars. However, the cultivars viz., Golda, Semu 240/84 and Lirasol were ranked as highly susceptible ones against *M. incognita* infection. It was observed that reproduction of nematode was favored on highly susceptible and susceptible cultivars but inhibited on moderately resistant one. Therefore, all tested cultivars showed great variability in their reaction to the nematode infection according to the host type. Finally, the differences among the tested cultivars should serve as a good resource for plant breeders and cropping systems to limit the loss due to the nematode infection.

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Root-knot nematode *Meloidogyne incognita wartellei* on pomegranate in Swat, KPK, Pakistan

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Root-knot nematode *Meloidogyne* spp., infect several agricultural crops worldwide. Pomegranate (*Punica granatum* L.) being an important fruit crop was reported to be attacked by *Meloidogyne javanica* and *M. incognita* from Balochistan, Pakistan (Khan *et al.*, 2005) and *M. incognita* from lower Sindh (Khan & Shaikat, 2005). Recently pomegranate orchards in Swat, KPK (Ex-NWFP) particularly Archan area was observed to be heavily infected by the root knot nematode. On uprooting such infected plants, numerous small to big size galls/ knots were noticed on the roots, resulting in very poorly developed root system. The specific identity of nematode was determined by cutting perineal patterns of the female. On the basis of perineal pattern and other characters such as stylet length, head shape and larval length, the root-knot nematode was identified according to Eisenback (1985) as *Meloidogyne incognita wartellei* Golden & Birchfield (1978). This is the first report of the occurrence of *Meloidogyne incognita wartillei* on pomegranate from Swat, KPK (NWFP), Pakistan.

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New records of *Mesorhadtidae* (Nematoda: Rhabditida) from different habitats of Sindh and Punjab, Pakistan

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Six known species viz., *Crustorhabditis scanica* (Allgen, 1949) Andrassy, 1983; *Cruzema brzeskii* (Brzeski, 1989) Sudhaus & Hooper, 1994; *Distolabrellus veechi* Anderson, 1983; *Teratorhabditis andrassyi* Tehseen & Jairajpuri, 1988; *Mesorhabditis striatica* Dassooville & Heyns, 1984 and *Bursilla monhystra* Butschili, 1873 belonging to the family Mesorhabditidae Andrassy, 1976 have been reported for the first time from various localities of Pakistan. These species are briefly redescribed and illustrated herein. The genera *Crustorhabditis*, *Teratorhabditis* and *Bursilla* are being reported for the first time from Pakistan.

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Plant-parasitic nematodes associated with garden egg (*Solanum aethiopicum*) in Obio-akpor LGA, rivers state, Nigeria

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Five garden egg fields (monoculture) were visited within Obio-Akpor LGA during 2007-08 seasons. Root and soil samples were collected and processed to identify and estimate the population levels of plant-parasitic nematodes associated with garden egg in the area. The predominant genera in the soils in terms of frequency of occurrence are *Meloidogyne* spp., (31%), *Pratylenchus* spp., (20.3%), *Helicotylenchus* spp., (18.6%), *Scutellonema* spp., (9.7%), *Radopholus* spp., (4.4%), *Tylenchulus* spp., (4.4%) and others (11.6%) such as *Aphelenchoides* spp., *Trichodorus* spp., *Aphelenchus* spp., and *Xiphinema* spp. The roots contain *Meloidogyne* spp., (34.9%), *Pratylenchus* spp., (24.5%), *Helicotylenchus* spp., (14.2%), *Scutellonema* spp., (8.5%), *Radopholus* spp., (4.7%), *Aphelenchoides* spp., (3.8%), *Tylenchulus* spp., (2.8%) and others (6.6%). The results of the survey showed that root-knot nematodes might be the major plant parasitic nematode of garden egg in this area and need to be managed.

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Phytoparasitic nematodes associated with ornamental shrubs, trees and palms in Saudi Arabia, including new host records

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Phytoparasitic nematodes associated with 22 different species of ornamental shrubs, trees and palms viz., *Albizia lebbek*, *Callistemon viminalis*, *Carissa macrocarpa*, *Chamaerops humilis*, *Cordia myxa*, *Duranta repens*, *Eremophila bowmanii*, *Ficus religiosa*, *Hibiscus tiliaceus*, *Melia azedarach*, *Parkinsonia aculeata*, *Phoenix canariensis*, *Pithecellobium dulce*, *Pongamia pinnata*, *Prosopis juliflora*, *Sabal palmetto*, *Sterculia diversifolia*, *Vitex agnus-castus*, *V. trifolia*, *V. trifolia variegata*, *Washingtonia robusta* and *Zizyphus spina-christi* were surveyed in Riyadh region, Saudi Arabia during the period from April 2008 to July 2009. A total of 235 composite soil and root samples were collected for the nematode survey. Twenty one nematode genera were found associated with the rhizosphere soils of surveyed ornamental plants. The nematode genera *Meloidogyne*, *Rotylenchulus*, *Tylenchorhynchus*, *Aphelenchus* and *Zygotylenchus* were the most frequent and/or prominent genera found associated with the surveyed ornamentals, whereas *Trichodorus*, *Xiphinema* and *Longidorus* were the least ones. Mean population densities of all nematode genera ranged between 17-983 nematodes/250 cm³ soil of all surveyed ornamentals. Roots of *A. lebbek*, *C. myxa*, *F. religiosa*, *P. dulce*, *P. pinnata*, *P. juliflora*, *S. diversifolia*, *V. agnus-castus*, *V. trifolia*, *V. trifolia variegata* and *W. robusta* were found infected with *M. incognita*, while *M. javanica* was identified on roots of *C. viminalis*, *C. macrocarpa*, *C. humilis*, *D. repens*, *E. bowmanii*, *M. azedarach*, *P. canariensis*, *S. palmetto* and *Z. spina-christi*. *Meloidogyne arenaria* mixed with *M. javanica* were found on roots of *Hibiscus tiliaceus*. Numerous young and adult females of the reniform nematode, *Rotylenchulus reniformis* were found attached to roots of *Parkinsonia aculeata* with high population of immature females in the soil averaged 1837 nematodes/250 cm³ soil. The above mentioned root infections by root-knot and reniform nematodes were first record on these ornamental plants in Saudi Arabia.

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A survey of root-knot and citrus nematodes in some new reclaimed lands in Egypt

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A survey was carried out to know the frequency of occurrence of both root-knot nematodes *Meloidogyne* spp., and citrus nematode *Tylenchulus semipenetrans* (Cobb, 1913) in the new reclaimed lands in three different governorates in Egypt viz., Behira (El-Tahrir), Minufiya (El-Sadat) and Sharkiya (El-Salhiya) regions as they represent different soil types, crops and climatic conditions. A total of 54 composite soil samples were

collected from fields growing different vegetable crops i.e., tomato, potato, eggplant and pepper as well as citrus. Nematodes were extracted and their population density (P.D) and percentage of occurrence were calculated. Results revealed that percentage of occurrence of *Meloidogyne* spp., was 96.26 % in the surveyed fields, while *T. semipenetrans* was 85.18 %. Population densities of *Meloidogyne* spp., greatly differed at all examined locations. The highest P.D was found in El-Tahrir, followed by El-Salhiya regions, whereas El-Sadat region was the lowest one with the values 242, 158, and 114 J2 / 250 g soil, respectively. The highest population densities of *T. semipenetrans* was found in El-Salhiya, followed by El-Tahrir, whereas El-Sadat region was the lowest by 2881, 1661 and 512 J2 / 250 g soil, respectively. Our survey indicates that *Meloidogyne* spp., and *T. semipenetrans* were widely spread in all examined locations in the new reclaimed lands in Egypt and nematode management strategies must become a part of production practices planning program.

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Control of nematodes associated with almond using oil-cakes in Balochistan

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Field experiments were conducted for the control of nematodes associated with almond using castor and mustard oil-cakes. The nematodes *Meloidogyne incognita*, *Helicotylenchus handooi* and *H. digonicus* were controlled by these treatments at Khuzdar. The nematodes associated with almond at Kalat were *M. javanica*, *H. digonicus* and *Macroposthonia curvata* and were controlled by oil-cakes and carbofuran. However, the yield of almond was not elevated by the phytonematicides.

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Plant extracts to control *Meloidogyne incognita* on cucumber

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Nematicidal activities of some native plants of Iran have been investigated against cucumber root-knot nematode (*Meloidogyne incognita*) in laboratory and greenhouse. For this purpose, the effects of alcoholic extract of the leaf of castor bean, chinaberry, sweet wormwood and rapeseed with concentrations of 0, 50, 100, 200, 300, 400, 500 and 1000 ppm on the percentage of immobility of second stage juveniles and hatching of eggs were evaluated. After proving the anti-nematode activity of treatments, the investigation was held in greenhouse by two methods. In the first method extract of plants were added into pots having cucumber seedlings infested with nematode and in the second method seedlings were dipped in alcoholic extract and then transplanted into nematode infested pots. The results indicated that all of the plant extracts had nematicidal activity. Overall alcoholic extracts of chinaberry with 68.66% was most effective on second stage juvenile and sweet wormwood with 32.69% had higher efficacy on un-hatched eggs of nematode in the laboratory conditions. The results of greenhouse experiments showed that the alcoholic extract of chinaberry and castor bean reduced the number of galls and population of nematodes in soil in a proper way. The results also revealed that the dipping of seedling in extracts reduced population of nematodes and numbers of galls.

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***Meloidogyne incognita* suppression and changes of grapevine yield properties determined by waste residues from jojoba, black seed oil extraction and slow release of nitrogen fertilizera.**

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Five different treatments i.e., cold-pressed jojoba residues (CPJR), screw-pressed jojoba residues (SPJR), cold-pressed black seed residues (CPBR), screw-pressed black seed residues (SPBR) and slow release nitrogen fertilizer (SRNF) namely “Enciabein” were applied as soil amendments for their efficacy in suppressing the root-knot nematode, *Meloidogyne incognita* infesting grapevine cv. Superior. This nematode was found infesting nine-year-old grapevines cv. Superior planted in newly reclaimed sandy soil under a drip irrigation system. The impact of the tested additives were also studied on plant growth variables and yield production when incorporated into the soil at three rates (on base lower rate, recommended rate and higher rate) during two successive seasons. The equatorial and longitudinal dimensions of the berries, leaves and soil contents of N, P, K and Fe were determined. All the tested substances significantly ($P \leq 0.01$ or 0.05) suppressed *M. incognita* populations either in the soil or in roots through the two successive seasons as compared to the control vines. Statistical differences in the nematode populations were found within and between the tested treatments. In respect of percentage efficacy of such substances in reducing *M. incognita* populations in both soil and roots of Superior cv., the recommended rate of SRNF compound has surpassed the other compounds two times through two successive seasons however, at using all rates of SPJR, the lower rate of each of CPJR and SPBR treatments and the recommended rate of each of CPJR and CPBR substances were superior for one experimental periods in reducing *M. incognita* populations in both soil and roots of Superior cv. All the treatments had increased N, P, K and Fe concentrations in the soil and grapevine leaves compared to checks. All yield, physical, vegetative and chemical properties of berries were increased to some extent while, all treatments gave low total acidity (TA) in juice and high ratio of TSS / TA especially with the recommended rate of SPBR in the first season and the higher rate of CPJR compound in the second season. These data proved that some natural compounds may be effective as natural nematicides in the control of *M. incognita* and improve the growth and yield of grapevines.
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Assessment and creating awareness of integrated nematode management strategies to chickpea growers in Allahabad, UP, India

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Integrated Nematode Management (INM) is a bio intensive scientific approach of managing key nematodes of a particular field crop so as to gain maximum economic yield without destroying the environment health of community. Chickpea (*Cicer arietinum*) is grown in tropical, sub-tropical and temperate regions for its nutritive seeds with high protein content. Kabuli type of chickpea is grown in temperate regions while the Desi type of chickpea is grown in the semi-arid tropics (Muehlbauer & Singh, 1987; Malhotra et al., 1987). Chickpea yield 21% starch suitable for textile sizing, giving a light finish to silk, wool, and cotton clothes (Duke, 1981). Chickpea is grown in India for domestic use and to fetch certain amount of rupee by the farmers.
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First record of the genus *Tetrameres* Creplin, 1846 (Nematoda: Tetrameridae) in Pakistan

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Five male nematodes of the genus *Tetrameres* Creplin, 1846 were collected from gizzard of black coot, *Fulica atra* L. (Gruiformes: Rallidae) in Sindh province of Pakistan. The nematodes have close resemblance with *Tetrameres globosa* (Von Linstow, 1879) in all aspects but differ in having only one spicule. In some reports *T. globosa* has been reported with only one spicule or the second spicule is rudimentary. Therefore,

the present specimens are identified as *T. globosa* (Von Linstow, 1879). This is a first record of the genus *Tetrameres* Creplin, 1846 and *T. globosa* from Pakistan.
2011, Vol. 29(2): 213-218

Mass production of eight Pakistani strains of entomopathogenic nematodes (Steinernematidae and Heterorhabditidae)

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Eight nematode species of the genera *Steinernema* and *Heterorhabditis* viz., *Steinernema pakistanense*, *S. asiaticum*, *S. abbasi*, *S. siamkayai*, *S. carpocapsae*, *S. feltiae*, *Heterorhabditis indica* and *H. bacteriophora* were cultured in vivo on three insect species, in vitro on soya flour, wheat flour, lipid media, corn flour and on assemblage culture on *Galleria mellonella* larva and lipid modified media for mass scale to assess their production potential. On in vivo culture at the highest concentration the production of infective juveniles were 60×10^4 to 87.4×10^4 IJs from each larva of *G. mellonella* 4.2×10^4 to 9.8×10^4 IJs from each adult of *Callosobruchus chinensis* and 0.3×10^4 to 1.7×10^4 IJs from each larva of *Tribolium castaneum*. Soya flour medium gave the highest population as compared to other media. The minimum multiplication was found in corn flour medium. As compared to cultured separately, the production of infective juveniles increased approximately two fold in assemblage medium. In vivo production of IJs in *G. mellonella* larvae and in vitro soya flour medium were also exposed to four different temperatures. Maximum production of all other species was found at $32 \pm 2^\circ\text{C}$, except *S. feltiae* which gave highest production at $20 \pm 2^\circ\text{C}$. The present investigation can be valuable for selecting strains of entomopathogenic nematodes for mass production on large scale to provide protection to crops against insects.

2012, Vol. 30(1): 1-20

Plant parasitic nematodes associated with different mentha species

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Thirteen mint species were evaluated for the presence of nematode fauna associated with their rhizospheres. Six plant parasitic and six saprophytic nematode genera were found associated with mint rhizosphere. *Tylenchorhynchus* spp., was found to be associated with highest number of mint varieties that is seven while *Trichodorus* was found attached with only one mint variety. The highest population recorded was of *Helicotylenchus* from six mint varieties. Maximum numbers of plant parasitic nematodes were found associated with pahari podina. No plant parasitic nematode was found associated with field mint (*Mentha arvensis*) which can further be investigated for its role as nematode repellent and can be used either as mulch or inter cropping.

2012, Vol. 30(1): 21-26

Biocontrol of black cricket, *Gryllus bimaculatus* (Orthoptera: Gryllidae) nymphs with entomopathogenic nematodes

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Entomopathogenic nematodes *Steinernema carpocapsae*, *S. feltiae* (Steinernematids) *Heterorhabditis indica* and *H. bacteriophora* (Heterorhabditids) were studied to control nymphs of black cricket *Gryllus bimaculatus*. Larvae (6th instar) of *Galleria mellonella* were infected in order to obtain culture of four different infective juveniles (IJs) of entomopathogenic nematodes *S. carpocapsae* (All isolate, cultured at 25 °C), *S. feltiae* (cultured at 25 °C), *H. bacteriophora* (HW79 isolate, cultured at 28 °C) and *H. indica* (Pakistani isolate, cultured at 28 °C). *S. carpocapsae* and *S. feltiae* were stored at 7 °C while other two viz., *H. indica* and *H. bacteriophora* were stored at 15°C. Results of all the experiments showed a significant difference in mortality percentage among all isolates. All the nematodes were found more effective when exposure time increased up to 8 days. *S. carpocapsae* showed better mortality, more production of infective juveniles (IJs) and maximum infectivity of black cricket nymphs as compared to other nematodes at 25 °C. On the other hand, both Heterorhabditids caused maximum mortality, production and infectivity as compared to two Steinernematids at 30 °C. When different dose concentration levels were tested in the sand arena, all dose concentrations resulted satisfactory mortality but a high level of dose concentration (400 IJs / ml) caused maximum insect mortality in all isolates. A similar response was observed in infectivity test when maximum percentage of IJs of both isolates of *Heterorhabditis* successfully penetrated into nymphs of *G. bimaculatus*. This research suggests some useful basic findings with suitable virulent selection of entomopathogenic nematodes for controlling nymphs of *G. bimaculatus*.

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Efficacy of some granular nematicides against root-knot nematode, *Meloidogyne incognita* associated with tomato

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Five granular nematicides namely, cadusafos, carbofuran, ethoprop, fosthiazate and oxamyl were assessed against the root-knot nematode, *Meloidogyne incognita* on tomato based on numbers of galls and juveniles (J₂) as well as on plant growth characteristics in a glasshouse. The rate of the formulated form of oxamyl, carbofuran or cadusafos was 0.1 g/kg soil, while it was 0.125 g / kg soil for fosthiazate and 0.25 g / kg soil for ethoprop. All nematicides caused reduction in root galls and J₂ in the soil. However, fosthiazate had the highest nematicidal effect with 97.52 % reduction in galls and 96.45 % juveniles in soil, while cadusafos was relatively least effective causing 77.51 and 86.63 % reduction in galling and J₂ population, respectively. Carbofuran, oxamyl and ethoprop ranked intermediate in descending order by 95.06 % and 94.26 %; 81.99 % and 87.60 %; 78.73 % and 87.88 %, respectively. However, none of the nematicides tested significantly affected shoot length, fresh shoot weight and root length compared to the untreated inoculated control. Except oxamyl, all of these nematicides significantly decreased root fresh weight.

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Performance of pesticide and biopesticide on growth, yield and forskolin content in *Coleus forskohlii* infected with *Meloidogyne incognita*

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A microplot experiment was carried out for assessing the performance of fungal biological control agents and chemical pesticides/nematicides on growth, yield and forskolin content in root-knot nematode infected *Coleus* plants. Among the tested treatments, *Trichoderma viride*, *Paecilomyces lilacinus*, *Glomus fasciculatum* and neem oil seed cake treated plants exhibited significantly outstanding performance on growth and reduced disease incidence as compared to the ones treated with chemical pesticides and other treatments including

control. Forskohlii content of biopesticides, *T. viride*, *P. lilacinus* and biofertilizers, *G. fasciculatum* and neem oil seed cake was estimated much higher against each of the chemical pesticide treated plants. However, both the biopesticides (*T. viride* and *P. lilacinus*) and biofertilizers (*G. fasciculatum* and neem oil seed cake) were statistically at par, particularly, in respect to forskolin content.

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Nematicidal potentiality of some animal manures combined with urea against *Meloidogyne arenaria* and growth and productivity of sugar beet under field conditions

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Three animal culture manures viz., cattle manure (CM), sheep manure (SM) and chicken manure (ChM) at three rates as organic substances, in combination with urea as inorganic fertilizer, were tested for their action against root-knot nematode, *Meloidogyne arenaria* infesting sugar beet and plant growth, yield and total soluble sugars (TSS %) under new reclaimed sandy loam field. Results indicated that all treatments at their rates significantly ($p \leq 0.05$ and / or 0.01) reduced females, galls and egg-mass numbers as compared to un-amended plants. All rates of Ch M treatment gave best results in protecting sugar beet plants and diminishing the nematode population densities in various stages. But, SM treatment with their rates ranked statistically in the second category. However, the three levels of CM treatment achieved the third category in managing the nematode. All treatments significantly improved infected sugar beet growth including yield and TSS %. There were positive correlations between the evaluated concentrations and the obtained reduction in numbers of the nematode stages and also all plant growth parameters including root weight (yield) and total soluble sugars.

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Efficacy of nematicides in management of root-knot nematode, *Meloidogyne incognita* in okra in farmers's participatory mode

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Okra is quite defame for its susceptibility to root-knot nematode (*Meloidogyne incognita*), poses serious losses in its yield. Attempts to manage the test nematode were made to assess the efficacy of nematicides (seed treatment with carbosulfan 25 SD) 5% a.i. (w/w), acephate (75 SP) 5% a.i. (w/w), soil application of carbofuran (3G) @ 2 kg a.i. / ha, Phorate @ 2 kg a.i. / ha, benfurocarb (3G) @ 2 kg a.i./ ha, slurry application of naemin with FYM 25 kg/ha and to compare with farmers practice. Results revealed that nematicides which are used seed dresser and granular formulations were found to be cost effective and easy to apply whenever they were compared with Naemin. Granular application of carbofuran and phorate, both at 2 kg a.i. / ha were quite effective in reducing root-knot disease and nematode population densities and in increasing fruit yield of okra. Next promising chemicals were seed dressing with carbosulfan and acephate both at 5% a.i. and application of Naemin at 25 kg/ ha. These effective chemicals, carbofuran, phorate and Naemin that were rated as strong inhibitors against nematodes can be exploited in developing an INM package as one of the components for better management of root-knot disease in okra.

2012, Vol. 30(1): 67-73

Lehli (*Convolvulus arvensis*) weed, a new alternate host of *Meloidogyne incognita* in Pakistan

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In a field trial at area of Vegetable Research Institute (AARI), Faisalabad in 2011, a new host of root-knot nematode (RKN) was recorded. Moderate galls on the roots of *Convolvulus arvensis* were observed due to RKN infestation. Under the stereoscopic microscope mature whitish pear shaped females were isolated from the roots of *C. arvensis*. By using perineal pattern technique (Eisenback *et al.*, 1981), a most common and abundant species of root-knot nematode *M. incognita* (Kofoid & White, 1919) Chitwood, 1949 was identified from the host. The perineal pattern of *M. incognita* comprises a distinct dorsal arch composed of smooth to wavy lines and no lateral incisures. This new record of *M. incognita* has not been hitherto reported in Pakistan (Zarina & Maqbool, 1991; Maqbool & Shahina, 2001; Khanzada & Khan, 2003; Zarina, 2004; Khan *et al.*, 2005; Erum *et al.*, 2005; Shahid *et al.*, 2006, 2007, 2008; Shahina *et al.*, 2009).
2012, Vol. 30(1): 75-76

Endemicity of intestinal parasites with special reference to nematodes in individuals related to education (Students, Staff and Workers) in Swat, KP, Pakistan

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This study was aimed to assess the impact of education on the prevalence of nematode intestinal parasites among individuals relevant to education under and above 15 years age in Swat, Pakistan. Stool samples were randomly collected during January 2006 to December 2008 and examined from a total of 420 individuals including 238 and 182 under and above 15 years age, respectively from Urban and Rural area of Swat, Pakistan. The techniques used were wet mount (WMT), sedimentation and centrifugation. A number of 171 individuals were found infected with any single species of parasite, 81 cases were found infected with double species of parasites, 21 individuals were having triple and 4 individuals were found to be infected with four species of parasites. Nematodes were the most prevalent intestinal parasites than cestodes and protozoans. The prevalence rate was: *Ascaris lumbricoides* 39.8, *Trichuris trichura* 19.1, *Enterobius vermicularis* 8.25, *Ancylostoma duodenale* infection 3.64, *Taenia saginata* 12.8, *Hymenolepis nana* 10.1, *Entamoeba histolytica* 4.36 and *Giardia* species 1.69 %. The children were found more infected than adults but adults were found infected with multiple infection. Present study leads to understand that sanitary measures should be effectively adopted and health education should be given as a compulsory subject.

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Determination and biocontrol potential of endemic entomopathogenic nematodes through cluster analysis

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The eighteen strains of entomopathogenic nematodes (EPNs) (Rhabditida: Steinernematidae and Heterorhabditidae) of different geographical regions of Pakistan were evaluated against *Galleria mellonella* (L.). The corrected mortality, day to the death of larvae, emergence of IJs and reproductive at a concentration approximately 95 IJs/cm² were analyzed under laboratory conditions. The highest mortality (100%) was showed by *S. pakistanense* (Pak.P.S.13) and *H. bacteriophora* (Pak.S.H.17), while percentage of larval mortality was varied slightly among strains, ranged from 83.3 ± 5.83% to 100 ± 0.0%. Time to death of insect also showed a significant effect varying from 5.40 ± 0.07 to 7.07 ± 0.17 days. The number of days to first IJs emergence also showed significant difference statistically among species. *S. pakistanense* produced

after 5.40 to 6.67 days, 5.24 to 6.50 days for *S. siamkayai* strains and 7.80 days for *H. bacteriophora*. Reproduction potential was also varied among nematode strains. In *S. pakistanense* reproduction ranged from 725 to 1000 IJs/mg larvae, and in *S. siamkayai* IJs yield ranged from 811 to 1000 IJs/mg larvae while in case of *H. bacteriophora* reproduction rate was 950 IJs/mg larvae. On the basis of cluster analysis Group 3 which included two sub groups (3a and 3b), *H. bacteriophora* (Pak.S.H.17) of 3a and *S. pakistanense* (Pak.P.S.13) of 3b showed markedly greater mortality and the least time to the death of insect; highest emergence of IJs and reproduction potential as compared to other strains.

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Effect of salicylic acid and *Pseudomonas fluorescens* against *Meloidogyne incognita* in eggplant using split-root technique

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A pot experiment was conducted to evaluate the efficacy of salicylic acid (SA) and *Pseudomonas fluorescens* Migula-1895^{AL} in inducing systemic resistance against *Meloidogyne incognita* (Kofoed & White) Chitwood using split root technique in eggplant (*Solanum melongena* L.), where the root system of a single eggplant was spatially divided into two separate parts. Results revealed that Salicylic acid at concentration of 5000 ppm or *Pseudomonas fluorescens* at dilution of S/2 (10^8 CFU/ml/2) in one-half of root tested as soil drench significantly ($p \leq 0.05$) reduced nematode parameters in another half of root and improved plant growth compared to the whole plant inoculated with the root-knot nematode only. The activities of the enzymes, peroxidase, polyphenol oxidase and chitinase increased in the treated plants compared to inoculated non-treated control.

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Occurrence and interactions among sugar beet cyst nematode and beet soilborne viruses in northern Turkey

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A survey was conducted to determine the distribution of *Beet necrotic yellow vein virus* (BNYVV), *Beet soilborne virus* (BSBV), their vector *Polymyxa betae* and sugar beet cyst nematode (*Heterodera schachtii* Schm.) (SBN) in sugar beet fields in northern parts of Turkey. A total of 200 soil samples were collected at random from fields in Samsun, Amasya, Tokat, Corum, and Cankırı provinces during 2004 and 2005 growing seasons. The results of ELISA tests showed that BSBV was the most prevailing virus (40.5%), followed by BNYVV (27.5%) in the regions. Of the 200 fields surveyed, 92 samples infested by at least one virus (46%), 55 samples infested by SBN (27.5%) and 161 samples infested by viruliferous or aviruliferous *P. betae* (80.5%). In the mixed infections, the combination BNYVV and BSBV was the most frequent (15%) followed by aviruliferous *P. betae*+SBN (8.5%). Also, the number of nematode cysts was significantly lower when BNYVV+*P. betae*, BSBV+*P. betae*, BNYVV+BSBV+*P. betae* and aviruliferous *P. betae* compared with healthy samples.

2012, Vol. 30(2): 115-127

Molecular characterization of root-knot nematodes with five new host records from Pakistan

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During nematode surveys in the different regions of the country, high infestation of root-knot nematodes were found. On morphological characterization these RKN species were identified as *Meloidogyne incognita* and *M. javanica*. Molecular characterization of 16 strains of these root-knot nematodes were also done and incorporated herein including three new species. The 18S rDNA of 16 strains of *Meloidogyne* spp., were amplified and directly sequenced. Phylogenetic trees based on alignments of these sequences were constructed using distance, parsimony and likelihood optimality criteria. The molecular characterization of 16 strains of RKN was done for the first time from Pakistan. Moreover, during the studies *Meloidogyne incognita* and *M. javanica* were found associated on five new hosts viz., fever few (*Parthenium hysterophorus* L.), olive (*Olea europaea* L.), malabar spinach (*Basella rubra* L.), canna (*Canna indica* L.) and dehla (*Jasminum multiflorum* Burm. f.) not reported earlier. The molecular analysis of these RKN species associated with new host records are in progress.

2012, Vol. 30(2): 129-141

Effect of organic and inorganic fertilizers on *Meloidogyne incognita* infesting sugar beet

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This experiment was conducted in a field having sandy loam soil infested with root-knot nematode, *Meloidogyne incognita* (Kofoed & White) Chitwood. Sugar beet (*Beta vulgaris* L.) cv. Sallow was grown in the field. The soil was treated with a mixture of cattle manure (30m³), calcium superphosphate (15.5% P₂O₅) (250kg/fedden), potassium sulphate (48% K₂O) (100kg/fed.), ammonium sulphate (33.5% N) (100kg/fed.) and sulphur (100kg/fed.) at the rates of 7.5, 5.0 and 2.5kg/m² with equivalent to 30, 20 and 10 tons/fed. The mixed fertilizers were added to the soil at the time of sowing, after thinning and during root formation. Results obtained showed that the number of galls significantly decreased with increasing the applied fertilizer rates, except the number of egg-masses as the highest percentage reduction 85.9% occurred when the plants were treated by the mixed amendments at the highest rate after thinning, while the highest reductions of 84.1 and 84.7% were achieved at the moderate rate (20 tons/fed.) at the times of sowing and root formation, respectively. As for yield of roots, production per feddan (equal to 4200 m² area) significantly increased especially at the moderate rate of application when the plants were treated at the time of sowing. Phytotoxicity occurred at the highest rate of fertilizers.

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Management of nematodes associated with chilli using Fertinmakil-plus and Carbofuran

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The effect of Fertinmakil-Plus and Carbofuran was investigated on the population densities of three nematodes and yield of chilli. The populations of *Meloidogyne incognita*, *Longidorus elongatus* and *Rotylenchus capsicumi* were significantly reduced by both the nematicides.

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Plant-parasitic nematodes associated with tomato and okra fields of Allahabad, Uttar Pradesh, India

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An extensive survey was carried out for the infestation of plant parasitic nematodes associated with vegetable growing fields i.e., tomato and okra. Soil and root samples were collected from 238 tomato fields represents 16 different locations (villages) where TSS-1 to TSS-238 varieties and 227 soil and root samples from the okra fields were collected (OSS-1 to OSS-227) represents 16 different locations (16 villages) to identify the hot spots of plant-parasitic nematodes of Allahabad, Uttar Pradesh, India. Results revealed that incidence of root-knot nematodes were found 60% and 55.9% in tomato and okra fields, respectively. Beraunji, Basahra, Mansoorabad and Urua villages were found most infested areas of okra and tomato crops. Root-knot nematode infestation was found to maximum i.e., 60%. Moreover, other plant-parasitic nematodes such as *Rotylenchulus reniformis*, *Longidorus* spp., *Hoplolaimus* spp., *Hemicriconemoides* spp., *Xiphinema* spp., *Helicotylenchus* spp., *Tylenchorhynchus* spp., *Paratylenchus* spp., and *Pratylenchus* spp., were also recorded. 2012, Vol. 30(2): 157-167

Response of eggplant (*Solanum melongena* L.) cultivars to *Meloidogyne incognita* infection

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Experiments were conducted to screen ten eggplant cultivars including Dilnasheen, VRIB-04, VRIB-01, VRIBH-03, Cluster king, Faisalabad-Long, PPR, Purple Queen, Nirrala and Bemissal against *Meloidogyne incognita* infection in the green house at 25±4°C. At harvesting, roots of Nirrala contained significantly fewer galls (45) and egg-masses (51) compared to the other nine cultivars. Nine cultivars including Dilnasheen, Purple Queen, VRIB-01, Faisalabad long, PPR, Bemissal, VRIBH-03, VRIB-04 and Cluster king had 5 root galling and egg-masses indices (from a scale of 0-5). Out of ten, five cultivars viz, VRIBH-03, VRIB-01, VRIB-04, Cluster king and Dilnasheen were subjected for the invasion and development of *M. incognita*. All the varieties showed variability in their response to *M. incognita* infestation. Maximum invasion and development of nematodes was recorded in Dilnasheen followed by VRIBH-03 and Cluster king. Minimum invasion and development was recorded in VRIB-04. Root weight had direct relationship with the number of developing *M. incognita*.

2012, Vol. 30(2): 169-178

Nematicidal effect of root extract of certain medicinal plants in control of *Meloidogyne incognita* in *in vitro* and *in vivo* conditions

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In the present study aqueous extract of medicinal plants viz., *Amaranthus spinosus*, *Chenopodium album*, *Catharanthus roseus*, *Solanum nigrum* and *Ocimum sanctum* were investigated for their nematicidal activity against second stage juvenile of *Meloidogyne incognita* by in vitro technique. Aqueous extract of all plant roots exhibited nematicidal activity. LC50 values calculated as 1024 ppm for *C. roseus*, 1867 ppm for *S. nigrum*, 1968 ppm for *A. spinosus*, 3428 ppm for *C. album* and 962 ppm for *O. sanctum*. LC50 values showed that out of these extracts *O. sanctum* found to be the most effective. In vivo experiment was conducted to study the effect of root extract of *O. sanctum* on *M. incognita* infecting French bean. Different concentrations viz., 10000 ppm (S), 5000 ppm (S/2), 2500 ppm (S/4), 1250 ppm (S/8), 625 ppm (S/16) and 312.5 ppm (S/32) of aqueous extract of *O. sanctum* roots was applied by seed soaking and foliar spray methods.

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Nematicidal activities of chromatographic fractions from *Alstonia boonei* and *Bridelia ferruginea* on *Meloidogyne incognita*

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The leaves of *Alstonia boonei* (de Wild) and *Bridelia ferruginea* (Benth) were air dried at ambient temperature (27 °C) and subjected to successive cold extraction using n-Hexane, Ethyl acetate and Ethanol. Thirty grams from the resulting crude extracts were further subjected to open column chromatography on silica gel (100-120 mesh grades) using glass column. The chromatographic fractions were tested in vitro along with their crudes and carbofuran on *Meloidogyne incognita* juveniles and eggs. The fractions were significantly effective in causing juvenile mortality. 75% concentrations of fraction being more active and showed significant differences from other concentrations. Fractions from *A. boonei* were significantly ($p < 0.05$) effective in the first hour of exposure to *M. incognita* juveniles with a percentage mortality of 48.62% which was not significantly different from carbofuran. At 4th and 6th hour of juvenile exposure to treatment, fractions from *A. boonei* were significantly ($p < 0.05$) more effective than carbofuran with a percentage mortality of 67.87 and 72.57% against carbofuran with 63.77 and 69.31% mortality, respectively. Mortality increased with increase in exposure time. The fractions were also as effective as carbofuran in inhibiting egg hatch, but there was minimum inhibition among the crude extracts. Spectroscopic analyses revealed that the fractions contain organic compounds that are nematicidal in nature which include phenols, carboxylic acids, aliphatic hydrocarbons, aldehydes, anhydrides, amides, mono and di substituted aromatics and long chain carbon fatty acid esters.

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New records of *Boleodorus* Thorne, 1941 from *Berberis vulgaris* L. in Iran

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Nematode fauna associated with barberry (*Berberis vulgaris* L.) was investigated and identified. Soil samples were collected in the spring and summer seasons of 2012 from rhizosphere of barberry in South Khorasan Province, Iran. The plant parasitic nematodes were identified on the basis of morphological and morphometrical characters. In this study, four species of *Boleodorus* Thorne, 1941 were identified. These species were *Boleodorus typicus* Husain & Khan, 1968; *B. impar* Khan & Basir, 1964; *B. volutus* Lima & Siddiqi, 1963 and *B. thylactus* Thorne, 1941. Except *B. thylactus* these species have recorded for the first time in Iran.

2013, Vol. 31(1): 1-9

Characterization of symbiotic bacteria associated with *Steinernema abbasi* (strain 507), *S. siamkayai* (strain 157) and *Heterorhabditis bacteriophora* (strain 1743)

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During phenotypic and biochemical observations three different species of bacteria viz., *Xenorhabdus indica*, *X. stockiae* and *Photorhabdus luminescens luminescens* were reported for the first time from Pakistan. They were associated with the infective stage juveniles of the entomopathogenic nematodes *Steinernema abbasi*, *S. siamkayai* and *Heterorhabditis bacteriophora*, respectively.

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Effect of medicinal plant extracts on physiological changes in tomato, inoculated with *Meloidogyne javanica* and *Fusarium oxysporum* f. sp. *lycopersici*

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The nematocidal and fungicidal effect of plant materials of two Iranian native plant species, *Ferulago angulata* and *Zataria multiflora* was evaluated. The interrelationship between *M. javanica* and *F. oxysporum* f. sp. *lycopersici* in susceptible local tomato, *Lycopersicon esculentum* Mill. was studied and their management by plant materials was evaluated in glasshouse conditions. The effects of different parts of these two medicinal plants, on growth-related parameters, the chlorophyll content photosynthesis and gas-exchange parameters of tomato were also determined. Statistical analysis indicated a significant effect of tested plant extracts on all tested parameters. On the basis of these tests, in *Meloidogyne* infected plants, leaf powder of *F. angulata* at the rate of 0.4 percent was most effective on tomato growth parameters, whereas in case of plants infected with both pathogens, stem powder of *F. angulata* at the same rate was the best treatment. Data showed that chlorophyll a, b and total, were significantly increased by treating the *Meloidogyne* infected plants as well as the plants infected with both pathogens, with leaf powder of *Z. multiflora* at the rate of 0.2 percent. In this treatment, the amount of chlorophyll was considerably more than the uninoculated control plants. In case of intercellular CO₂ concentration (Ci), transpiration (E) photosynthesis rate (A), stomata conductance (Gs) and water use efficiency (WUE), the best treatments were leaf extract of *Z. multiflora* (0.4%), leaf powder of *Z. multiflora* (0.2%), leaf powder of *Z. multiflora* (0.4%) leaf extract of *Z. multiflora* (0.2%) and leaf extract of *F. angulata* (0.5%), respectively. The findings from this study suggest that the performance of *L. esculentum* can be improved by soil application of these plant materials. The results for the test of effects of different parts of plants on gall formation and reproduction rate of *M. javanica* on tomato plants, inoculated with nematode alone or combination of nematode and *F. oxysporum* f.sp. *lycopersici*, indicated a significant effect of plant materials on studied characters. On the basis of LSD test, stem powder of *F. angulata* at the rate of 0.4 percent was the most effective treatment in reducing the reproduction rate of the nematode, whereas the flower extract of this plant at the same rate significantly reduced the gall and egg-mass numbers.

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Investigations on mass production of the potato rot nematode, *Ditylenchus destructor* (Thorne, 1945) using different monoxenic cultures

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The reproduction of an Iranian population of *Ditylenchus destructor* Thorne, 1945 was investigated in different media under laboratory conditions to identify the best medium and fungal host for mass production of this nematode. Four media, including three handmade PDA media (Potato Dextrose Agar), prepared from extracts of three cultivars of potato (Santana, Ramos & Maradona) and one medium of OMA (Oat Meal Agar), were used as substrates to grow fungi isolated from potato fields, including different anastomosis group of *Rhizoctonia solani* (AG3, AG4, AG5, AG6, AGD, AG9), *Phytophthora capsici*, *Botrytis cinerea* and *Fusarium oxysporum* f.sp. *lycopersici*. These fungal cultures were then inoculated with the nematodes and maintained at 20 and 25 °C. The results showed that the nematode fed and reproduced more on *R. solani* (AG3, AG4 and AGD) and *F. oxysporum* f.sp. *lycopersici* than on other fungi.

However, *R. solani* (AG3 and AG5) and *P. capsici* at 25 °C were also suitable for mass production of this nematode. The reproduction of the nematode was greater at 25 °C than at 20 °C.
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Evaluation of some cucurbitaceous rootstocks for resistance or susceptibility to root-knot nematode and fusarium wilt under greenhouse conditions

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Southern root-knot nematode, *Meloidogyne incognita* and Fusarium wilt *Fusarium oxysporum* are the most serious soil borne diseases of cucumber. The present study aimed to evaluate some cucurbit rootstocks for their resistance and/or susceptibility to root-knot nematode and fusarium wilt fungus in two successive seasons (2009 and 2010) under greenhouse conditions. Data indicated that in autumn season, winter squash (*Cucurbita maxima*) was highly resistant and resistant when the pots were inoculated with *M. incognita* only or nematode plus fungus, respectively. *Lagenaria siceraria* rootstock was moderately resistant in both cases of inoculation. Other rootstocks were susceptible to nematode or nematode plus fungus except *Cucurbita ficifolia* and *Luffa aegyptiaca*, which were highly susceptible to nematode only. While, in spring season, *Benincasa hispida* and hybrid 6001 were moderately resistant to infection by the root-knot nematode. Other rootstocks were susceptible to nematode or nematode plus fungus except *Luffa acutangula* and *Cucumis sativus* var. Hesham which were highly susceptible. The results obtained on the enzyme content showed that some cucurbit rootstocks exhibited the highest content of polyphenoloxidase, peroxidase and lignin contents being the lowest in some rootstocks. Significant and highly significant reductions in shoot and root fresh weights, root and shoot lengths were recorded in most cucurbit rootstocks in autumn and spring seasons as a result of nematode, nematode plus fungus or fungus infections compared to non-infected rootstocks.

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Combined effect of *Pasteuria penetrans* and neem extract on the development of root-knot nematode in medicinal plants

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Medicinally important plant babchi (*Psoralea corylifolia* L.) is highly susceptible to root-knot nematode (*Meloidogyne incognita*) infection. Study was conducted to access the potential of *Pasteuria penetrans* and neem extract alone and in combination on *Meloidogyne incognita*. All treatments significantly reduced the nematode infection as compared to control. Infection was least when *P. penetrans* and neem extract applied in combination. It gave maximum increase in shoot weight, shoot length and reduction in the root weight. Minimum number of juveniles per root system was observed in case of combined application of *P. penetrans* and neem extract.

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Effect of certain abiotic and biotic materials on the mortality of *Meloidogyne incognita*

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The study was conducted to test the direct effect of different concentrations (1250, 2500, 5000, 10000 and 15000 ppm) of the abiotic materials, γ -amino-n-butyric acid (GABA), chitosan, salicylic acid and acetyl salicylic acid and the biotic agent, *Pseudomonas fluorescens* at S, S/2, S/10, S/20, S/50 and S/100 for 24, 48 and 72 hr on the mortality percentage of *M. incognita* juveniles. Results revealed that the percentages mortality and net mortality were positively correlated with the concentrations and exposure period of all tested materials.

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Evaluation of some black and yellow seed-rape against *Rotylenchulus reniformis* and other Tylenchids coinhabiting seed-rape field in Egypt

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Thirty eight imported oil seed-rape cultivars were evaluated for their relative susceptibility against the reniform nematode, *Rotylenchulus reniformis* and other tylenchids under field conditions. Statistical differences ($P \leq 0.05$ and 0.01) in varieties were found in either final nematode populations or the yield components. The potential of each cultivar to support reproduction of the reniform nematode or other tylenchids was calculated in relation to that of Sedo cv or Semu DNK 86/233 cv, respectively which were regarded as check cultivars. The tested cultivars were classified for their susceptibility against *R. reniformis* as follows: Tower was rated as immune cultivar, while Drakkav, Gloda, Gloda Semu 250/84, Moneta Semu 249/84, Anima Semu 204/83, Semu DNK 235/84, Semu DNK 239/84, Semu DNK 240/84, Semu DNK 85/201, Semu 2080, PF 1/85, PF 2/85 and PF 550/86 were graded as highly resistant. Candle, Hanna, Silva, Duplo, Lirasol, Loras, Topas, Semu DNK 242/84, Semu DNK 246/84, Semu DNK 85/202, Semu DNK 264/84, Semu DNK 232/83 and Semu DN 205/82 were rated as resistant cultivars. Six cultivars graded as less susceptible viz., Global, Semu DNK 249/84, Semu DNK 248/84, Semu DNK 204/83, Semu DNK 232/84 and Semu DA 15/81 cultivars. Only PF 2886/85 cv was categorized as moderately susceptible. On the other hand, four cultivars viz., Sedo, Semu DNK 265/84, Semu DNK 206/84 and Semu DNK 86/233 were ranked as highly susceptible cultivars. It was observed that reproduction of nematode was favored on highly susceptible and susceptible cultivars but inhibited on resistant ones. Therefore, all tested cultivars showed great variability in their reaction to the nematode infection according to the host type. The different yield components of oil seed-rape varieties were also discussed. Finally, the differences among the tested cultivars should serve as a good resource for plant breeders and cropping systems to limit the loss due to the nematode infection.

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Efficacy of soil solarization and post-planting mulch on control of root-knot nematodes

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Experiments were carried out in naturally infested soil with root-knot nematodes, *Meloidogyne* spp., in the summer season of 2005 and 2006 at two locations in Beheira governorate, Egypt. Five different color polyethylene sheets (transparent, red, black, green and blue) were used to cover the naturally infested soil as a solarization and post-planting mulch. Reduction in number of galls, egg-masses, females/root system and number of second stage juveniles (J2)/250 g soil was recorded as compared to untreated control. The highest reduction percentage of total nematode population and reproduction rates of *Meloidogyne* spp., were occurred

in transparent sheet compared to the others. Tomato plant growth parameters were also markedly enhanced in different color sheets.

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Biocontrol of root-knot nematode by arbuscular mycorrhizal fungi in *Luffa cylindrica*

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Experiment was conducted to evaluate the efficacy of arbuscular mycorrhizal (AM) fungi (*Glomus* spp. and *Gigaspora* spp.) as bioprotectant against root-knot nematode *Meloidogyne incognita* in sponge gourd (*Luffa cylindrica* (L.) Roem.), mycorrhizal plant of family Cucurbitaceae. All parameters were estimated in roots, shoot and leaves of mycorrhizal and non mycorrhizal plants. Physical/biochemical and carbon profile were taken into account. Comparative study clearly indicates the significant variations in all parameters. Leaf area and plant height were increased in mycorrhizal plants than non-mycorrhizal, while it showed a sharp decrease in nematode infected plants, same plants also showed less water content due to xylem vessels damage. However, in mycorrhizal plants, roots had large amount of carbohydrates indicating transfer of photosynthates to fungal partner. Nematode infected roots have least amount of carbohydrates showing a great sink of carbon to rhizosphere.

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Seasonal dynamics of phytonematodes associated with olive cv. Toffahi affected by soil temperature and moisture

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Seasonal dynamics of the reniform nematode, *Rotylenchulus reniformis* in soil and roots and the spiral nematode, *Helicotylenchus* sp. in soil of olive (*Olea europaea* L.) cv. Toffahi over one year were analyzed. Population densities of both nematodes reached higher populations in spring with the onset root growth through summer and winter and significantly ($p \leq 0.05$) declined in autumn revealing that these nematodes were negatively correlated with the prevailing soil temperature ($^{\circ}\text{C}$) and were positively correlated with percentage soil moisture at different sampling months and seasons. Correlation coefficients (r) were calculated to ascertain these relationships.

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Genotypic response of different potato cultivars against *Meloidogyne incognita*

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The use of resistant genotypes is an attractive alternative for managing yield losses caused by plant parasitic nematodes. Experiments were designed to identify resistant potato germplasm against root-knot nematode, *Meloidogyne incognita*, at Faisalabad, Pakistan. Ten potato cultivars, replicated five times in RCBD layout, were sown in a sick plot infested with *M. incognita*. Root-knot nematode reproduction and host damage were assessed by recording root galls, egg-mass indices, root weight, shoot weight, number of leaves,

fruit weight, rate of reproduction and final population of nematodes. The data revealed considerable variation in response against *M. incognita* among the genotypes tested but none of the cultivars was immune. The cultivar FD-8-1 was highly susceptible. Other nine cultivars had lesser galling index, with low fecundity = indicating their ability to restrain the adult female reproduction. The cultivar FD-61-3 scored least number of root galls and egg-mass indices.

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In vitro mortality of root-knot nematode *Meloidogyne incognita* from lac based chemicals

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In vitro two lac based chemicals viz., 9-hydroxy Δ^2 -nonenoic acid (synthesized from aleuritic acid, a major component of lac) and its methyl ester was evaluated against juveniles (J2) of *Meloidogyne incognita*. Nematicidal activity of 9-hydroxy Δ^2 -nonenoic acid (HNA) and its methyl ester (MENA) was dependent on dose and exposure time. The mortality rate was increased as concentration increases from 62.5 to 1000 ppm. Maximum mortality was recorded after 72 h of methyl ester in comparison to 9-hydroxy Δ^2 -nonenoic acid over the control due to increase in lipophilic character of methyl ester which might have dissolved the lipid layer of nematode cuticle causing death.

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Plant parasitic nematodes from rhizosphere of saffron (*Crocus sativus* L.) with two new records of *Geocenamus squamatus* and *Filenchus pratensis* from Iran

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For the investigation and identification of plant parasitic nematodes associated with saffron, 88 soil samples were collected in the autumn of 2012 from the rhizosphere of saffron in different areas of southern Khorasan province, Iran. Nematodes were extracted by centrifugal flotation technique. The extracted nematodes were transferred to glycerine for preparing permanent slides. Then plant parasitic nematodes were identified by using morphological and morphometric characters. In this study, a total of 30 species of nematodes were identified. Among them, two species viz., *Geocenamus squamatus* and *Filenchus pratensis* are recorded for the first time in Iran.

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Intraspecific variations and phylogenetic relationships among heat tolerant strains of *Steinernema siamkayai* (Rhabditida: Steinernematidae) from Pakistan

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The genetic diversity and phylogenetic intraspecific relationship among thirty heat tolerant strains of *Steinernema siamkayai* from Pakistan were investigated during summer season. DNA fragment lengths of

amplified ITS region obtained from eighteen *Steinernema* strains ranged from 742 to 1009 bp (182 bp nucleotide difference). There were high intraspecific variations among the Pakistani strains detected from different regions of Pakistan 0.01 to 0.09 %. However, the fragment length of twelve strains of amplified 12S rDNA gene ranged from 500 to 594 bp. The intraspecific variation of the sequences ranged from 0.02 to 0.07 % (94 bp nucleotide difference). Phylogenetic relationships based on both molecular makers ITS rDNA and 12S rDNA gene was constructed by using Bayesian Interference (BI) and Maximum Parsimony (MP) tree. Both the rDNA ITS1 and 12S rDNA genes sequences are useful for resolving relationships among *S. siamkayai* strains. The highest survival rate for heat tolerance was observed in PAK.S.S.38 (5600±5.5 IJs/ml) at 39.5 °C. In *Galleria mellonella*, the mortality % was 100±2.8 in PAK.S.S.58 and the reproduction rate was 1018.8±5.5 (IJs/mg larvae) in PAK.S.S.38 strain. The mortality % and reproduction rate was found maximum in PAK.P.S.80 of *Planococcus ficus* (95.74±2.8; 223.3±2.8 IJs/mg larvae).
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A comparative study of the efficacy of *Paecilomyces* species against root-knot nematode *Meloidogyne incognita*

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Three *Paecilomyces* species viz., *Paecilomyces variotii*, *P. lilacinus* and *P. fumosoroseus* were examined at various intensity levels to manage root-knot nematode *Meloidogyne incognita*. Unlike *P. fumosoroseus*, increasing concentrations of *P. variotii* and *P. lilacinus* culture filtrates considerably inhibited egg-hatching and sustained juvenile transience. Increase in shoot and root weights were observed after applying biocontrol agents *in vitro* and *in vivo* on mungbean (*Vigna radiata*).

Significant reductions in number of galls per root system as compared to the control treatment were observed when isolates of *P. variotii* and *P. lilacinus* were used. A variation in the efficacy of local isolates of *P. variotii* was also evident.

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Different appearance in broad bean stocks attacked by *Rotylenchulus reniformis* and *Pratylenchus* spp. in Giza, Egypt

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The stocks of twenty broad bean (*Vicia faba* L.) were screened for their relative susceptibility against the reniform nematode, *Rotylenchulus reniformis* and lesion nematode, *Pratylenchus* spp. The experiment was performed under a clay field conditions, pH 8.1 located at the western Experimental Station of the Faculty of Agriculture, Cairo University, Giza. Significant differences ($P \leq 0.05$ and 0.01) in the evaluated stocks are found in both parameters viz., final nematode populations and the plant growth and yield components.

The potential reproductive index (PRI) of each stock to support increase of *R. reniformis* and *Pratylenchus* spp., was estimated in relation to that of L 348 or G 3, respectively which were regarded as check stocks and the host category (HC) based on PRI of each cultivar was recorded. In this regard, the stocks could be rated for their susceptibility against *R. reniformis* as follows: Seven stocks, L 57, L 47, L 46, L 92, L 49, L 99 and L 375 were categorized as highly resistant (HR) to the nematode. L 71, L 13, G 429 and G 3 stocks were considered as resistant (R). Four stocks L 9, L 52, L 16 and L 24 were graded as less susceptible (LS). Only L

31 was rated as moderately susceptible (MS). On the other hand, four broad bean stocks L 348, L 241, L 101 and L 50 were categorized as highly susceptible (HS) to nematode infection. As for the response of twenty stocks to the *Pratylenchus* spp., L 57, L 31, L 99, L 101 and L 50 were considered as (HR). L 52, L 47, L 46 and L 375 stocks were rated as (R). Also, five stocks L 71, L 348, L 241, L 92 and L 49 were categorized as (LS). L 9, L 16, L 24 and L 13 stocks were rated as (MS). In contrast, two broad bean stocks G 429 and G 3 were rated as (HS) to the lesion nematode infection. It was noticed that build-up of nematode was favored on highly susceptible and susceptible cultivars but suppressed on resistant ones.

Therefore, all stocks evaluated showed great variability in their reaction to the nematode infection based on the host type. Plant growth parameters and yield components of broad bean stocks were also discussed.

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Genetic diversity assessment of cereal cyst nematode resistant wheat genotypes using different molecular marker systems

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Investigations were conducted to estimate the genetic diversity of wheat germplasm. Random Amplified Polymorphic DNA (RAPD) and Simple Sequence Repeats (SSRs) were employed for this purpose. Six cereal cyst nematode (CCN) resistant wheat genotypes viz., TD-1, SD-8006, Marvi-2000, Moomal-2002, Inqilab-91 and Bhattai were found to be genetically diverse on the basis of RAPD analysis using 14 deca-mer primers. Inferences have indicated that the most diverse genotype was Moomal-2002 as compared to the rest of the genotypes studied and the most effective loci to screen diversity was found to be OPA-09. Forty six SSR primers performance expressed that the genotype (Marvi-2000) was the most diverse and it was also identified as the most resistant genotype against CCN. It is therefore recommended to introduce Marvi-2000 in the breeding program for wheat improvement against CCN.

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Phytonematodes associated with peach (*Prunus persica* L.) seedlings in Balochistan, Pakistan

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Sixty six rhizosphere soil samples of peach seedlings were collected from six nurseries of Khuzdar and Kalat districts of Balochistan from December, 2012 to February, 2013. Eight different phytonematodes were found associated with the seedlings. The most predominant nematode was *Helicotylenchus pseudorobustus* and the least frequent were *Meloidogyne javanica* and *Tylenchorhynchus annulatus*. A matrix of similarities with respect to nematode species assemblages, for the six nurseries is given.

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Integrated approaches of phytonematodes management by organic soil amendments and ploughing

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In a field study the efficacy of various organic amendments, ploughing and nematicides were evaluated against population build up of phytonematodes on carrot crops. The integrated application of organic amendment and ploughing was found very effective to control the phytonematodes, infecting carrot plantations. The soil populations of phytonematodes were significantly reduced by integrated application of organic amendment and ploughing. As a consequence of nematode suppression, plant growth characters of carrot plants were improved. The efficacy of these treatments was enhanced in deep ploughed beds as compared to normal ploughed beds.

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Control of *Meloidogyne javanica* and *Fusarium solani* in chilli (*Capsicum annuum* L.) with the application of chitin

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The chilli crop in Pakistan is attacked by a number of pathogens. Root-knot nematode (*Meloidogyne javanica*) and root-rot (*Fusarium solani*) are the most serious diseases that attack chilli crop. Chitin amendment is recommended as a safe and commercially applicable method for controlling soil borne pathogens. The main objectives of the study were to examine the effectiveness of chitin for the management of soil borne diseases of chilli plant by different methods i.e., soil amendment and transplant root dip method. Results indicated that of the two methods, soil amendment was more effective in contrast to transplant root dip method.

2013, Vol. 31(2): 165-170

Survival analysis of infective juveniles of Pakistani EPN strains (Steinernematidae and Heterorhabditidae) for mass production

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Laboratory investigations were carried out to study the survival of entomopathogenic nematodes of the genera *Steinernema* and *Heterorhabditis* of eight Pakistani species viz., *Steinernema pakistanense*, *S. asiaticum*, *S. abbasi*, *S. siamkayai*, *S. carpocapsae*, *S. feltiae*, *Heterorhabditis indica* and *H. bacteriophora* at different time durations and temperatures in distilled water. Effect of soil medium and different temperatures on survival of IJs in infected cadavers was also observed. When time period increased both species of steinernematids and heterorhabditids at room temperature showed static behaviour. At room temperature after 30 days 90 ± 1.5 , 67 ± 2.0 , 65 ± 1.0 , 75 ± 1.0 , 57 ± 1.5 , 15 ± 2.0 , 60 ± 1.5 and 62 ± 1.0 IJs of all species remained active. As time period passed the activeness of *S. feltiae* ceased at 32 ± 2 °C. Freshly harvested IJs of eight Pakistani species of entomopathogenic nematodes were exposed to four different temperatures viz., 20 ± 2 , 25 ± 2 , 32 ± 2 and 38 ± 2 °C. *S. pakistanense* found to be most temperature tolerable species. In soil medium, after 2-6 weeks high proportion of infective juveniles were found viable except *S. feltiae*, may be due to exposure of temperature none of the IJs viable at the entire period. Effect of four different temperatures on survival of IJs in infected cadavers showed that IJs failed to produce at 20 ± 2 and 25 ± 2 °C and survived at 32 ± 2 and 38 ± 2 °C. For continual commercialization of these nematodes in the field, it is important to examine the behaviour and survival of IJs at extreme environmental conditions because specific survival mechanisms employed by different species of EPN.

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Evaluation of groundnut germplasm for resistance against root-knot nematodes

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An experiment was conducted to evaluate the local germplasms of ground nut. 71 germplasms of groundnut were examined against *M. arenaria* and *M. javanica*. Twelve germplasms were found to be highly resistant while sixteen were resistant. Moderately resistant germplasms were thirty three. Ten germplasm were susceptible. However, none were found to be either immune or highly susceptible.

2013, Vol. 31(2): 179-181

New host record of the genus *Porrocaecum* Railliet & Henry, 1912 (Nematoda: Anisakidae) from the bird *Egretta garzetta* in Hyderabad, Sindh, Pakistan

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During survey of helminth parasites of bird little egret *Egretta garzetta* (Aves: Ardeidae) of Jamshoro and Hyderabad Districts of Sindh, Pakistan; 28 (10♂ and 18♀) nematodes were collected from gizzard of 4 hosts. Specimens were first fixed in steaming 70% alcohol and later stored in glycerin-alcohol solution. Among all species of the genus *Porrocaecum* Railliet & Henry, 1912, present nematode has close resemblance with *Porrocaecum angusticolle* Molin, 1860 in all essential features and is identified as such. Molin (1860) described *Porrocaecum angusticolle* from stomach of the bird *Egretta alba* in Ukraine, Europe while, present species is recorded from gizzard of *Egretta garzetta* in Hyderabad, Sindh, Pakistan. *Egretta garzetta* is the new host record for the genus *Porrocaecum* Railliet & Henry, 1912. However, this genus is being reported for the first time from Sindh, Pakistan.

2013, Vol. 31(2): 183-186

Checklist of marine worms reported from Pakistani marine waters

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The Pakistani marine invertebrate fauna is poorly known. Nevertheless there has been good number of attempts to investigate and document the diversity of marine worms. Pakistan possesses a strong tradition in the study of parasites of domestic wildlife and marine vertebrates. For more than 50 years the helminth fauna of these Pakistani hosts has been studied by national parasitologists. This report is an attempt to compile all the worms reported so far from the Pakistan coast. The present annotated list is intended to help the growing number of scientists in and outside Pakistan who are interested in marine fauna, keeping them up to date as to what species are known, their current scientific names. This checklist summarizes information on the Pakistani marine worms contained in the world literature dating from 1866 to the end of 2012.

2013, Vol. 31(2): 187-280

Distribution and association of root-knot nematodes (*Meloidogyne* spp.) with tomato crop in Faisalabad District

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A detailed survey of tomato fields located in different parts of Faisalabad district was conducted to identify the association of root-knot nematode (RKN) species with tomato crop and to assess their infestation. Hundred and sixty-one samples from 23 locations scattered over the vegetable growing areas of four tehsils of Faisalabad district including Faisalabad, Chak Jhumra, Jaranwala and Samundri. The results showed that 87% of the tomato fields were infested. The incidence of RKN ranged from 0 to 100% with an average of 36%. The galling index (GI) was ranged between 0 to 5 with a mean of 3.0. RKN incidence and GI varied from field to field. The RKN incidence was 45%, 34.3%, 28.6% and 10.71%, in the tomato growing areas of Faisalabad, Jaranwala, Samundri and Chak Jhumra, respectively. *Meloidogyne incognita* and *M. javanica* were found singly or in combination among the tomato root samples. The presence of *M. incognita* was 75.8% and *M. javanica* 20.2%.

2014, Vol. 32(1): 01-06

Population dynamics of *Heterodera zae* under stress of a cropping sequence regime in Egypt

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Population dynamics of juveniles and cysts of corn cyst nematode, *Heterodera zae* under stress of a cropping sequence regime revealed that the average numbers in each stage greatly fluctuated. The density of juveniles or cysts gradually increased with the favorable host (Giza 2 corn) to reach its peak at the crop maturity, while the nematode population dropped sharply when the field became fallow. Likewise, the population densities of the previous stages declined gradually even though in the presence of the non host crop (Meskawi Egyptian clover).

2014, Vol. 32(1): 07-10

Plant parasitic nematodes (Tylenchida: Nematoda) in Turkey

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Plant parasitic nematodes, host association and distribution in different localities of Turkey have been surveyed. A total number of 240 nematode species of plant parasitic nematodes belonging to 56 genera of Tylenchida detected in Turkey. These nematode species found associated with 66 plants from 48 different localities of the country.

2014, Vol. 32(1): 11-31

Eco-friendly management of root-knot nematodes using acacia compost and bioagents in brinjal

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A field experiment was conducted in root-knot nematode infested plot to evaluate the efficacy of acacia compost individually and in integration with bioagents viz., *Pochonia chlamydosporia* and *Paecilomyces lilacinus*. Acacia compost, poultry manure and carbofuran were also tested. All the treatments were significantly superior over untreated check. Acacia compost enhanced the growth parameters with drastic reduction in root-knot index. However, the treatment combinations of acacia compost with different bioagents performed well with highest growth shoot, root length, root weight, yield and lowest root-knot indices.

Among the integrated treatments, *P. lilacinus* with acacia compost recorded maximum growth parameters and yield with least root-knot index. In contrast with other works of combination treatments of two bioagents, *P. lilacinus* + *P. chlamydosporia* with acacia compost registered high root-knot index and decreased growth parameters and yield among the other integrated treatments. Further, poultry manure and carbofuran were on par with all the parameters studied.

2014, Vol. 32(1): 33-38

Efficacy of plant oils and garlic cultivation on controlling *Meloidogyne incognita* infected tomato plants

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The efficacy of seven essential plant oils and cultivation of two garlic cultivars: Balady and Sods-40 were evaluated for controlling root-knot nematode, *Meloidogyne incognita* infecting tomato plants under laboratory, greenhouse and field conditions. Treatments with essential oils of arugula, camphor, castor, garlic, nigella, onion and sesame resulted in 48.0-92.7% reduction in numbers of root galls/root under laboratory conditions. Similarly, application of these oils resulted in great reductions of 59.2-92.8% and 47.4-89.6% in numbers of root galls and egg-masses/root when oils applied before and after transplanting of tomato seedlings, respectively. The highest reduction (%) of galls, egg-masses and reproduction of *M. incognita* infecting tomato plants were reached with Nemacure® (95.2-98.8%) and garlic oil was best control among the seven tested essential plant oils with 78.0-98.6% reduction. Moreover, a great reduction of nematode galls, egg-masses and juveniles/250 cc soil (93.6-97.5%) was reached on tomato seedlings, which transplanted in soil previously cultivated with either tested garlic cultivars. In the greenhouse experiment, values of reproductive factor (Rf) decreased as a result of garlic oil to reach (0.07- 0.23 and 0.16-0.34) before and after transplanting of tomato seedlings, respectively. Likewise, Rf values were sharply decreased to reach 0.032-0.041 in soil previously cultivated with garlic plants, in the field experiment. Moreover, applications of the seven tested essential plant oils and cultivation of garlic cultivars enhanced plant growth parameters to reach 34.9-80% increase as compared to the check treatment.

2014, Vol. 32(1): 39-50

Protecting cucumber from *Meloidogyne incognita* using graft onto resistant cucurbit rootstocks and antagonistic marigold as an alternative to nematicide

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The effect of cucumber grafting onto suitable and selected two rootstocks, wax melon, *Benincasa hispida* (grafted onto *Bh*) and *C. maxima* x *C. moshata* Ercola hybrid 6001 (grafted onto Ercola 6001), marigold (*Tagetes* spp.) as root antagonistic plant and Rugby as a nematicide (two formulation, Rugby 10G and Rugby 20L) for control of *Meloidogyne incognita* cucumber root-knot were evaluated in nematode naturally infested soil under greenhouse conditions in two successive spring seasons (2011 and 2012). Cucumber, *Cucumis sativus* var. Sinai was planted as a scion. Results indicate that cucumber plants grafted onto Ercola hybrid 6001, *C. maxima* x *C. moshata* (Ercola 6001) and *Bh* had highly significant less root galling, number of females and egg-masses than non-grafted and infested one. The reduction in number of galls ranged between Rugby 10G (47%) grafted onto *Bh* (98.3%) and Rugby 10G (30.2%) grafted onto Ercola 6001 (84.5%), respectively in two seasons followed by grafted onto Ercola 6001 and marigold and finally Rugby 10G. These results indicated that maximum reduction in number of females and egg-masses forming was on cucumber grafting onto resistant plant rootstocks *Bh*; grafting onto resistant plant rootstocks Ercola 6001, followed by

Rugby 20L, marigold and finally Rugby 10G, respectively as compared by nematode infested cucumber. Root-knot nematode (RKN) significantly decreased shoot plant height and leaf area, when they were grown in soil infested by RKN compared to infested plant (check). In addition, RKN infestation alone decreased the plant nematodes, in natural infested soil experiments in both seasons, data was non-significant. Plant and fruit characteristics; cucumber yields (number of days to first flower), fruit characteristics (fruits weight, length and diameter), total early fruits (first four gathering) and total fruit per plant were significantly improved in plant leaves compared with infested cucumber. Consequently, the shoot macro and micro-elements were increased compared with infested cucumber. The macro and micro-elements and chlorophyll contents were recorded but the variation between them were non-significant.

2014, Vol. 32(1): 51-58

Entomopathogenic nematodes (Steinernematidae, Heterorhabditidae: Rhabditida) of Turkey

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A total of 82 species of entomopathogenic nematodes (EPNs) has been identified worldwide belonging to *Steinernema* (65), *Neosteinernema* (1) and *Heterorhabditis* (16). This number is going up in parallel to new investigations. Five species of *Steinernema* and three *Heterorhabditis* species were identified in Turkey. There are only a few literature supports about detrimental effects of Turkey origin EPNs on maleficent groups having economical importance.

2014, Vol. 32(1): 59-65

Influence of poultry litter and rapeseed cake on infestation of *Meloidogyne incognita* on tomato in Dire Dawa, eastern Ethiopia

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Study was conducted at Dire Dawa, Haramaya University Research Station in naturally root-knot nematode infested soil to determine the influence of poultry litter and rapeseed cake application against root-knot nematode infestation in tomato var. Mraglobe. Five levels of poultry litter (control (0), 5, 10, 15 and 20 ton/ha) and three levels of rapeseed cake (control (0), 100, 200 kg/ha) was applied in experimental plot three weeks before transplanting the seedlings. The experiment laid in RCBD factorial arrangement. Application of poultry litter except 5 ton/ha significantly reduced eggs per egg-mass, root galling and final population of root-knot nematode at $p < 0.001$. Rapeseed cake at 200 kg/ha significantly reduced final population and eggs per egg-mass compared to control treatment at $p < 0.05$. Applications of poultry litter at 5 ton/ha to 15 ton/ha in combination with rapeseed cake at 200 kg/ha remarkably suppressed root-knot nematode infestation.

2014, Vol. 32(1): 67-72

Influence of the host age on development and virulence of *Heterodera zeae* in Egypt

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Four ages of corn *Zea mays* L., cultivar Giza 2 were used to evaluate its influence on infectivity, development and virulence of *Heterodera zae*. The results revealed that the nematode final population and rate of build-up correlated negatively with the host age. The nematode multiplied highly on the youngest seedlings; and was more virulent on the youngest than on the oldest plants.

2014, Vol. 32(1): 73-76

Nematicidal potential of *Faidherbia albida* fruit against *Meloidogyne javanica* on cowpea

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The effect of *Faidherbia albida* fruit powder and extract on root-knot nematode *Meloidogyne javanica* in the laboratory and screen house was investigated. Nematodes egg suspension at 100 eggs/5ml syringe introduced into each Petri dish containing both crude and diluted extracts of fruit powder (5, 10, 15 and 20 ml) except the control, which received only distilled water. Petri dishes were treated to the same concentrations of the extract in Petri dishes containing 1000 second stage juveniles of *M. javanica*. Egg hatch inhibition and larval mortality was observed over a period of 72 hrs. Sterilized loamy soil (4 kg) contained in 36 perforated plastic pots (30 cm dia. and 40 cm depth) were separately mixed with 0, 30, 40, 50 and 60 g (equivalent to 0, 10 15, 20 and 25 tons/ha) of the fruit powder. Carbofuran was applied at 0.060 g/pot. Control pots received no amendment. Two early maturing cowpea varieties EX-Gurin and EX-Yobe were planted separately into the pots containing the amendment. Pots were inoculated with 1000 J₂/pot. The results of the study showed that the crude extract gave better egg inhibition and 85% juvenile mortality. In the screen house pots treated with 25 t/ha gave better growth parameter, yield and better nematode control than the other treatments. It is suggested that field trial be conducted to determine the level of control before recommending to cowpea farmers.

2014, Vol. 32(1): 77-83

Potential of EPN in management of cotton bollworms in Pakistan

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Cotton is the most important cash crop of Pakistan and plays a vital role in the economy of country. It is attacked by insect pests including bollworms. These pests are controlled by frequent use of pesticides. However, the indiscriminate use of synthetic pesticides has disturbed agro-ecosystem and costs over US\$ 195 million per year to the nation in terms of environmental and social costs. Pathogenicity and efficacy trials of indigenous entomopathogenic nematodes (EPNs) isolates have positive results. Four EPN isolates viz., *Steinernema pakistanense*, *S. aiaticum*, *S. feltiae* and *Heterorhabditis indica* were assessed for their infectivity against the cotton bollworm complex in field. EPNs cultured on *Galleria mellonella* L. and stored in distilled water at 5 °C, were kept at room temperature for 24 hrs before use. The number of bollworms on plants before and 24 hrs after EPN spray @ 1000 and 2000 juveniles/ml water were assessed for mortality percentage. All four species of insects, viz., *Helicoverpa armigera*, *Earias insulana*, *E. vitella* and *Pectinophora gossypiella* were found susceptible to infective juveniles of the four EPN species; *S. pakistanense* was the most virulent EPN species. There is a dire need to focus further research on these EPN isolates to explore and exploit their potential as an alternative to synthetic pesticides in Pakistan, especially in IPM programmes.

2014, Vol. 32(1): 85-90

Characterization, phytochemical analysis and nematicidal activity of *Daniella oliveri* leaves against *Meloidogyne incognita*

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This study was carried out to identify and evaluate the nematicidal potential of *Daniella oliveri* leaves. The leaves of *D. oliveri* were air dried and extracted with n-hexane, there after acetone. The concentrated extracts were subjected to chromatography on a silica gel packed column. The nematicidal activity of the fractions were evaluated in the laboratory using a 4x4x3 factorial experiment, while the crude extracts were tested on *Meloidogyne incognita* infecting *Abelmoschus esculentus* in the field. Three hundred juveniles were used for the assessment. Acetone extract coded DNLO/Me₂CO caused a significant increase in plant height, number of leaves, number of fruits per plant and fruit weight per plant as compared with Carbofuran (p<0.05). In the laboratory, chromatographic fractions from acetone extract had the highest percentage juvenile mortality. The infrared analysis of the fractions revealed the presence of anhydride and carbonyl stretching frequencies at 3638, 1702, 1735 and 1771 cm⁻¹. The Nuclear Magnetic Resonance (NMR) of the fractions showed signals that agreed with ozoic and daniellic acids. Preliminary phytochemical screening of the leaves revealed the presence of flavonoids, steroids, terpenoids, reducing sugars, phenols, alkaloids, glycosides and carbohydrates. Nematicidal activity of *D. oliveri* leaves is being reported for the first time. The crude extracts and chromatographic fractions are potent at very low concentrations compared with standard carbofuran. Therefore, the leaves of *D. oliveri* could be employed as a viable source of natural nematicide instead of synthetic toxic nematicides.

2014, Vol. 32(1): 91-100

Nematicidal activity of *Citrullus colocynthis* extracts against root-knot nematodes

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The nematicidal activity of *Citrullus colocynthis* seed, pulp, fruit and creeper extracts were evaluated against root-knot nematodes (*Meloidogyne* spp.) at 28 ± 2 °C in laboratory. Gas chromatograph interfaced to a Mass spectrometer (GC-MS) results indicated that *C. colocynthis* contains various bioactive compounds. The mentholic extracts of seed had the highest mortality (100%) at highest exposure time (72 hrs) while, the pulp and fruit extracts showed 60 and 80% mortality, respectively. Among various extracts of creeper hexane extract (HH-CC) showed 100% mortality after 72 hrs at all concentrations as compared with standard carbofuran. Whereas, HE-CC and HWCC showed 100% mortality only at highest concentrations after 72 hrs. Ethyl acetate fraction was most active at highest concentrations causing 60% nematode mortality after 72 hrs. However, aqueous fraction (1 and 0.5) showed 40% mortality after 72 hrs exposure.

2014, Vol. 32(1):101-112

Nematodes associated with datepalm orchards of Kairpur district Sindh, Pakistan

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Nemicfauna survey from eight sites viz., Khairpur, Kingri, Kot Diji, Faiz Gunj, Thari Mir Wah, Gambat, Sobhoderi and Nara revealed that twenty five plant parasitic and seven free-living soil nematode species associated with date palm plantations in district Khairpur, Sindh, Pakistan. Population density and frequency of all nematodes varied considerably at all surveyed sites. Occurrence of plant parasitic nematodes was found high at Gambat (33.3%) and low in Kingri (15.38%). In free-living soil nematodes Nara has found high (10%) and low in Kingri (3.84%). The dendrogram indicated that there was 4 groups of 8 localities in relation to 32 nematode species. Morphological and taxonomical studies indicated that all nematode genera and species have been identified and recorded for the first time from date palm orchards of Khairpur district. *Merlinius nothus* Allen (1955) Siddiqi, 1980, is reported as a new record nematode species in Pakistan. It is briefly redescribed and illustrated herein.
2014, Vol. 32(1): 113-119

***Melilotus indica* and *Chenopodium murale* as new hosts of *Meloidogyne incognita* in Pakistan**

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Melilotus indica (sanji or yellow sweet clover) and *Chenopodium murale* (krund) were recorded as new hosts of root-knot nematode (RKN) in the area around the Plant Pathology Research Institute, Ayub Agricultural Research Institute, and Faisalabad, Pakistan. Yellow sweet clover and krund roots found moderately infested with root-knot nematode galls and whitish pear-shaped mature females were isolated from these root-galls. On these hosts, the most common and abundant species of root-knot nematode *M. incognita* (Kofoid & White, 1919) Chitwood, 1949 was identified on the basis of perineal patterns (Eisenback *et al.*, 1981). These new host records of *M. incognita* have not been hitherto reported in Pakistan (Zarina & Maqbool, 1991; Maqbool & Shahina, 2001; Khanzada & Khan, 2003; Zarina, 2004; Khan *et al.*, 2005; Erum *et al.*, 2005; Shahid *et al.*, 2006, 2007, 2008; Shahina *et al.*, 2009; Haq *et al.*, 2012).
2014, Vol. 32(1): 121-122

New records of plant parasitic nematodes *Nothotylenchus ferepolitor* and *Neopsilenchus paragracilis* from rhizosphere of *Allium cepa* in Iran

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In this study, 42 soil samples from onion fields of Razavi and Northern Khorasan provinces resulted 16 species of nematodes viz., *Psilenchus curcumerus*, *Ditylenchus apus*, *D. medians*, *Basiria gracilis*, *B. graminophila*, *Aphelenchus isomerus*, *A. avenae*, *Boleodorus thylactus*, *Zygotylenchus guevarai*, *Pratylenchus thornei*, *P. neglectus*, *Iranotylenchus clavidorus*, *Neopsilenchus magnidens*, *Neopsilenchus paragracilis*, *Nothotylenchus ferepolitor*, *Filenchus pratensis*. Among these species *Neopsilenchus paragracilis* and *Nothotylenchus ferepolitor* are new records in Iran.
2014, Vol. 32(2): 123-129

Induction of systemic acquired resistance in date palm plants against certain plant parasitic nematodes by some chemicals

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A field experiment was conducted at Faculty of Agriculture Farm in Giza Governorate, Cairo University, Giza, Egypt on clay loam soil planted to date palm cv. Zaghlool infested with plant parasitic nematodes, *Rotylenchulus reniformis* and *Helicotylenchus* sp. An experiment was carried out to investigate the efficacy of acetyl salicylic (ASA) and γ -amino-n-butyric acids (GABA) as chemical resistance inducer at the concentrations of 5, 10 and 20 mM against nematodes and consequently on date palm yield. The results showed that number of *R. reniformis* in soil and roots and *Helicotylenchus* sp., were reduced in soil one month after application at the harvest according to the tested concentrations as compared with control significantly ($p \leq 0.05$). GABA achieved at the highest and moderate concentrations the highest dates yield (%) increases (25.4 and 17.8%) as compared to ASA (16.2% and 12.9%), respectively. The lowest concentration from each material achieved the lowest result.

2014, Vol. 32(2): 131-136

Effect of *Pasteuria penetrans* against *Meloidogyne* spp., on peanut cultivars

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Twelve phytoparasitic nematode genera were found infected or associated with the rhizosphere of peanut plants. *Meloidogyne arenaria* was the most common nematode in all collected soil samples followed by *Tylenchorhynchus* spp., *Helicotylenchus* spp., *M. javanica* and *Pratylenchus penetrans*. All tested peanut cultivars were resistant to *M. incognita* race 2 and moderately resistant to *M. javanica*. Whereas, peanut cvs. Balady, Ismailia 1 and Giza 6 were found highly susceptible to *M. arenaria* race 1 and Giza 4 and Giza 5 cvs. were susceptible. The suppressive efficacy of using three isolates of *Pasteuria penetrans* (*Pp*) against *M. arenaria* race 1 infected peanut was tested through two microplot experiments during two growing seasons 2011-12. Treatments in 1st season with two concentrations of the three mixed *Pp* isolates caused the highest reduction of 74.8-86.9% in number of nematode root galls, egg-masses/root system and number of $J_2/250\text{ cm}^3$ soil compared with any single *Pp* isolate application. Meanwhile, all treatments in 2nd season with both concentrations of all *Pp* isolates either alone or as a mixed isolates resulted in 65.7-94.7% reduction in all nematode parameters. Treatments with high concentration of all *Pp* isolates either alone or as mixed resulted 61.4-72.2% encumbered J_2 in the 1st season and increased to 93.2-97.9% in the 2nd season. Treatments with two concentrations of mixed isolates and *PpT* isolate resulted in a significant increase of 51.7-77.0% in dry weights of shoot and root systems and number of peanut pods/plant, followed by treatments with the same concentrations of *PpB* and *PpG* isolates, which showed 32.7-48.5% increase. Number of bacterial nodules/root system was significantly increased with *Pp* treatments in both seasons. However, numbers of adherent endospores on J_2 cuticle were ranged 3.6-9.4 and 6.2-11.4 endospore/ J_2 in the 1st and 2nd season, respectively. High *Pp* concentrations resulted in the highest numbers of adherent endospores.

2014, Vol. 32(2): 137-147

Determining yield losses in rice cultivars resulting from rice white tip nematode *Aphelenchoides besseyi* in field condition

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This study was carried out to determine the effects of rice white-tip nematode *Aphelenchoides besseyi* on yield and yield components in the experimental fields of the Thrace Agricultural Research Institute, Turkey in 2012. Four rice cultivars commonly grown in Turkey were used in trial. The experiment was conducted as split plot in a completely randomized block design with four replications with treatments (naturally infected seeds, artificially infected plots, 5000 *A. besseyi* m⁻² and non-infected) as a main plots, cultivars (Halilbey, Gala, Tunca and Edirne) as a sub-plots were evaluated. In nematode-contaminated plots where it was seen that decreases of yield and weight of 1000 seeds found statistically important at the level 0.01 ($P < 0.01$). Compared to the control treatment, in naturally infected treatment cultivars Halilbey, Edirne, Gala and Tunca exhibited 26.7%, 15.8%, 15.6% and 8.1% yield decrease, respectively. In the artificially infected treatment cv. Halilbey, Edirne, Gala and Tunca exhibited 29.6%, 14%, 13.5% and 5.1% yield decrease, respectively. 2014, Vol. 32(2): 149-154

Organic control of phytonematodes with *Pleurotus* species

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The nematicidal ability of *Pleurotus ostreatus*, *P. florida* and *P. citronpileatus* against phytonematodes of vegetables was determined in this study. Crude extract from *Pleurotus* spp., were tested against *Pratylenchus*, *Xiphinema*, *Tylenchorhynchus*, *Tylenchus*, *Helicotylenchus*, *Ditylenchus*, *Psilenchus*, *Aphelenchus*, *Hoplolaimus*, *Longidorus*, *Aphelenchoides* and *Paralongidorus* spp. Extracts from the fruiting bodies, mushroom waste and broth culture of *Pleurotus* species at four different concentrations and three time intervals were tested against the nematodes. Nematodes killed by the application of crude extracts of *Pleurotus* species never recovered to life after placing in simple water. *P. citronpileatus* was found more effective than other species and it killed 100% nematodes after 24 hrs followed by fruiting body extracts of *P. florida* 99% and waste of *P. ostreatus* 77%. 2014, Vol. 32(2): 155-161

Distribution of the root-knot nematode *Meloidogyne* spp., in tomato greenhouses at Lattakia and Tartus Province in Syria

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A survey of 35 tomato greenhouses from Syrian provinces Tartus and Lattakia revealed the presence of *Meloidogyne incognita* and *M. javanica*. In Lattakia province, *M. javanica* was the dominant species (91%) and *M. incognita* found only once (9%). In Tartus province, *M. incognita* was the most prevalent species particularly in the southern parts (76%) and *M. javanica* occurred in several locations (24%) in northern Tartus. The majority of the sampled tomato cultivars were infected with two *Meloidogyne* species; once both species were detected on the same variety. 2014, Vol. 32(2): 163-172

Phylogenetic relationship of Pakistani entomopathogenic nematode strains on the basis of ITS-1, 5.8S and ITS-2, D2-D3/28S (LSU) rDNA region and 12S rDNA mitochondrial gene

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Entomopathogenic nematodes (EPNs) belong to families Steinernematidae and Heterorhabditidae have proved as extremely useful biological control agents and infected a wide range of insect pests. Phylogenetic relationships among Pakistani entomopathogenic nematode strains; steinernematids and heterorhabditid were estimated by nucleotide sequences using three molecular makers viz; ITS-1, 5.8S and ITS-2 rDNA (seventy nine); D2-D3 and 28S (LSU) sequences of rDNA region (fifteen) and 12S rDNA mitochondrial gene (twenty nine) to investigate the genetic diversity. Phylogenetic trees were constructed using two different methods maximum parsimony (MP) and Bayesian inference (BI) in which most of them form highly to moderately supported clades.

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Evaluation of inducers for tomato resistance against *Meloidogyne incognita*

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The potency of the some chemicals from different groups known as inducers of systemic acquired resistance (SAR) viz., acetylsalicylic acid (ASA), DL-3-aminobutyric acid (BABA), 2,6-dichloroisonicotinic acid (INA), 5-chlorosalicylic acid (CSA), nitrosalicylic acid (NSA), salicylic acid (SA), ascorbic acid (AS) and selenium (SE) in reducing development and reproduction of *Meloidogyne incognita* in tomato plants cv. Castel Rock was investigated under greenhouse conditions. All inducers were applied as soil drench to tomato plants grown in 25 cm-diam. earthen pots. Three days-before nematode inoculation time treatment maximized the efficacy of tested chemicals in reducing nematode galls, egg-masses and eggs numbers followed by synchronized addition with inoculation. While, post-inoculation treatment was less effective. Reiterative doses post-inoculation were improved the efficacy of single dose revealed that three doses remained more effective than one or two. While, differences between two or three time doses were insignificant. On the other hand, plant fitness was slightly impaired with third dose than second one. INA and SE showed pronounced effect in inhibition nematode population after third dose compared with the rest chemicals. However, three doses of SE were reduced plant fitness after enhanced by double doses. While, INA showed phytotoxicity gradually increased by repeating doses. Gathering between the most effective application time (before inoculation) and the proper activated dose after inoculation was studies for emphasized their action and comparing with pre-inoculation only in suppressing *M. incognita* population. Enzyme activity of both peroxidase and polyphenol oxidase were elevated in infected tomato roots than healthy ones. Chemical activators showed enhancing in these antioxidant activities, indicating the SAR four chemicals was occurred. In conclusion, CSA, NSA, BABA and SA have potential to suppress root-knot nematode infection in tomato plants through induced systemic resistance.

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Evaluation of rhizobacteria as resistance inducers or bio-control agents for the control of *Meloidogyne incognita* in tomato

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Bacterial strains *Bacillus brevis*, *B. cereus*, *B. firmus*, *Klebsiella planticola*, *Lactobacillus agilis*, *L. fermentum*, *Methylobacterium methanica*, *Neisseria elongata*, *Obesumbacterium proteus* and *Pseudomonas aeruginosa* recovered from tomato rhizosphere and tested for their ability to induce systemic resistance or bio-control agent against *Meloidogyne incognita* in tomato under greenhouse condition. Results showed that all tested bacterial strains showed significant reduction in nematode development and reproduction. The most effective strains were *M. methanica*, *B. cereus*, *B. brevis* and *O. proteus*. They were achieving the highest reduction in nematode total population and fecundity. Plant growth was improved as a result of application of rhizobacteria. Antioxidant enzymes activity for both peroxidase and polyphenol oxidase were elevated in bacteriazied plants as compared nematode infected plant as well as total phenol content. Results revealed that crude culture suspension of bacteria was more effective for reducing nematode population followed by cell-free culture filtrates, bacterial live cells and bacterial dead cells, sequentially. It was concluded that bacteria has induced tomato resistance or bio-control effects against *M. incognita* in tomato.

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Efficacy of garlic clove and oil aqueous extracts against *Meloidogyne incognita* infecting eggplant

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A green house experiment was conducted to control root-knot nematode *Meloidogyne incognita* infecting eggplant *Solanum melongena* with aqueous extracts of garlic *Allium sativum* mashed clove and oil. The plant materials were diluted with distilled water at concentrations of 2.5, 1.25 and 0.625% and drenched in each plot. Results showed that the plant extracts showed nematicidal and nematode-hatching inhibitory activity reduced nematode criteria including number of galls, egg-masses and hatched juveniles on roots of eggplant and number of juveniles in soil at harvest stage compared to untreated plants significantly ($p \leq 0.05$). Lower concentration of the tested materials caused higher percentages reduction the mentioned nematode criteria. Vice versa, increase in length of shoots, dry and fresh weights of shoots and roots occurred by higher concentration of each material followed by those occurred by moderate and lower ones. The percentages of total soluble carbohydrates, proteins, phenolic and carotenoid contents increased at all tested concentrations as compared to untreated plants, but no any relation among them.

2014, Vol. 32(2): 223-228

Effect of bromination and oxidation on the nematicidal potential of orange peel oil using *Pratylenchus penetrans* infecting maize

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Study was conducted to investigate the effect of oxidation and bromination of fresh and decomposed orange peels on the nematicidal potential of orange peel oil against *Pratylenchus penetrans*. Results showed that the oxidised/brominated orange peel oils were significantly effective at ($p \leq 0.05$) than ordinary orange peel oils and compared with the standard mocap. The decomposed orange peel oil was effective than the fresh peel oil and showed 51.42% mortality as compared to 39.38% after 24 hrs. Plants received brominated/oxidised oils were taller with better yields than untreated and nematode infested plots in the field. The GC/MS result indicated that the major constituents of the orange peel oils were limonene, octanal and citrionellol.

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Plant nematodes associated with grapevine seedlings and rootstock in Balochistan

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Sixty-six samples of seedlings and rootstock of grapevine were selected from 6 vineyards from two districts of Balochistan, Pakistan. Seven species of nematodes were found associated with the seedlings/rootstock including *Aphelenchus avenae*, *Helicotylenchus indicus*, *Hoplolaimus indicus*, *Meloidogyne javanica*, *M. incognita*, *Xiphinema americanum* and *X. index*. A matrix of similarity between six vineyard-nurseries was computed using Bray-Curtis index.

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Phylogenetic analysis and biological studies of entomopathogenic nematode *Steinernema abbasi* isolates

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In this study seven entomopathogenic nematode *Steinernema* isolates were examined using genetic analysis by ITS rDNA and 12S mtDNA. Phylogenetic analysis of these isolates was inferred by using four different methods i.e., Maximum Evolution (ME), Maximum Likelihood (ML), Maximum Parsimony (MP) and Neighbor Joining (NJ) based on the two makers. Sequence composition and phylogenetic analyses of these isolates showed closeness with *Steinernema abbasi*. On the basis of ITS rDNA region these seven Pakistani isolates were compared with seven worldwide isolates of *S. abbasi* and species of *bicornutum* group. While one isolate PAK.S.S.15 (JN599140) was analyzed using 12S mtDNA with other known species. In all four trees, isolate PAK.S.S.15 form monophyletic group with *S. abbasi* (AY944002). In laboratory experiment, biological life cycle of three isolates of *S. abbasi* PAK.P.S.9 (EF469773), PAK.S.S.15 (JN571086) and PAK.S.S.16 (JN571096) and one other isolate of *Heterorhabditis indica* PAK.S.H.56 (GU130179) were applied against fungus growing termite *Microtermes mycophagus* (D.). The study were also influenced by mortality; days to death, infection cycle length and reproductive potential. Highest mortality 100% was obtained on PAK.S.S.16 @ 75 IJs/cm². The strains PAK.S.S.16 and PAK.P.S.9 showed shortest 1.21 and 1.2 days to death in termites, while the isolate PAK.P.S.9 showed the shortest infection cycle length (4.65). Moreover, the strain PAK.S.S.16 showed highest rate of reproductive potential (830) than other three strains. The study was influenced by mortality; days to death, infection cycle length and reproductive potential. To elaborate biological life cycle, the results were presented using dendrogram of the association groups hierarchical cluster analysis.

2015, Vol. 33(1): 1-16

Identification and quantitative composition of nematicidal ingredients in leaves of some *Aloe* species

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Phytochemical and infrared analyses were carried out for eight *Aloe* species: *Aloe schweinfurthii* (ASF), *Aloe succrotina* (AST), *Aloe vera* (AVR), *Aloe chinensis* (ACS), *Aloe arborescens* (AAR), *Aloe keayi* (AKY),

Aloe macrocarpa (AMC) and *Aloe schweinfurthii* x *Aloe vera* (ASV) that showed nematicidal activity in *in vitro* on *Meloidogyne incognita*. The phytochemical analyses revealed that the *Aloe* species had similar phytochemicals: tannins, saponins, flavonoids, cardenolides, phenols, alkaloids and anthraquinones. However, total phenol (14.3 mg/g), tannins (14.5 mg/g) and saponins (59.8 mg/g) were highest in AKY than in other aloes. Flavonoid content (3.7 mg/g) was highest in AAR while alkaloid content was highest in AST. The infrared analyses revealed that the *Aloe* species had similar functional groups; amines, hydroxyl, unsaturated aromatic compounds, ketone, aldehyde and phenol. The nematicidal potentials of these *Aloe* species might be due to the type and quantity presence in these phytochemicals. The presence of the nematicidal principles identified in *Aloe* species used in the management of *M. incognita*.

2015, Vol. 33(1): 17-29

Histopathology of sweetpotato roots infected with *Meloidogyne incognita*

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Meloidogyne incognita infected roots of sweetpotato (*Ipomoea batatas* (L.) Lam.) were observed for histopathology changes included cellular disorganization in the root cortex, endodermis and vascular cells. Female nematode displaced root cells and occupied large cavities and the surrounding cells were compressed. The nematode induced formation of an average of four giant cells each with 7 ± 0.5 nuclei around the head of nematode close to vascular cells. Nematode eggs were seen in the cortical cells but more eggs were recorded near the root surface. Multiple infections were also observed.

2015, Vol. 33(1): 31-37

Efficacy of different bacterial strains against *Meloidogyne incognita*

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Study was conducted to determine the effect of *Meloidogyne incognita* on plant health and production of tomato in field. Various strains of bacteria were examined for their influence on shoot, root length, plant height, egg-mass, number of juveniles and number of knots per root system. Outcomes revealed that Controlled (C₁) *Meloidogyne* sp., *Bacillus* sp., (T₁), *Meloidogyne* sp., and *Bacillus thuringiensis* (T₂) remarkably suppressed nematode infestations because they act as growth inhabiting agents for juveniles; reduce gall masses, diminish knot formation on root system, together with increasing shoot and root length as compared to other treatments.

2015, Vol. 33(1): 39-46

Compatibility of *Heterorhabditis indica* with neem seed and kernel granules for suppressing *Meloidogyne incognita* infecting tomato

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A glass house experiment was conducted to study the effect of neem seed granules (NSG), neem seed kernel granular (NSKG) formulation and *H. indica* alone as well as their combinations on *Meloidogyne incognita* infecting tomato. Among the different treatments, combined application of *H. indica* @ 160 J₃/g soil +NSKG

formulation @ 1 g/kg soil followed by *H. indica* @ 160 J₃/g soil + NSG formulation @ 1 g/kg soil were found high to all other treatments in suppressing the *M. incognita* population (267 and 289 J₂/g soil) and thus, significantly ($P \geq 0.05$) less gall formation (237 and 361), respectively, as compared to untreated inoculated control (1368 galls per plant). Also the treatment of *H. indica* @ 160 J₃/g soil alone, reduced the number of galls (433) significantly in comparison with inoculated control (only *M. incognita* J₂/g soil). All the treatments resulted in improved plant growth characters such as root length, shoot length, root fresh weight and shoot fresh weight at $P \geq 0.05$ significance level in comparison with the treatments only *M. incognita* inoculum. 2015, Vol. 33(1): 47-55

***In vitro* nematocidal activity of some Aloe species extracts on eggs and second-stage juveniles of Meloidogyne incognita**

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The nematocidal activity of acetone extract (AE) and water extract (WE) of leaves and roots of *Aloe schweinfurthii* (ASF), *Aloe succrotina* (AST), *Aloe vera* (AVR), *Aloe chinensis* (ACS), *Aloe arborescens* (AAR), *Aloe keayi* (AKY), *Aloe macrocarpa* (AMC) and *Aloe schweinfurthii* x *Aloe vera* (ASV) on egg-hatching and mortality of second-stage juveniles (J₂) of *Meloidogyne incognita* was investigated *in vitro*. Extracts were tested at concentrations of 50,000 mg/kg and 25,000 mg/kg in an experiment laid out in completely randomized design in the laboratory. Data were collected on inhibition of egg-hatching, mortality of juveniles and analyzed using ANOVA ($P \geq 0.05$). Both concentrations of *Aloe* species extracts inhibited egg-hatching and second-stage juveniles mortality was observed significantly when compared with water control. The AE of AKY leaves at 50,000 mg/kg was the most effective in egg-hatching inhibited ($95.4 \pm 1.7\%$), followed by AVR ($94 \pm 0.8\%$) and AST ($88 \pm 1.4\%$). Water extracts of leaves of AKY, AVR and AST inhibited egg-hatching by $85.5 \pm 1.2\%$, $77.8 \pm 0.7\%$ and $81 \pm 1.3\%$, respectively. The AE of AKY, AVR, AST and WE of AKY leaves at 50,000 mg/kg were the most effective in J₂ mortality with 100% recorded at 48 hr after exposure to extracts. The AE extracts of AKY, AVR, AST and WE of AKY and AVR roots at 50,000 mg/kg had 100% J₂ mortality at 72 hrs. This study reveals that *Aloe* species have nematocidal activity and used in the management of *M. incognita*. 2015, Vol. 33(1): 57-69

Damage induced by root-knot nematodes and its alleviation by vesicular arbuscular mycorrhizal fungi in roots of Luffa cylindrica

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The effect of vesicular arbuscular mycorrhizal (VAM) fungi inoculated with nematodes in roots of *Luffa cylindrica* (L.) Roem was studied under greenhouse conditions. Six treatments were used; viz., C = Control, T₁ = VAM only, T₂ = nematodes only, T₃ = VAM and nematodes simultaneously, T₄ = VAM fungi one week before nematodes and T₅ = VAM fungi one week after nematodes. Damage produced by nematodes was observed in T₂ and T₅, vascular tissue obliterated by root-knot nematodes. However, VAM fungi suppressed the effects of root-knot nematodes in T₄. Giant cells, egg-masses and females of nematodes were observed in T₂, T₅ and to some extent in T₃. VAM fungi spores were seen in cortical as well as in pith region of root in T₃. 2015, Vol. 33(1): 71-78

Effect of *Meloidogyne incognita* on the growth characteristics of *Vigna mungo* treated with leaf extract of *Mimusops elengi*

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The present study was conducted to evaluate the effect of leaf extract of magilam, *Mimusops elengi* on the root-knot nematode, *Meloidogyne incognita* infecting the black gram, *Vigna mungo* with different inoculum levels (5, 10, 15, 20 and 25 egg-masses/plant) with different concentrations (5, 10, 15, 20 and 25 ppm). The control and treated plants were analyzed for various growth characteristics such as, root and shoot length, fresh and dry weight of root and shoot, leaf area, root gall index and chlorophyll content after 65 days. These growth characteristics found decreased with increasing inoculum levels of egg-masses and increased with increasing concentrations of leaf extract treatment and fresh and dry weight of root and root gall index found increased with increasing inoculum levels of egg-masses and decreased with increasing concentrations of leaf extract treatment.

2015, Vol. 33(1): 79-86

Damage threshold of *Meloidogyne arenaria* to common bean influenced by dates of planting

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Effect of root-knot nematode *Meloidogyne arenaria* was studied on common dry bean plants under natural infestation in the field at two different seasons of planting. In the first season, bean was grown in Autumn, 2012 while, the second season in early Spring, 2013. For the first season, the relation between nematode initial population density and bean yield was significantly negative ($r = -0.6$). A significant reduction in bean yield ($P = 0.05$) was obtained when nematode density was more than 100 J₂/200 g soil. While, damage threshold level (DT); nematode density at which yield begin to decrease; was estimated by 3 J₂/200 g soil. For the second season, no significant relation ($P = 0.05$) between nematode population density and bean yield was found ($r = 0.33$). DT was estimated as 22 J₂/200 g soil. Total protein and nitrogen element decreased in seeds of infected plants compared with those of healthy ones.

2015, Vol. 33(1): 87-92

Effect of amendments for the control of nematodes on peach seedlings

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The effect of several amendments was evaluated against nematodes associated with peach (*Prunus persica* L. Batsch) seedlings. Three major nematode populations were found in the soils including *Helicotylenchus pseudorobustus*, *Xiphinema americanum* and *Pratylenchus thornei*. Soil containing nematodes was collected from peach orchards near Kalat, Balochistan and filled in pots and peach seedlings were transplanted. Various soil amendments were applied including sawdust, sugarcane bagasse, neem (*Azadirachta indica*) leaf powder and marigold (*Tagetes erecta*) flower powder used alone and in combination with Fertinmakil. Untreated pots were kept as control. Carbofuran a chemical nematicide was used for comparison. Subsequently after 8 weeks nematode populations were studied. The results showed that amendments significantly influenced the nematode population though the nematode populations themselves did not differ significantly. The

effectiveness of various amendments was in the order Carbofuran > Fertinmakil > marigold + Fertinmakil > neem powder + Fertinmakil against *Helicotylenchus pseudorobustus*. With respect to *Xiphinema americanum*, Carbofuran > neem powder + Fertinmakil > marigold + Fertinmakil > neem powder. While, *Pratylenchus thornei* was best abated by Carbofuran > marigold + Fertinmakil > neem powder + Fertinmakil > marigold in that order. The role of different nematodes associated with peach is discussed. 2015, Vol. 33(1): 93-97

Prevalence of nematodes in different districts of Punjab, Pakistan

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During the survey a total 69 soil samples were collected from various agro-ecological areas with different cropping history in six districts comprising Mianwali, Bhakkar, Gujranwala, Sialkot, Gujrat and Mandi Bahauddin of Punjab province, Pakistan and assessed for nematode populations. Analysis of soil samples revealed the presence of eight genera of plant parasitic and soil nematodes. The most frequently isolated nematode population from all the soil samples were *Tylenchorhynchus* sp., *Xiphinema* sp., and *Cephalobus* sp. Prevalence of nematodes were high in districts Mandi Bahauddin and Gujranwala with soil cropping history of maize and rice cultivation. 2015, Vol. 33(1): 99-104

Comparative efficacy of *Trichoderma harzianum*, neem extract and furadan on *Meloidogyne incognita* infecting tomato plant growth

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Root-knot nematode *Meloidogyne incognita* (Kofoid & White) Chitwood is the virulent pathogen of tomato plants. The artificial inoculation of *M. incognita* developed a large number of galls and suppressed the tomato plant growth significantly. Three different concentrations of neem extract, furadan and *Trichoderma harzianum* were evaluated to control the *M. incognita*. All concentrations proved effective in reducing the disease development in nematode inoculated tomato plants. However, high dose of furadan became phytotoxic and plant growth was checked together with a number of galls. While, higher doses of neem extract and *T. harzianum* improved the plant growth. The combined applications of neem extract, furadan and *T. harzianum* were more effective than alone. In combined application also, the higher dose of furadan caused negative effects on plant growth. Present studies showed that incorporation of biocontrol agent like *T. harzianum* and botanical products such as neem extract against root-knot nematode provided good results and can provide an alternate of chemical pesticides which will be ecofriendly as well. 2015, Vol. 33(1): 105-112

Prevalence of root-knot nematode (*Meloidogyne* spp.) on sunflower in Malnad region of Karnataka

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Root-knot disease caused by *Meloidogyne* spp., on sunflower in severe form in Doddagatta village of Kadur taluk, Chickamagalur district and RKI up to 4 was found in many of the plants. It may be due to the adaptive nature of *Meloidogyne* spp., to different climatic conditions which has resulted in severe infection of sunflower plants. Soil analysis of sunflower field of the area revealed that the population of nematodes is very high (4 juveniles/g of soil). Amaranatha & Krishnappa (1990) reported *Meloidogyne* and other species of nematodes from Karnataka state.

2015, Vol. 33(1): 113-114

Review of the genus *Helicotylenchus* Steiner, 1945 (Nematoda: Hoplolaimidae) with updated diagnostic compendium

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A compendium of the genus *Helicotylenchus* based on 16 diagnostic characters to separate *Helicotylenchus* species viz., habitus, body length, ratios a, c, c', vulva position, DGO from base of stylet knobs, stylet length, shape of stylet knobs, shape of head, number of head annules, shape of tail, number of tail annules, position of phasmid in relation to anus, presence of male and female posterior genital branch is presented. These allometric and morphometric characters were derived from the original descriptions. An up to date list of 230 valid nominal species from world along with available illustrations and 32 species from Pakistan with diagnostic key is provided.

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First report of *Xiphinema rivesi* Dalmasso, 1969 on citrus in northern Egypt

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In a survey, specimens of dagger nematode (*Xiphinema* sp.) were collected from soil around the rhizosphere of citrus trees (*Citrus sinensis* (L.) Osbeck) with poor growth appearance and low yield from EL-Nobarria, EL-Behera governorate, northern Egypt, during 2012-13. Dagger nematode (*Xiphinema rivesi* Dalmasso, 1969) was identified on morphology of females that included female body and total stylet (odontostyle and odontophore) length, location of guiding ring and excretory pore from oral aperture, shape of head and tail including various tail measurements and vulva percentage in relation to body length. This is the first report of this nematode from Egypt, Africa. The values of the morphological parameters completely fall within the previously reported ranges for *X. rivesi*.

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Host status of some imported sugar beet varieties to *Meloidogyne incognita* in Egypt

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Ten sugar beet *Beta vulgaris* L., varieties were tested for their susceptibility/resistance against root-knot nematode *Meloidogyne incognita* under screen house conditions. All the tested varieties varied in their degree of susceptibility/resistance according to nematode damage index. Host vigor calculated as an average of percentages root weight potential and the tested technological characteristics (total soluble solids %) were used as a new scale to assess host reaction. The combination between the degree of susceptibility/resistance and host vigor of each variety gave a better evaluation and clear relationship between nematode infection and sugar beet variety yield quality and quantity. On this basis, sugar beet varieties were categorized into one variety as highly susceptible (BTS303), four varieties as susceptible (BTS 237, Gazelle, Meridi and SN627), one variety as highly resistant (Panther), three varieties as resistant (BTS301, BTS302 and SN626) and one variety as tolerant (Tenor). It is concluded that the tested sugar beet varieties differed in their susceptibility/resistance to root-knot nematode *M. incognita* depending on their damage index in combination with their plant vigor. The highly resistant or resistant sugar beet varieties determined in this study could be recommended for breeding programme and could be introduced in integrated pest management program of root-knot nematode.

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Histopathological changes caused by *Heterodera sacchari* in NERICA 1 rice roots

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The cyst nematodes (*Heterodera* spp.) are particularly damaging group of pests on a wide range of crops. *Heterodera sacchari* is an important nematode of rice (*Oryza* spp.) causing significant damage and yield loss in rice. This study was initiated with the major objective of understanding the histopathological changes caused by *H. sacchari* on susceptible NERICA 1 rice cultivar. Three-week old seedlings of NERICA 1 rice were inoculated with 5000 second-stage juveniles of *H. sacchari* and roots were obtained from rice at 7, 14, 21 and 24 days after inoculation (DAI). Infected roots were rinsed with tap water and fixed in formalin-propionopropanol. Fixed roots were dehydrated in graded isopropyl alcohol series. Roots were infiltrated with paraffin wax and embedded in molten paraplast. Root sections of 14 µm were cut with a rotary microtome and photomicrographs were taken. Infective second-stage juveniles of *H. sacchari* penetrated, developed and established multinucleate syncytia seven DAI. The number of syncytia observed near the head of each nematode ranged from two to seven. Extensive root damage and disorganization of epidermal, cortical and vascular elements occurred 14 and 21 DAI. Severe root cracks occurred and aggregation of matured white females along the root axis were observed 21 DAI. Large numbers of embryonated eggs were observed inside the females with extensive destruction of roots 24 DAI. Syncytia were observed in both cortical and vascular regions of the root.

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Effect of *Mimusops elengi* leaf extract on *Meloidogyne incognita* and biochemical changes of black gram

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The present study was conducted to evaluate the effect of leaf extract of *Mimusops elengi* on the root-knot nematode *Meloidogyne incognita* infecting the black gram *Vigna mungo* with different inoculum levels of egg-masses (5, 10, 15, 20 and 25). Plants treated with the leaf extract of *M. elengi* at different concentrations (5, 10, 15, 20 and 25ppm). The control and experimental plants were analyzed for various biochemical

constituents such as, carbohydrate, protein, amino acid, lipid, proline and phenol content after 65 days of treatment. Carbohydrate and protein were found decreased with increasing inoculum levels of egg-masses and increased with increasing concentrations of leaf extract treatment and lipid, amino acid, proline and phenol content found increased with increasing inoculum levels of egg-masses and decreased with increasing concentrations of leaf extract treatment.

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Host suitability of date palm seedlings to *Meloidogyne incognita* as influenced by stress of plant age

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The influence of date palm *Phoenix dactylifera* L., seedling age was determined on nematode reproduction to susceptible date palm cv., Sewi inoculated with root-knot nematode, *Meloidogyne incognita*. Seedlings of 4, 3 and 2 month old supported more nematode populations than 0 and 1 month old seedlings as indicated by number of galls and egg-masses on roots and juveniles in soil but they were rated as less affected by root-knot nematode depending their plant growth vigor. It is concluded that younger date palm seedlings seem to require root tissue maturation before expressing full resistance against root-knot nematode.

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Nematicidal activity of seaweeds against *Meloidogyne javanica*

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Root-knot nematodes (*Meloidogyne* spp.) are serious disease causing agents and attack nearly all types of plants. In this study 32 seaweeds were evaluated to determine nematicidal activity against *Meloidogyne javanica* (egg hatching and larval mortality tests) *in vitro*. Results revealed that seaweed biochemical potential in two different solvents viz., water and methanol @ ratios 2.5, 5 and 10%. It is observed that *Sargassum tenerrimum*, *Padina tetrastrum* and *Melanothamnus afaqhusainii* showed maximum egg hatching (96%) and larval mortality (99%) and (100%), respectively in water and methanol extract @ 10% concentration after 72 hours exposure time. Similarities between Ward's cluster analysis of hatching egg and larval mortality in water and methanol extract of different seaweeds showed significant difference. Methanol extract was more effective as compared to water extract. In conclusion, use of seaweeds is positive sign against harmful microorganisms which are responsible for considerable losses in agriculture yield.

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Effect of time on the degradation of *Pasteuria penetrans*-infected females of *Meloidogyne javanica* and the proportion of parasitized nematodes in the roots of tomato planted subsequently

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Different parameters were evaluated to confirm that how long *Pasteuria penetrans* infected *Meloidogyne javanica* females took to degrade and for spores to be released from the cadavers into the soil. Regression analysis was carried out to compare the degradation of *P. penetrans* infected females cadavers in different time intervals over two crop cycles. There were highly significant decreases in the total number of egg-masses per plant between the 3 weeks and other treatments. Infected females (%) over both crop cycles were compared by the estimated coefficients of the fitted lines and increased significantly with degradation period and significantly higher in the second crop. The 3 week duration apparently allowed more spores to disperse which was reflected in the observations of more infected female nematodes and reduced numbers of egg-masses and total females per plant compared with the first crop. The results of this experiment suggest that dispersal of spores from the degrading females occurs after 2 weeks and this is reflected in a significant reduction in egg-masses, galling and the female population between the 1 week and 3 weeks treatments. The greatest percentage of infected females and numbers of endospores were recorded in that treatment where *P. penetrans* infected females were left to degrade for 3 weeks.

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Population density of *Meloidogyne incognita* under stress of different cropping sequences

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Five different cropping sequences including cucumber, dry common bean, cowpea, maize and sesame plants replacing sugar beet for controlling root-knot nematode, *Meloidogyne incognita* resulted that sugar beet-Hybridmaize and sugar beet-sesame cropping sequences proved most effective against root-knot nematode as they reduced nematode parameters as indicated by the number of galls, egg-masses and hatched juveniles on roots. Consequently, they lowered rates of nematode population ranged from 0 and 0.01, respectively. However, the higher nematode populations were supported rest crops. It is concluded that use of poor or non host crops may be beneficial for controlling root-knot nematode population densities in intensive cropping system.

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Production of proline and other biochemicals as stress measures in mycorrhizal, biotic and abiotic factors in *Luffa cylindrica*

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Luffa is a genus of tropical and subtropical vines in the cucumber (Cucurbitaceae) family. Proline and other biochemical parameters effect was evaluated on bottle gourd (*Luffa cylindrica* (L.) Roem) in control, mycorrhizal and other biotic and abiotic soil components treated plants. Higher proline concentrations reflected in leaves of treated plants as compared with mycorrhizal treated plants. The decrease in shoot length, number of leaves and leaf area were observed in non mycorrhizal and plant treated with other biotic and abiotic stresses. Higher amount of proline was produced in non mycorrhizal and stressed plants in result of reduced availability of water and dry matter translocation to the shoots. The proline contents of *Luffa* leaves showed a vast difference in different treatments. It may be concluded here that proline is an indicator of environmental stresses imposed on plants.

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Meloidogyne graminicola an emerging threat to rice and wheat in Punjab province in Pakistan

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Meloidogyne graminicola causes heavy yield losses in rice ranging from 30% under field condition to 97% under green house conditions (Sharma *et al.*, 2005), it and was reported first time from Pakistan (Munir & Bridge, 2003). However, no comprehensive approach was applied to estimate the infestation and yield losses caused by this nematode in the rice belt of Punjab. We have observed its prevalence from last three years in rice-wheat cropping system in Faisalabad and Chiniot districts of Punjab. For this purpose, a survey was conducted in rice growing fields during September, 2014 from above mentioned districts. In this survey, 40 samples were collected from each district. Each sample was collected at 5 km distance. These samples were processed in Plant Nematology Laboratory in Department of Plant Pathology, University of Agriculture, and Faisalabad. Results showed 20% infestation rate in Faisalabad and 17% in Chiniot district. A comprehensive study on this emerging threat is going on to assess the prevalence, rate of infestation and yield losses caused by *M. graminicola* in the rice belt of Punjab, Pakistan.

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Two new records of plant nematode species from pomegranate gardens in southern Khorasan Province of Iran

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In nematological investigations of pomegranate gardens of Ferdows and Birjand cities ten plant parasitic nematodes species were identified on morphological and morphometrical characters viz., *Boleodorus thylactus*, *Filenchus cylindricaudus*, *Geocenamus tenuidens*, *Iranitylenchus clavidorus*, *Merlinius brevidens*, *M. communis*, *M. pistaciei*, *Neopsilenchus magnidens*, *Pratylenchus neglectus* and *Zygotylenchus guevarai*. Among these species *M. communis* and *M. pistaciei* are new records for nematode fauna of Iran.

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Taxometrical and numerical characterization of an isolate of *Steinernema abbasi* (Elawad *et al.*, 1997) with larger infective juveniles comprehensive from ITS1-5.8S-ITS2 region of rRNA

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In present investigation *Steinernema* sp. isolate CS₁ was identified with the aid of numerical taxonomy as an additional tool. Presence of two horn-like structures on head region of 3rd stage infective juveniles (IJs) placed the nematode in bicornutum group and differentiated from other compared *Steinernema* spp. The morphological characters of 3rd stage infective juveniles and 1st generation males showed close resemblance with *S. abbasi*, *S. thermophilum* and *S. pakistanense* however, the body length was varied (583mm vs 541mm, 555mm and 683mm, respectively). The morphometrical characters and life history events placed the present specimen near to the *S. abbasi*. Results obtained through the phylogenetic utility of maximum parsimony, maximum likelihood and neighbour joining methods and comparative account on nucleotides analyses based on ITSs study confirmed the present specimens as isolates of *S. abbasi*. The nucleotide composition resemblance within 5.8S gene with other *Steinernema* species evident the less polymorphism and highly conserved nature of this region as compared to ITS1 and ITS2 and delimit the relationship of steinernematid nematodes.

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Diversity of fresh water nematode fauna from different locations of Sindh, Pakistan

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Fresh water is natural source of water for drinking; domestic and industrial use which available primarily from melting of ice, rivers, streams ponds and ground. In Pakistan Indus River and its tributaries are the major sources of fresh water. Fresh water is clear from pollutants in upcountry, but as it flows downstream it becomes more pollutant. In the present study nematodes were selected as bio-indicators for these pollutants at eight localities of Sindh, which are Malir, Karachi; Kalri (Keenjhar) Lake, Thatta; Karachi Canal and Al-Manzar at River Indus near Jamshoro; Goth Detha Hyderabad; Khesana Mori near Tandojam; Mirpurkhas and Jamesabad (Kot Ghulam Mohammad). Samples from different sources of freshwater viz., river, lake, canal, tube well, pond and irrigation water chennal were examined for the prevalence of nematodes with an aim to disseminate the knowledge of fresh water nematodes as indicators in environmental monitoring. Detailed sample analysis revealed the presence of forty nematode species including three new species viz., *Bathyeurystomina minima* Nasira, Shahina & Shamim, 2014, *Belbolla longispiculata* Nasira, Shahina & Shamim, 2014 and *Metoncholaimus siddiqii* Shahina, Nasira & Shamim, 2015 while six species were reported as new records of Pakistan. These nematode species belong to 36 genera, 27 families and seven orders. Frequency of occurrence and distribution of nematode species varied from site to site. The overall occurrence (%) of fresh water nematode samples ranged from 3.22-32.25% at different sites. The highest number of positive samples was found at Malir, Karachi (32.25%) and the lowest was at Khesana Mori, Tandojam (3.22%). Free-living soil nematodes have more occurrences (55%) as compared to other group of nematodes. The occurrence (%) of nematode species at each site also varied considerably and ranged between 0.86-4.47% at Malir, Karachi; 1.93-5.79% at Kalri Lake, Thatta; 1.15-5.98% at Karachi Canal, Jamshoro; 1.58-5.93% at Al-Manzar, Jamshoro; 24-8.11% at Detha, Hyderabad; 2.33-8.84% at Khesana Mori, Tandojam; 1.71-5.57% at Mirpurkhas and 2.38-8.95% at Jamesabad. A similarity matrix based on the proportion of shared nematode community was used to establish the level of relatedness between the different sites. Two surveyed sites Karachi Canal and Al-Manzar at River Indus, Jamshoro were close to each other for the presence of fresh water nematodes as compared to other localities whereas, similarity for localities and nematode species ranged from 0.458 to 0.7 and 0.45 to 1.0, respectively. Ecological indices viz., Shannon's index, species richness, evenness and maturity index were used for monitoring environmental conditions of each sampling site. The two indices viz., diversity index and maturity index were lowest at sites, Jamesabad and Khesana Mori which can be considered as indications of stress at these sites.

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Distribution of the entomopathogenic nematodes in apple growing areas of Karaman, Turkey

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Study was conducted to determine the distribution of the entomopathogenic nematodes in apple growing areas in Karaman province, Turkey and their efficacy on *Galleria mellonella* (Lepidoptera: Pyralidae). Soil samples were collected from 130 apple orchards in April 2012 and 2013. Entomopathogenic nematodes were found in 25 samples (19.23%). Entomopathogenic nematodes species isolated: *Heterorhabditis bacteriophora* Poinar, 1976 (Rhabditida: Heterorhabditidae) (16.92%) and *Steinernema feltiae* (Filipjev, 1934) (Rhabditida:

Steinernematidae) (2.3%). Entomopathogenic nematodes distributed in low sand content and low-fertilized soils in Karaman province. The efficacy of *H. bacteriophora* and *S. feltiae* on *G. mellonella* was 100% after 72 h with 50 infective juveniles at 25 °C.

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Root-knot nematode (*Meloidogyne* spp.) on coriander under shade net condition from Karnataka, India

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Surveys were conducted of coriander plantations from open and protected cultivations at Karnataka for the prevalence of nematode. Heavy infestation of root-knot nematode was observed on coriander with small to big sized galls or knots on the roots. Soil and root samples were collected for analysis of nematode infestation. Coriander plants also exhibited poor growth showing stunting and chlorosis due to severe infestation. This is the first report of root-knot nematode from Karnataka.

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Histochemical alterations of various metabolites and their localization in *Luffa cylindrica* roots infected with *Meloidogyne incognita*

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Experiment was carried out to study the alterations and histochemical localization of various metabolites in normal and galled roots of spongegourd, *Luffa cylindrica* L., infected with root-knot nematode *Meloidogyne incognita*. Histochemistry of the roots revealed an increase in protein, nucleic acids (RNA and DNA) and amyloextrin (hydrolyzedstarch) concentration in the infected regions as compared with normal healthy sections. Protein localization found more pronounced at the sites of infection of *M. incognita* viz., cortical cells, giant cells, abnormal xylem, medullary region and nematode body. Active RNA synthesis in infected cortical, medullary and vascular regions was observed by positively dark stained nucleoli, nucleoplasm and cytoplasm of their cells and syncytium. High DNA amount was observed in concentrate form infected cells of cortex, pericycle and xylem tracheid of vascular region. Hyper hydrolysis of starch induced by *M. incognita* in sponge gourd roots was tested by studying the localization of amyloextrin. A positive test was observed with nematode body and surrounding tissues when stained with toluidine blue.

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Influence of different initial spore concentrations of *Pasteuria penetrans* on the infection of root-knot nematodes over three host crop cycles

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The numbers of egg-masses, females per plant, over all the crop cycles were compared by accepting a parallel line, logarithmic model. The number of egg-masses per plant over all the crop cycles decreased significantly ($P < 0.05$) more in the ten females treatment as compared with control. A highly significant difference was found in total number of females per plant where ten *Pasteuria penetrans* infected females were originally added as compared to the control treatment. A separate line model was fitted to compare the percentage of infected females by observing twenty females per replicate, but no infected female was recorded in any of the *Pasteuria* treatments after the harvest of the first crop. There was a highly significant difference in endospore production in root systems of the one female and ten females treatments and increased exponentially with the number of females over all the crop cycles. Infected females (%) increased and found significantly higher in the ten females treatment. The soil bioassay after first harvest showed few juveniles encumbered with an average of 1-5 spores and the number of juveniles without spores very high.

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Emergence of *Steinernema feltiae* from infected *Galleria mellonella* cadavers in moist and dry conditions

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Entomopathogenic nematodes (EPN) are one of the promising alternatives to synthetic insecticides for the control of insect pests. For successful insect management, EPNs must be established in the soil and remain infective, persistent and pathogenic for long periods. The present study investigated on the emergence of *Steinernema feltiae* infective juveniles (IJ) from infected *Galleria mellonella* cadavers in moist and dry conditions. A significantly high number of infective juveniles of *S. feltiae* emerged in moist conditions as compared to dry. A positive correlation was found between the weight of the *Galleria* larvae at infection and the numbers of IJ recovered in the moist as compared with dry conditions.

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Effect of sugar beet as a trap crop on the population density of *Meloidogyne incognita* infecting subsequent common dry bean

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Sugar beet (*Beta vulgaris* L.) cv. Gazelle was planted under screen house conditions to assess its ability as a trap crop to reduce population density of root-knot nematode, *Meloidogyne incognita* on subsequent common dry bean (*Phaseolus vulgaris* L.). Treatments were made by removing whole plant or cutting sugar beet above the surface of soil in each pot 6, 12, 18, 24, 30 and 36 days after nematode inoculation. The population density of root-knot nematode as indicated by the number of galls and egg-masses on roots of sugar beet increased gradually as influenced by the time of gathering. Root-knot nematode started to lay egg-masses after the 18th day to the 24th day till the end of experiment. On subsequent common dry bean, root-knot nematode significantly ($p \leq 0.05$) reduced on that cultivar of dry bean as influenced by the tested treatments made to sugar beet i.e. cutting or uprooting (removal) and time of harvest. In general, the nematode parameters as indicated by the numbers of galls, egg-masses and hatched juveniles on roots of dry bean and number of juveniles in soil were higher on dry bean plants replacing cutting sugar beet than those on dry bean plants replacing uprooted sugar beet within the most periods. In contrast, plant growth parameters were higher for dry bean plants replacing uprooted sugar beet than parameters for plants replacing cutting sugar beet.

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Evaluation of marine red alga *Melanothamnus afaqhusainii* against *Meloidogyne incognita*, fungus and as fertilizing potential on okra

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Study was conducted to evaluate seaweed *Melanothamnus afaqhusainii* using its powder and different extracts including *n*-hexane, DMSO and water extract against naturally occurring soil nematode namely *Meloidogyne javanica* anti fungal activity against *Fusarium moniliforme* and *Rhizoctonia solani* and fertilizing potential on okra *Abelmoschus esculentus*. It was observed that the soil sample which was mixed with algal powder supported the growth of the okra plant and proved that the alga under investigation possessing some level of fertilizing potential.

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New host record of root-knot nematode (*Meloidogyne graminicola*) in Pakistan

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During survey, typical symptoms of hook like galls on roots were observed not only in rice plants but also in weeds. Root samples were examined in Plant Nematology laboratory in Department of Plant Pathology, University of Agriculture, Faisalabad. Roots of different weeds; *Cyperus rotundus*, *Dactyloctenium aegyptium*, *Echinochloa crusgalli*, *Eclipta alba*, *Paspalum distichum* from rice field and *Avena fatua*, *Phalaris minor* and *Rumex dentatus* from wheat field were collected during summer and winter 2014-15, respectively. Heavy galling on roots indicated the root-knot nematodes infestation. Roots of each plant were separated according to gall structure and mature nematode females were isolated under stereomicroscope through dissection. From each plant, five samples of roots and ten nematode females were examined. Impression of perineal patterns of each female were prepared and identified. Mixed population of nematode was found in *A. fatua*, *R. dentatus* and *P. minor*. All weed plants showed symptoms of *M. graminicola* on their roots that was confirmed through perennial pattern. The other species was identified as *M. arenaria*. These are new host records from Punjab, Pakistan.

2016, Vol. 34(1): 101

Description of six new species of *Oscheius* Andrassy, 1976 (Nematoda: Rhabditida) from Pakistan with a key and diagnostic compendium to species of the genus

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Six new species of the genus *Oscheius* Andrassy, 1976 viz., *Oscheius citri* n. sp., *O. cynodonti* n. sp., *O. cobbi* n. sp., *O. esculentus* n. sp., *O. punctata* n. sp. and *O. sacchari* n. sp., are described by both morphological and molecular means from different agro-climatic regions of Sindh, Punjab and Azad Jammu & Kashmir, Pakistan. All species belong to insectivora group on the basis of leptoderan bursa, crochet needle-shaped

spicules, normal rectum, lateral field with six separate lines and had unique ribosomal DNA-ITS, sequence. A compendium of the genus *Oscheius* (of both insectivora and dolichura groups) based on the following characters: body length, tail, spicules and gubernaculum length, ratios a, b, c, c' and vulva percentage is given. The morphometric and allometric characters with anterior and posterior regions were derived from the original descriptions. An identification key to 42 valid species of both insectivora and dolichura group of the genus *Oscheius* is given.

2016, Vol. 34(2): 109-161

Occurrence of phytoparasitic nematodes on some crop plants in northern Egypt

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A nematode survey was conducted in northern Egypt and a total of 240 soil and root samples were collected from the rhizosphere of the surveyed plants. Twenty-three genera of phytoparasitic nematodes were detected in the collected soil and root samples. In soil samples from Alexandria governorate, the sugar beet cyst nematode (*Heterodera schachtii*) was very common on sugar beet while the root-knot nematodes *Meloidogyne incognita* and *M. javanica* were very common on guava, olive trees and sugar beet. *Helicotylenchus pseudorobustus*, *M. incognita*, *Pratylenchus* sp., *Rotylenchulus reniformis* and *Xiphinema* sp. were observed in spearmint soil samples. The dagger nematode *Xiphinema rivesi* was found in orange soil samples from El-Nobarria, El-Beheira governorate. In lantana soil samples from El-Giza governorate, *Aglenchus geraerti*, *Bitylenchus ventrosignatus*, *Coslenchus capsici*, *Helicotylenchus indicus* and *Malenchus bryanti* were identified for the first time in Egypt. Survey results revealed new host plant records for most of the identified nematode species in Egypt.

2016, Vol. 34(2): 163-169

Effect of temperature on emergence of *Steinernema feltiae* from infected *Galleria mellonella* cadavers under moist and dry conditions

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The management of insect pests is mainly relied on synthetic insecticides which are inimical to humans, livestock and environment. To dispense with the pernicious consequences of chemicals, use of entomopathogenic nematodes (EPNs) is among the viable alternatives. The successful management by EPNs is dependent on their establishment in soils, infectivity, persistence and pathogenicity for longer periods. In the present study, emergence of *Steinernema feltiae* infective juveniles (IJs) from infected *Galleria mellonella* cadavers was monitored under moist and dry conditions at 5 and 10°C. Greater numbers of IJs of *S. feltiae* recovered from *G. mellonella* cadavers kept at 10°C than from those kept at 5°C. Likewise, significantly greater number of infective juveniles emerged in moist conditions as compared to dry. The relationship between both the temperatures and wet and dry conditions was highly significant ($P < 0.001$).

2016, Vol. 34(2): 171-176

Interactions of *Heterodera daverti*, *H. goldeni* and *H. zae* with *Meloidogyne incognita* on rice

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The interactions of the cyst nematodes *Heterodera daverti*, *H. goldeni* and *H. zae* with the root-knot nematode *Meloidogyne incognita* on rice (*Oryza sativa*) cultivars 'Giza 178' and Sakha 101' were studied in the greenhouse. Inoculation with *H. goldeni* alone or one week before inoculation with *M. incognita* on rice cv. Sakha 101 resulted in a significant increase in the number of cysts of *H. goldeni* as compared to plants inoculated with *M. incognita* concurrently or a week beforehand. When *H. daverti* or *H. zae* were inoculated one week after inoculation with *M. incognita* on rice cultivars Giza 178 or Sakha 101, respectively, the final population of these cyst nematodes increased. Treatments with *M. incognita* alone or one week before inoculations with the tested cyst nematodes induced a significant increase in the numbers of *M. incognita* root galls and egg-masses as compared to other treatments.

2016, Vol. 34(2): 177-182

Antagonistic effects of some indigenous isolates of *Trichoderma* spp. against *Meloidogyne javanica*

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Two studies, *in vitro* and in the green house, were conducted to determine the efficacy of some Saudi *Trichoderma* isolates against *Meloidogyne javanica*. The isolates included: *Trichoderma hamatum* (one isolate), *T. viride* (one isolate), *T. asperellum* (three isolates), *T. atroviride* (one isolate) and *T. harzianum* (two isolates). *In vitro*, results showed that all eight tested isolates and their culture filtrates were effective at different levels, in egg hatch inhibition and mortality of juvenile (J₂). The mortality of J₂ and un-hatching of eggs increased as the concentrations of the culture filtrates increased. In general, *T. harzianum* (isolate No.27), *T. hamatum* (isolate No.5) and *T. viride* (isolate No.8) were the most effective among all tested isolates. Therefore, these three isolates were further evaluated in the greenhouse test on tomato against *M. javanica*. The three tested isolates inhibited the reproduction, root galling and number of juveniles of *M. javanica*. The *T. harzianum* (isolate No.27) was the most effective isolate.

2016, Vol. 34(2): 183-191

Estimation of genetic relationship of wheat germplasm against cereal cyst nematodes using RAPD technique

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Investigations were conducted at molecular level, to estimate genetic diversity among wheat germplasm (20 cultivars/lines) in relation to their response against cereal cyst nematodes *Heterodera avenae*, through Random Amplified Polymorphic DNA (RAPD) technique. A total of 589 bands were generated using 14 primers with an average of 28.8 bands/genotype. Maximum percentage of polymorphic loci was 92.86% for genotype TJ-83. Inferences have been made regarding bioassay and molecular characterization that the most diverse and resistant genotype against CCN was Moomal-2002 as compared to the rest of the genotypes studied and the most effective loci to screen diversity was OPA-09.

2016, Vol. 34(2): 193-204

Occurrence of some nematode parasites in the gastrointestinal tract of Ariidae (Teleostei: Siluriformes) catfish, *Arius arius* (Hamilton, 1822) from Karachi coast

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Current study was carried out in December, 2014 to investigate the occurrence of helminth parasites in catfish species belonging to family Ariidae (Blecker, 1862). Four species of catfishes namely *Arius arius* (Hamilton, 1822), *Arius caelatus* (Valenciennes, 1840), *Arius dussumieri* (Valenciennes, 1840) and *Arius sona* (Hamilton, 1822) off the Karachi coast were screened for the occurrence of helminth parasites. Fish were examined after washing contents of gastrointestinal tract and observed under light microscope with the help of regular parasitological methods. The nematode parasites namely; *Raphidascaris acus* (Bloch, 1779) larvae, *Metabronema magnum* (Taylor, 1925), *Haplonema immutatum* (Ward et Magath, 1917) and *Hedruris bryttosi* (Yamaguti, 1935) were recorded from the gut of the catfish, *Arius arius* (Hamilton, 1822). These are new host records as these parasites have not been reported from *Arius arius* species in the region, off the Karachi coast. 2016, Vol. 34(2): 205-212

Description of *Aphelenchoides turnipi* n. sp. and redescription of *A. siddiqii* with notes on *A. bicaudatus* (Nematoda: Aphelenchoididae) from Pakistan

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A new species of the genus *Aphelenchoides* is described from soil around the roots of turnip (*Brassica rapa* L.) plants collected from Mianwali, Punjab, Pakistan. *Aphelenchoides turnipi* n. sp. belongs to the Group 2 of *Aphelenchoides* species *sensu* Shahina with one or sometimes two mucronate structures in female tail terminus and is characterized by small body size (0.29-0.38 mm); two lateral incisures in the lateral field; small stylet with minute basal swellings (stylet: 7-9 µm); vulva at 67-69 percent of body, tail short with pointed mucro (tail = 25-30 µm); and excretory pore situated just behind the median bulb, anterior to nerve ring. Female have a short post vulval uterine sac extending 25-34% of vulva-anus distance. Also included is the first record of *A. siddiqii* Fortuner, 1970 from around the roots of carrot (*Daucus carota* L.), from Hasan Abdal, Punjab, Pakistan. Morphometric data of a known species *A. bicaudatus* (Imamura, 1931) Filipjev & Schuurmans Stekhoven, 1941 is also given.

2017, Vol. 35(1): 03-12

Description of new stunt nematode species, *Merlinius nagerensis* n. sp. and new records of plant parasitic nematodes from Gilgit-Baltistan, Pakistan

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One new species *Merlinius nagerensis* n. sp. and five new records were found during the surveillance of different crop fields of Gilgit-Baltistan, Pakistan. The new species is characterized by punctuation on the entire body and with rounded and smooth tail terminus. This species comes close to *M. montanus* and *M.*

khuzdarensis, but differs from *M. montanus* in having pointed tail terminus and from *M. khuzdarensis* by longer stylet. The taxonomic studies on *Boleodorus volutus*, *Merlinius alboranensis*, *Paratylenchus* (*P.*) *nanus*, *Pratylenchus allenii*, *Telomalenchus williamsi* are presented in this paper. The indigenous fauna had similar morphological and morphometrical characters to the corresponding type population.
2017, Vol. 35(1): 13-35

Study of some mononchids (Nematoda: Mononchida) from Iran

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The survey of soil nematodes of the West Azarbaijan province of Iran revealed the presence of predatory nematodes of the order Mononchida. A total of 36 soil samples were collected in the summer of 2014 from the rhizosphere of stone fruits in different areas of the province. Soil analysis results in the identification of 5 species of mononchid nematodes viz., *Anatonchus kashmirensis*, *A. tridentatus*, *Clarkus papillatus*, *Mylonchulus brachyuris* and *M. paitensis*. Among them, *A. kashmirensis* is recorded for the first time in Iran.
2017, Vol. 35(1): 37-45

Description of *Filenchus maqbooli* n. sp., and redescrptions of five new records of plant parasitic nematodes of maize crops from Punjab, Pakistan

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In a recent study of plant parasitic nematodes, the following species of nematodes were encountered from maize and its adjoining crops from Punjab, Pakistan. New species *Filenchus maqbooli* n. sp., characterized by small body with short stylet and tail long, filiform has been described. Five new record species of plant parasitic nematodes viz., *Helicotylenchus certus* Eroshenko & Nguen Vu Tkhan, 1981, *Helicotylenchus gulabi* Jain, Siddiqui & Aruna Parihar, 2000, *Helicotylenchus jasminii* Jain Siddiqui & Aruna Parihar, 2000, *Pratylenchus goodeyi* Sher & Allen, 1953 and *Telotylenchus indicus* Siddiqui, 1960 and two new host records of maize viz., *Tylenchorhynchus tritici* Golden, Maqbool & Handoo, 1987 and *Malenchus labiatus* Maqbool & Shahina, 1985 are briefly redescrbed herein.
2017, Vol. 35(1): 47-64

Infection of *Galleria mellonella* larvae by *Steinernema affine* and production of infective juveniles

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The information regarding relationship between nematode dosage and infective juveniles (IJ) production are available for *Steinernema affine*. Therefore, in the present study the effect of inoculation doses of *S. affine* and extraction methods was investigated on the production of IJ in *Galleria mellonella*. There was significantly greater emergence of IJ of *S. affine* from the *Galleria mellonella* using White traps than with modified

Baermann extraction trays. In Baermann extraction trays, the maximum emergence of IJ of *S. affine* was observed at an inoculation dose of 400 IJ followed by the dose of 50 IJ. The minimum emergence was found with an inoculation dose of 100 IJ. On the other hand, in case of White traps, the maximum emergence of IJ was recorded with doses of 100 and 50 IJ. The minimum emergence of IJ was observed with a dose of 200 IJ. The relationships between inoculation doses and emergence of IJ from the cadavers for both the methods were found to be non-significant.

2017, Vol. 35(1): 65-71

Effect of medicinal plant extracts on inoculated *Meloidogyne javanica* in tomato

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In this study, the inhibitory effect of medicinal plant extracts viz., marigold (*Tagetes* spp.), rosemary (*Rosmarinus officinalis* L.) and nigella (*Nigella sativa* L.) on root-knot nematode, *Meloidogyne javanica* @ 1500, 2500 and 5000 juveniles were studied on susceptible tomato cv. Karoon under greenhouse condition. Although all the treatments reduced root infections rate and significantly effect on root weight ($P \leq 0.05$). It was observed that when the nematode inoculum increased, reproduction factor also increased while extract treatments effect decreased. In between treatments, rosemary extract has the greatest impact on the reduction of nematode populations @ 40% concentration as compared to control.

2017, Vol. 35(1): 73-78

Evaluation of six leguminous crops against the root-knot nematode, *Meloidogyne javanica* infection

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Twenty seven leguminous cultivars were tested for their host response to *Meloidogyne javanica*. The nematode species succeeded in developing and multiplying on almost all the tested crops. According to rating scale based on nematode reproduction, Lencoln and Victory cultivars of pea were considered as highly susceptible hosts with (R_f) values 36.5 and 25.68 folds, respectively. While Maser-1 cultivar of broad bean and Bronco, Exira, Giza-6, Polista and Savana cultivars of common bean were classified as moderately susceptible hosts to nematode infection with (R_f) values ranged between 5.27 and 14.21 folds. Thirteen other tested cultivars were found least susceptible with (R_f) values ranged between 1.13 and 4.86 folds. On the other hand, *M. javanica* failed to reproduce and multiple on Giza-2 and Giza-30 of fenugreek and Giza-1 and Giza-2 of lupine which were ranked as highly resistant hosts with (R_f) values 0.12, 0.33, 0.19 and 0.42 folds, respectively, whereas Giza-843 and Giza-51 of broad bean and lentil were regarded as resistant hosts to nematode infection with (R_f) values 0.59 and 0.80 folds, respectively.

2017, Vol. 35(1): 79-84

Evaluation of some non-fumigant nematicides and the biocide avermectin for managing *Meloidogyne incognita* in tomatoes

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A pot experiment was conducted to evaluate the efficacy of avermectin a new bio-nematicide in Egypt, in comparison with five non-fumigant nematicides namely, cadusafos, ethoprophos, fenamiphos, fosthiazate and oxamyl for managing the root-knot nematode, *Meloidogyne incognita* in tomatoes based on number of galls per root system, number of egg-masses, eggs per egg-mass and number of juveniles (J_2) in the soil as well as plant growth characteristics. All nematicidal treatments reduced the incidence of root-knot nematodes when compared with the untreated check. However, fenamiphos and oxamyl were proved to be the highest chemical compositions that decreased galls by 91.73 and 89.53% and egg-masses by 90.80 and 88.65%, respectively. Whereas, avermectin has relatively least effective causing 66.69% and 66.31% reduction in gall formation and egg-masses, respectively. Meanwhile, cadusafos and oxamyl achieved the greatest reduction for eggs per egg-mass by 68.26 and 63.17%, consecutively. As for eggs per egg-mass, avermectin provided 16.34% reduction. All the tested nematicides significantly reduced the population of J_2 in the soil ranging from 69.49 to 90.31 %. Also, all applied treatments enhanced tomato growth indices as compared to the untreated inoculated control.

2017, Vol. 35(1): 85-92

Toxicity of essential oils extracted from *Corymbia citriodora* and *Eucalyptus camaldulensis* leaves against *Meloidogyne incognita* under laboratory conditions

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Essential oils (EOs) were extracted from *Corymbia citriodora* and *Eucalyptus camaldulensis* fresh leaves and tested for their nematicidal activity at four different concentrations viz., 125, 250, 500 and 1000 mg/l against root-knot nematode, *Meloidogyne incognita* under laboratory conditions. All concentrations significantly inhibited egg hatching (31.24–66.35%) and mortality of second stage juvenile. Inhibition of egg hatching (%) and mortality (%) of J_2 were increased linearly with increasing concentration of EOs. *Corymbia citriodora* EO was more effective than *E. camaldulensis* in inhibiting egg hatchability and suppressing J_2 viability. Probit analysis results showed median inhibitory concentration (IC_{50}) values of 412.7 and 615.9 mg/l for *C. citriodora* and *E. camaldulensis* leaves EOs, respectively. In addition, the lethal concentrations (LC) causing 50% J_2 mortality (LC_{50}) of *C. citriodora* and *E. camaldulensis* oils were 235.9 and 327.7 mg/l, for *C. citriodora* and *E. camaldulensis* leaves EOs, respectively. Essential oils were analyzed by gas chromatography-mass spectrometry (GC-MS). Isopulegol (53.68%), citronellol (15.26%) and isopulegol acetate (15.25%) were found to be major constituents of *C. citriodora*, while eucalyptol (55.36%) and α -pinene (14.87%) were the major components of *E. camaldulensis* leaves EO. Because of the high nematicidal performance of studied EOs, further trials are required to investigate their efficacy in controlling nematode infection and to use them as alternatives to synthetic nematicides in integrated nematode management.

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Effect of papaya and neem seeds on *Ascaridia galli* infection in broiler chicken

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Experiment was carried out to assess the efficacy of ethanolic extract of papaya (*Carica papaya*) and neem (*Azadirachta indica*) plant seeds on *Ascaridia galli* infectivity in broiler chicken. A total of eighteen broiler birds were randomly selected that were divided into three groups (A, B and C) with 6 birds in each group. The birds were then artificially infected with *Ascaridia galli* @ 2000 eggs/bird. Ethanolic extracts of papaya and neem were applied to Group B and C, respectively while Group A was left untreated that served as control. The fecal egg count (FEC) was conducted on weekly basis. The pre-treatment values of FEC in all three groups found negative from day 0 to 14 after artificially inducing infection. On day 21, the FEC pretreatment values in group A, B and C were recorded as 1424.5, 1346.3 and 1806.4, respectively. The FEC post treatment values of groups B and C were significantly ($P>0.05$) decreased as compared to the control (group A). However, no significant difference was observed between group B and C. It was concluded that the ethanolic extract of both the papaya and neem was effective in controlling the *Ascaridia galli* infection in chicken. However, papaya extract was found more effective than neem.

2017, Vol. 35(1): 105-111

Morphological and molecular identification of four new species of marine nematodes

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Marine nematodes play a vital role in the ecosystem of seas and estuaries as a diverse species, universally rich and often showing sensitive responses to ecological changes. During present study, surveys were conducted at four locations of Sindh coast viz., Kaemari, Korangi Creek, Ibrahim Haidry, Mubarak Village and two of Balochistan coast viz., Gadani and Sonmiani beach. As a result, four new species *Oncholaimus paraoxyuris* n. sp., *Metoncholaimus medispiculatum* n. sp., *Theristus (P) karachiense* n. sp. and *Theristus cylindricus* n. sp. were found. *O. paraoxyuris*, *M. medispiculatum* and *T. karachiense* were molecularly identified on the basis of 18S ribosomal gene with accession numbers KY497017, KY979964 and KY979968, respectively.

2017, Vol. 35(2): 113-150

The cyst nematodes *Heterodera* and *Globodera* species in Egypt

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A survey was conducted in three governorates Alexandria, El Behera and Sohag of Egypt during 2012-2016 and one hundred seventy-eight soil and root samples were collected for the detection of cyst nematodes. The results showed the prevalence of nine cyst nematode species associated with different crop plants: *Heterodera avenae* on wheat, *H. daveri* and *H. trifolii* on Egyptian clover, *H. leuceilyma* on Bermuda grass, *H. lespedezae* on lentil, *H. goldeni* on qasabagrass, *H. schachtii* on cabbage and sugar beet, *H. zae* on corn and wheat and *Globodera rostochiensis* on potato. The cyst nematodes *H. leuceilyma* and *G. rostochiensis* are new records of the country and *H. lespedezae* on lentil is a new host plant record in Egypt.

2017, Vol. 35(2): 151-154

First report of *Meloidogyne javanica* on *Berberis vulgaris* in Iran

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A survey was conducted in March 2016, which showed nearly 80% of the common barberry (*Berberis vulgaris* L.) shrubs planted in Birjand (Ghattargaz region), South Khorasan province of Iran infected with root-knot nematode. On the basis of perineal pattern the nematode was identified as *Meloidogyne javanica* and is the first report on *B. vulgaris* in Iran.

2017, Vol. 35(2): 155-156

Two new records of entomopathogenic nematodes (Nematoda: Steinernematidae) from Gilgit-Baltistan, Pakistan

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A survey of District Hunza, Gilgit and Nager, Gilgit-Baltistan, Pakistan was conducted during January, 2017. Out of 20 soil samples, 6 samples were found positive for *Steinernema* species. One sample of *Prunus avium* had *Steinernema affine* from Hunza, two samples had *S. cholashanense* from *Juglans nigra* and *Malus pumila* from Gilgit, and three samples harboured *S. feltiae* from *Prunus armeniaca*, *Prunus persica* and *Malus pumila* from Nager. This paper deals with re-description of *S. affine* based on comparative study of morphological and molecular characteristics with brief study of *S. cholashanense* and *S. feltiae*. *S. affine* Pak. G.S.356 deposited in NCBI with accession number MF150033; *S. cholashanense* Pak.G.S.350 and Pak. G.S.355 with accession numbers MF125282 and MF0339642, respectively; *S. feltiae* Pak. G.S. 354, 357, 358 deposited with accession numbers MF150034, MF158314 and MF144570, respectively.

2017, Vol. 35(2): 157-173

Prevalence and densities of banana nematodes in Kondotty-local Government Area, Kerala State, India

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To determine the types, frequency of occurrence and population densities of plant parasitic nematodes in soil samples associated with banana (*Musa paradisiaca*), a survey was conducted in the Kondotty Taluk of Malappuram district, Kerala, India. A total of 12 genera of nematodes including six commonly occurring nematodes in the banana rhizosphere, three new records from banana and one new unidentified genus were obtained during the survey. Two free-living nematodes were also frequently observed in the analyzed soil samples from banana rhizosphere including *Caenorhabditis elegans* and *Mononchus* sp. *C. elegans* is exclusively found associated with rhizosphere of Nendra and Nattupooan banana varieties.

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Relationship of soil abiotic factors with population abundance and vertical distribution of root lesion nematode in robusta coffee plantation

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This research was undertaken with the aim to know the abundance and vertical distribution of *Pratylenchus* sp. influenced by soil abiotic factors and coffee plant varieties in three fields. The research was conducted in Malang Sari, Getas and Candiroti fields. Samples of soil and roots were collected and various parameters of soil abiotic factors (pH, soil moisture, soil temperature, soil texture and organic matter) were obtained from each of the three fields. Vertical distribution was assessed using two soil sample depths (30 cm and 50 cm). This research showed that the highest population abundance of *Pratylenchus* sp. both from soil and roots was in Candiroti field with BP 42 variety i.e. 27 nematodes per 100 ml of soil and 60 nematodes per 10 g of roots, respectively. Relationship between pH and soil temperature with population abundance was negative correlation whereas soil moisture and organic matter had positive correlation. Vertical distribution of *Pratylenchus* sp. in all fields on Excelsa coffee, BP 308 and BP 42 variety were detected in < 30 cm depth, whereas in 50 cm depth only detected on BP 308 variety in Malang Sari Field. The abundance of *Pratylenchus* sp. was mostly influenced by soil moisture, soil texture and variety.

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Comparative suppressive effect of some organic acids against *Meloidogyne incognita* infecting tomato

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The comparative suppressive potential of some organic acids known as resistance inducing chemicals viz., salicylic acid (SA) and its two derivatives; acetylsalicylic acid (ASA) and 3,5-dinitrosalicylic acid (DNSA), along with L-ascorbic acid (AA), oxalic acid (OA) and citric acid (CA) for managing *Meloidogyne incognita* infecting tomato plants was investigated under greenhouse conditions. The results showed that all tested organic acids as well as the application methods significantly reduced tomato root galls and 2nd stage juvenile numbers in soil compared with control. Except DNSA and AA, foliar application of tested organic acids was more effective in reducing nematode galls than soil drench application. Foliar application of ASA caused superior effect in the reduction of J₂ in soil (100 %) followed by AA (89.44 %), OA (88.25 %) and SA (70.69 %). CA (96.52 %) was tended to be the most effective chemicals in reducing J₂ in soil when applied as soil drench. All treatments enhanced shoot and root length of tomato as well as shoot weight compared with the untreated check. Only SA and DNSA significantly increased the root weights. DNSA enhanced the growth indices of tomato plant when used as foliar spray more than soil drenching and opposite trend was observed for OA. These chemical activators have potential to suppress *M. incognita* infection through the stimulation of tomato tolerance.

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Soil bioassay with time interval and spore density factors affecting the infection of *Meloidogyne javanica* by *Pasteuria penetrans*

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A bioassay study was conducted to confirm the effect of different time intervals on the degradation of *M. javanica* females cadavers filled with of *P. penetrans* endospores, release and dispersal in the soil. Three time intervals, of one week, two weeks and three weeks were allowed to observe the degradation of infected

female cadavers and the dispersal of released endospores. The hypothesis of this experiment was that, the spores of *P. penetrans* contained in *M. javanica* females that have been placed in soil would be released as the cadavers decompose and would attach to fresh J₂s added to the soil. A very highly significant difference was observed between the treatments as compared to control treatments of both crop cycles. The bioassay revealed a significant decrease in the total number of second stage juveniles from 50 g of the soil samples from second crop than the first crop soil samples. Three weeks duration allowed more endospores as compared to one week and two weeks treatment. These results showed that dispersal of endospores from the degrading female cadavers occurred after two weeks.

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Short communication

Anethum graveolens, A new host of *Meloidogyne incognita* in Turkey

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During a survey of plant parasitic nematodes, moderate to severe root-knot nematode infection was observed on the roots of dill [*Anethum graveolens* L. (Apiaceae)], growing in the greenhouse vegetable production area in Çiftlikköy Butterfly meadow location, Yalova (Turkey) (Fig. 1A.). After examination of the root galls, mature females were found attached in abundance on the roots. On the basis of the perineal pattern of mature females, the root-knot nematode was identified as *Meloidogyne incognita* (Kofoid & White) Chitwood (Southey, 1986; Jepson, 1987; Eisenback & Triantaphyllou, 1991). Dill, *Anethum graveolens* appears to be a new host of *M. incognita* in Turkey, and has not been previously reported (Kepenekci *et al.*, 2002; Kepenekci & Evlice, 2004; Kepenekci, 2012; Kepenekci, 2014).

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Interspecific variations of trematodes from *Acridotheres tristis* L. of District Larkana, Sindh, Pakistan

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Present studies regarding interspecific variations of earlier reported trematodes from Common Mynas based on 100 specimens collected from different localities of District Larkana, Sindh, Pakistan. Host birds common myna *Acridotheres tristis* L. These trematodes reflect inter specific disparity in different morphometric parameters viz., length and width of the body; length and width of the oral sucker; length and width of the pharynx, length and width of the ventral sucker, length and width of the right and left testis, length and width of the ovary, length of the post-testicular space and length and width of the eggs, respectively. The necessary measurements based on international morphometric parameters were used to record the interspecific variations of *C. murtazae*, *C. aliraazi*, *C. quratulaini* as reported by Soomro *et al.*, (2016, 2017) in the Vertebrate Biology Research Laboratory.

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Nematode community structure and trophic group composition of fresh water nematodes from Sindh, Pakistan

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Present study provides the information and estimation on fresh water nematode community structure from various water sources (river, lakes, canals, ponds, reservoirs and irrigation sources: tube well and tanks) and evaluation of feeding categories at eight collecting sites of Sindh. After analysis it was found that different parameters of community structure of fresh water nematodes varied considerably at different surveyed sites. Nematode community analysis revealed that frequency (absolute frequency, relative frequency), density (relative density) and prominence value were variable for nematode population within localities. Relative density of fresh water nematode species of studied sites ranged between 0.7-10.4 % while absolute frequency and relative frequency ranged between 15-98% and 0.86-8.8%, respectively.

Analysis of overall occurrence percentage of feeding groups revealed that predators dominated the entire nematode community (35%) followed by bacterivores (32.5%), herbivores (20%), algal feeders and fungivores shared the same occurrence percentage (5%) while the least occurrence percentage was of omnivores (2.5%). These studies add to the knowledge of diversity of fresh water nematodes and evidence of their categorization on the basis of feeding habits and the community structure.

2018, Vol. 36(1): 1-26

Incidence of root-knot nematodes on different date-palm (*Phoenix dactylifera* L.) cultivars

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A survey was conducted in different randomly selected localities of the date-palm (*Phoenix dactylifera* L.) growing areas of district Kharan for the determination of incidence, prevalence, severity and identification of major species of root-knot nematodes. During the survey, a total of 160 root samples were collected from different localities and cultivars of date-palm. The maximum prevalence was recorded from locality Nouroz Kalat (100%) and the minimum prevalence recorded was (20%) from Totazai and Raskoh. The incidence, as well as severity varied in all the cultivars.

The maximum severity and incidence of root-knot nematode was recorded from date-palm cultivar Rabi (90%) followed by Alini (80%) with galling index of 4 and the minimum was recorded in cultivar Kaluth (20%) with a galling index of 1. The root samples collected from date-palm cultivars showed the occurrence of two species of root-knot nematode *Meloidogyne incognita* and *Meloidogyne javanica* which were found to be associated with date-palm in district Kharan. In the present study date-palm (*Phoenix dactylifera* L.) is reported as a new host of *Meloidogyne javanica* in Pakistan.

2018, Vol. 36(1): 27-32

Estimation of yield losses in broad bean due to *Meloidogyne arenaria* in Egypt

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Loss in yield of broad bean grown in sandy soil naturally infested with root-knot nematode *Meloidogyne arenaria* was estimated during two successive seasons. Severity of nematode infestation (damage) was assayed at harvest stage as root-gall indices (GI) based on scale of 1-6 (1= no infection and 6= 100% root galling). In the first season (2014-2015) relationship between nematode damage and yield of broad bean was negative, however no significant reduction in growth and yield ($p = 0.05$) was obtained at all nematode root gall indices. Correlation coefficient between nematode damage and yield was low, 0.38 in case of pod yield and 0.40 in case of dry seeds. In second season (2015-2016), both pods and dry seeds yield were significantly

reduced by 10.6% and 15.2%, respectively at severe infestation (GI=6). Also correlation coefficient between nematode and yield was 0.92 in case of nematode-pod yield and 0.91 in case of nematode-seed yield. Seed contents viz., proteins, carbohydrates, zinc and copper decreased at severe infestation in the second season, while in the first season quality of seeds was not affected.

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Effect of sugar beet plant residues on population density of root-knot nematode, *Meloidogyne incognita* infecting cowpea and biochemical changes in treated plants

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Different sugar beet residues, fresh and dry leaves and mashed storage roots of sugar beet @20 and 10g were tested for controlling root-knot nematode, *Meloidogyne incognita* on cowpea in screen house. On the basis of the average percentages nematode reduction, mashed storage roots at the highest rate (20g) achieved 85.1% increase followed by dry leaves at the same rate caused the reduction 81.6%. Average nematode reduction (79.5%) was caused by using fresh leaves of sugar beet at the highest rate followed by that occurred by the lowest one compared to untreated control. Plant growth, number of nodules (produced by nitrogen fixing bacteria, *Rhizobium*) and yield followed the same trend as the highest rate of sugar beet residues was used; there was the highest percentages increase of plant growth, yield and number of nodules. It is clearly noticed that soluble carbohydrates, total carbohydrates, phenols and soluble proteins in seeds increased at the different treatments compared to those of the untreated check and the effect, in general, was higher by using the highest rate compared to the lowest one. On the other hand, the contents of chlorophyll a, chlorophyll b and carotenoids in leaf increased at untreated check compared to those at different treatments.

2018, Vol. 36(1): 41-48

An improved protocol for quantification of root-lesion nematode infection in barley

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In green house conditions, an improved protocol for testing barley plants against root lesion nematode (RLN) had been standardized. The plants were grown in 150 cm³ instead of 20 cm³ tubes and we increased the inoculum size from 400 to 1000 nematodes/plant in combination with a nutrient solution better adapted to the barley crop. Six barley accessions were tested with *Pratylenchus neglectus* and *Pratylenchus penetrans*. Tests were evaluated 7, 8, 9, and 10 weeks after inoculation. It was found; a shorter test period of 7 weeks is suitable for distinguishing resistant and susceptible genotypes. It was further demonstrated that 7 weeks after inoculations is sufficient to determine nematode numbers instead of 10 or 12 weeks after inoculation. Moreover, measuring the root fresh weight was necessary to calculate the relative number of nematodes/g root mass. In conclusion, results led to a more efficient, quicker and more accurate measurement of barley infections by *Pratylenchus* spp. which is important for selection during early generations of cultivar development.

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Efficiency of entomopathogenic nematodes (Rhabditida) against *Saccharococcus sacchari* (Cockerell) (Homoptera: Pseudococcidae) under laboratory conditions

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The objective of this study was to study the efficacy of four indigenous and one exotic isolated entomopathogenic nematodes (EPNs) against sugarcane mealybug *Saccharococcus sacchari* under laboratory conditions (27 ± 2 °C, RH $65 \pm 10\%$). The EPNs used in the study are *Steinernema* sp. (strain: AT4), *Steinernema* sp. (strain: EMB), *Heterorhabditis bacteriophora* (strain: EKB20), *Heterorhabditis* sp. (strain: EIK) and *Steinernema glasri* (strain: New Jersey). The bioassays were carried out on Petri dishes containing parts of pumpkin infested with adult females of *S. sacchari*, and were sprayed with EPN juveniles. Results showed that *H. bacteriophora* strain (EKB20) and *Heterorhabditis* sp. (EIK) were more efficient with higher pathogenicity and virulence in the laboratory than the other strains and gave the highest corrected mortality percentage in the infestation (from 68.59% to 70.83%). The LC_{50} were 25.42 and 45.5 IJs/ insect for the two strains, respectively.

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Efficacy of entomopathogenic nematode isolates from Turkey and Kyrgyzstan against black timber bark beetle, *Xylosandrus germanus* (Blandford) (Coleoptera: Curculionidae: Scolytinae) adults

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Six species of entomopathogenic nematodes (EPNs) (*Steinernema feltiae*, *S. carpocapsae* and *Heterorhabditis bacteriophora*) isolated from Turkey [*S. feltiae* (Aydin isolate), *S. carpocapsae* (Black sea isolate), *H. bacteriophora* (Aydin isolate) and *H. bacteriophora* (Çanakkale isolate)] and from Kyrgyzstan [*S. feltiae*(KG3) and *H. bacteriophora* (KG81)] were tested for the control of black timber bark beetle, *Xylosandrus germanus* (Blandford) (Coleoptera: Curculionidae: Scolytinae) under laboratory conditions. The studies were conducted in June, 2017 at the Ondokuz Mayıs University (Samsun, Turkey). The suspensions of nematodes were applied at one concentration (1000 IJs ml⁻¹) (200 IJs insect⁻¹ or approximately 15 IJs cm⁻²) at 25°C temperatures. The data for mortality was recorded after 2, 4, 6 and 8 days intervals. Insect mortality of the adult was higher in all nematode treatments than the control. Turkish EPN isolate *S. carpocapsae* (Black sea) and Kyrgyz EPN isolate *S. feltiae* (KG3) species showed the highest mortality (98.66%).

2018, Vol. 36(1): 65-70

Seasonal fluctuation and biological control of root- knot nematodes *Meloidogyne incognita* on cucumber

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The experiments were conducted under both greenhouse and field conditions to determine seasonal fluctuation and application of some bioagents to control root-knot nematode *Meloidogyne incognita* on cucumber. Seasonal fluctuation of the root-knot nematode *M. incognita* was studied on two cucumber cultivars (*Madia* and *Slaprt*) during the period from March to November in seasons 2015/2016 and 2016/2017. Soil population increased gradually on two cultivars during spring and throughout summer to

reach peak in August began to decrease during autumn and reach the lowest in winter (January and February) in two seasons where soil temperature reached $15 \pm 4^\circ\text{C}$. Seven treatments *Paecilomyces lilacinus*, *Arthrobotrys oligospora*, *Glomus faciculatum*, *Eucalyptus globules*, *Tagetes erecta*, *Allium sativum* and Fenamiphos (10%G) were evaluated to control *M. incognita*. All the treatments decreased the nematode population of *M. incognita* in soil and on roots compared with check. Data indicated percent increase of fresh weight of the whole plant which was greatly improved in all treatments.

2018, Vol. 36(1): 71-81

Management of banana plants against *Meloidogyne incognita* with indigenous medicinal and aromatic plants

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Twenty indigenous medicinal and aromatic plants viz., *Perovskia abrotanoides*, *Valeriana wallichii*, *Artemisia vulgaris*, *Peganum harmala*, *Saphora alopecuroides*, *Artemisia absinthium*, *Carum copticum*, *Berberis balochistanica*, *Matricaria lasiocarpa*, *Ephedra procera*, *Centratherum anthelminticum*, *Zatoria multiflora*, *Lallemantia royaleana*, *Mentha spicata*, *Withania coagulans*, *Achillea santolina*, *Ferula oopoda*, *Nepeta cateria*, *Teucrium stocksianum* and *Fagonia cretica* were screened for their efficacy test against *Meloidogyne incognita* both in laboratory and pot experiments at doses of 0.5g/lit water (0.5% w/v), 1.0g/lit water (1% w/v), 1.5g/lit water (1.5% w/v), 2g/lit water (2% w/v), 2.5g/lit water (2.5% w/v) and 3.0g/lit water (3% w/v). *Zatoria multiflora*, *Achillea santolina*, *Ferula oopoda* and *Nepeta cateria* showed more efficacies as compared to other medicinal and aromatic plants both in laboratory and pot experiments. During laboratory experiments highest mortality (100%) was exhibited by the extract of *Zatoria multiflora*, *Achillea santolina* and *Nepeta cateria* against dose of 3.0g/liter followed by *Teucrium stocksianum* and *Ferula oopoda* with mortality of 90% and 89%, respectively at the same dose of 3.0g/liter.

Further, in pot experiments all tested plants showed significant effect on management parameters of *M. incognita*; however, minimum juvenile population were recorded from extracts of *Matricaria lasiocarpa* which was 3532 at dose 3g/liter. Similarly minimum root-knot index (1.0) was recorded from extracts of fourteen medicinal and aromatic plants at dose of 3.0g/liter and reproductive factor was also minimum 0.56 at dose of 3.0g/liter from extracts of *Zatoria multiflora*, *Ferula oopoda* and *Matricaria lasiocarpa*.

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Community analysis of phytoparasitic nematodes associated with ornamental plants at Jimma University Agriculture Campus, Ethiopia

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This work was carried out to determine that a complex of plant-parasitic nematode groups are involved in the growth suppression and death of the ornamental plants and hence establishing records of their type and abundance is necessary to minimize the risk to future plantings. To assess the incidence of plant-parasitic nematodes, soil samples were collected in December, 2016 from three locations of Agriculture Campus of Jimma University located at 356 km Southwest of Addis Ababa, Ethiopia, at $7^\circ 68' \text{N}$ latitude and $36^\circ 83' \text{E}$ longitude with an altitude of 1752 m.a.s.l. The annual temperature ranges from $11.8\text{-}26.8^\circ\text{C}$ with a

relative humidity and mean rainfall of 91% and 1500mm, respectively. Collections were made from the rhizosphere of eight species of ornamental plants viz., *Rosa* spp., *Colocasia esculenta*, *Salvia splendens*, *Ctenanthe oppenheimiana*, *Phoenix abyssinica*, *Aster novea-angliae*, *Washingtonia robusta* and *Doronicum grandiflorum* growing along the roadsides in the campus showing severe infestation of phytoparasitic nematodes.

A total of ten genera of plant parasitic nematodes (*Helicotylenchus*, *Hemicyclophora*, *Meloidogyne*, *Pratylenchus*, *Scutellonema*, *Paratrichodorus*, *Rotylenchulus*, *Trichodorus*, *Mesocriconema* and *Tylenchorhynchus*) were recorded associated with these ornamental plant species. *Helicotylenchus* and *Scutellonema* were found associated with all ornamental plants followed by *Meloidogyne* that was not found in the rhizosphere of *A. novea-angliae*. On the other hand, *S. splendens* harbored eight of the detected genera other than *Rotylenchulus* and *Pratylenchus*. Moreover, *Helicotylenchus* and *Meloidogyne* were the most frequently encountered nematode genera with relatively high population densities.

2018, Vol. 36(1): 111-115

Population density of *Meloidogyne incognita* and eggplant growth vigour affected by sucrose-activated bread yeast (*Saccharomyces cerevisiae*)

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Active dry bread yeast containing fungus, *Saccharomyces cerevisiae* was used as a bio-agent for controlling root-knot nematode, *Meloidogyne incognita* on eggplant under screen house conditions. Three solutions of yeast and sucrose (as a bio-fermenter) at different yeast concentrations (1, 2 & 3% yeast) + a fixed concentration of 2% sucrose and three solutions of sucrose and yeast at different sucrose concentrations (2, 3 & 4% sucrose), a fixed concentration of 2% yeast were applied. The results indicated that there was a positive correlation ($R=0.097$) between average percentage nematode reduction and the applied concentrations of yeast or sucrose. The highest concentrations of bread yeast and sucrose (3% yeast + 2% sucrose) and sucrose + bread yeast solution (4% sucrose + 2% yeast) achieved the highest average percentages nematode reduction of 86% and 87.4%, respectively. On the other hand, eggplant growth parameters were the best by using 2% yeast + 2% sucrose or 2% sucrose + 2% yeast as growth index was 15.4. However, the highest concentration of yeast + sucrose solution (3% yeast + 2% sucrose) or sucrose + bread yeast solution (4% sucrose + 2% yeast) caused less growth indices as compared to untreated check.

2018, Vol. 36(2): 117-122

Pathogenicity and control of *Meloidogyne incognita* on rice in Egypt

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The pathogenicity of root-knot nematode *Meloidogyne incognita* race 1 (Mi1) and race 3 (Mi3) on rice (*Oryza sativa* L.) was studied in the greenhouse. Seventeen rice cultivars were tested for resistance to Mi1 and Mi3. The results showed that rice cvs Araby, Giza 159, Giza 170, Giza 171, Giza 172, Giza 177, Giza 178, Nahda, Sakha 101 and Sakha 102 were either susceptible or highly susceptible to Mi1. Rice cvs A95, IR1, IR22 and Japonica 47 were moderately susceptible to Mi1, whereas cvs IR28, IR459 and Philippini 24 were moderately resistant to Mi1. On the other hand, all the tested rice cultivars were either resistant or moderately resistant to Mi 3. Control of *M. incognita* race 1 on rice cv. Sakha 101 was studied in the greenhouse. Three tests were conducted to study the effects of soil treatment with some plant materials, stems of oyster mushroom

(*Pleurotus ostreatus*), the biocontrol agent *Bacillus thuringiensis*, the bionematicide abamectin, and the nematicide fenamiphos on Mi 1 on rice cv. Sakha 101. All the applied control treatments were effective in reducing nematode infection on rice plants.
2018, Vol. 36(2): 123-129

Analysis of *Arabidopsis* amino acid metabolism in response to *Heterodera schachtii* infection

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In the present study, a detailed amino acid analysis based on Ultra Performance Liquid Chromatography (UPLCTM) was performed. The results showed significant increase in arginine, proline and glutamine amounts in syncytia. Ammonium ions were also increased as an important precursor in arginine, proline and glutamine biosynthesis. In addition, branched chain amino acids and amino acids of shikimic acid based pathway were also enriched in syncytia. This study opens a door to understand the remodeling of amino acid metabolism in response to *H. schachtii* infection in plants.

2018, Vol. 36(2): 131-150

Comparison of development of *Globodera rostochiensis* in four potato cultivars

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Developmental stages of juveniles of *G. rostochiensis* Ro1 were studied in the susceptible cv. Marfona and in the resistant cvs Agria, Satina and Banba in glass-house conditions. The hatching response of the nematodes to root diffusates of these cvs was also investigated. Disinfected cysts of *G. rostochiensis* were placed in root diffusates and the numbers of hatched second stage juveniles (J₂) were counted weekly over a 6-week period. Pots were planted with a single sprout of each cv. and the soil was inoculated with a suspension of 400 freshly hatched J₂. There was a significant difference in the numbers of J₂ that had entered the roots as well as a delay of 1-2 weeks in the rate of development of juveniles in the resistant compared to the susceptible cvs. Overall, 44%, 23%, 10% and 4% of inoculated J₂ were found in the roots of susceptible Marfona, and resistant Satina, Agria and Banba cultivars, respectively. The first J₃ appeared in roots one week after J₂ entered the roots in Marfona and Satina, but after 2 weeks for the other cvs; the first J₄ was found 14 and 21 days after J₂ entry in the roots of susceptible and resistant cvs respectively. The numbers of white females found on the roots were fewer than 5 or none on roots of the potatoes resistant to pathotype Ro1. When cysts were exposed to root diffusates, 74% of J₂ hatched in Marfona diffusate as compared to 50% in Agria, 43% in Satina and 39% in Banba diffusates.

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Bio-control potential of *Bacillus* isolates against cereal cyst nematode (*Heterodera avenae*)

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The effects of twenty *Bacillus* isolates were investigated *in vitro* on the second stage juveniles of cereal cyst nematode, *Heterodera avenae*. The isolate XZ33-3 showed significant results against juveniles (J₂s) mortality followed by the isolate of XZ 17-1, XZ 24-2-1, MH 58-60-10, MH 58-60-04 and isolate MH 01-04-01, respectively. Among them four *Bacillus* isolates were identified on molecular basis using 16S rDNA, physiologically and biochemically and grouped as plant growth promoting bacteria (PGPB). In the green house experiments identified isolates; *B.cereus* XZ 24-2-1, *B. cereus* XZ-33-3, *B. weihenstephansis* MH-58-60-01, *B. thuringiensis* MH 032-003 and a nematicide (Avermectin) were used as seed coating. All four *Bacillus* isolates significantly reduced nematode infection of wheat roots when juveniles were used as inoculum after 10 days post inoculation. Noteworthy reduction in white female cyst development was observed on roots treated with Avermectin seed coating followed by isolates *B. cereus* XZ 24-2-1, *B. cereus* XZ-33-3, *B. weihenstephansis* MH-58-60-01 and *B. thuringiensis* MH 032-003 as compared to control treatment.

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Nematicidal performance of certain organic and inorganic compounds against *Meloidogyne incognita* infecting okra plants

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The present study was carried out to evaluate the nematicidal activity of some organic and inorganic compounds, as well as fosthiazate as a standard nematicide for their hatching inhibitory and juvenile mortality potential and to ascertain their role as organic amendments for the management of root-knot nematode (*Meloidogyne incognita*) affecting okra plants *in vitro* as well as *in vivo* conditions. Five concentrations of all chemicals were prepared. Data of *in vitro* studies showed a marked nematicidal and nematode hatching inhibitory activity against root-knot nematode (*M. incognita*). However, the nematicidal activity differed between treatments as compared to control. Fosthiazate was found as the most toxic compound against J₂ of *M. incognita* after 24 and 48 hour exposure time as well as inhibited the egg hatching significantly after 2, 5 and 7 days of exposure. Moreover, the juvenile mortality increased with increase in concentration of chemical compounds and the exposure time. *In vivo* studies data showed that all treatments reduced root galls, egg-masses, number of J₂ in soil, total eggs, final population and reproduction rate significantly. Meanwhile, the applied treatments exhibited enhancement in plant growth parameters and decreased the host infection by *M. incognita* over control. Among all the treatments Fosthiazate proved to be the best treatment while cattle manure was found as the least significant. The biochemical response of treated plants showed that infected plants with *M. incognita* recorded the least increase of total phenols (0.42 mg/g) and highest suppression in total proteins (10.41 mg/g), total sugars (7.86 mg/g) and reduced sugars (3.09 mg/g) as compared with untreated check. Moreover, citric acid was the most effective treatment which exhibited the highest values of total phenols (0.69 mg/g), total protein (18.08 mg/g), total sugar (17.89 mg/g) and reduced sugar (10.05 mg/g), whereas cattle manure gave the least values of total phenols (0.47 mg/g), total protein (11.70 mg/g), total sugar (9.74 mg/g) and reduced sugar (4.39 mg/g).

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Impact of nematode infestation on nutritional quality of some underground vegetables in Pakistan

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During the present investigation the nutritional quality of underground vegetables infected by root-knot nematode (*Meloidogyne incognita*) was evaluated. It was observed that physiological and biochemical changes occurred due to the invasion of root-knot nematodes in the studied vegetables. Results show that there was a significant difference in root-knot development and reproduction in infected and un-infected host plants. Data indicates that highest reproduction rate and root-knot index was observed in vegetable plants infected with root-knot nematodes after three months as compared to un-infected (control). The physiological parameters as well as biochemical contents showed significant difference in different growth criteria and amount of nutrients between infected host plants as compared to un-infected plants (control). Growth parameters of studied vegetable plants viz., fresh and dry weight and water content were decreased by the infection of root-knot nematode as compared to un-infected (control) plants. Similarly root-knot nematode decreased the host nutrients contents viz., total carbohydrates, total soluble sugars, total protein, total phenols and amino acids. Chlorophyll a, chlorophyll b and carotenoids also decreased in nematode infected plants as compared to control. This study gave the fair report towards nutritional quality because no significant work has been done so far on this aspect in Pakistan.

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***Ascaridia galli* infection induced gross-pathological changes in broiler chicken**

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In this study, the effect of *Ascaridia galli* infection on gross-pathological changes in broiler chicken was investigated. The postmortem examinations of broiler experimentally induced *A. galli* revealed gross pathological lesions of infected organs viz., small intestine, liver, lungs and heart. Hemorrhagic enteritis and acute fibrinous enteritis with clotted blood, hemorrhagic and reddish spots on intestinal wall, inflammation and necrotic patches with consolidation of intestinal contents were generally observed. Infected liver showed dark red coloration. Severe congestion, chronic pneumonia, exuded in one lobe of the lung were seen, whereas, necrosis and atrophy in infected heart were notable observations.

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Effect of *Mermis* spp. infection on the fecundity of insect pests of grasshoppers

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Grasshoppers are subjected to attack by a wide range of predators and parasites at all stages of their life cycle. Fecundity of these predators and parasites of the insects was affected when grasshoppers were contaminated with *Mermis* spp. Mostly, the females laid fewer eggs than normal. The numbers of eggs produced were 17.5 ± 3.0 , 11.2 ± 5.3 and 8.6 ± 4.3 for *Poeciloceris pictus*, *Oxya velox* and *O. hylahyla*, respectively, for infested insects, whereas, it was 43.3 ± 5.2 , 37.8 ± 6.30 and 39.34 ± 5.2 in uninfected grasshoppers. Beside this, it was also noticed that insect infected with *Mermis* spp. did not survive for long. Dissection examination showed that there was significant suppression of oocytes and testis development in infected individuals.

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Panama wilt of banana orchards in Sindh Province, Pakistan

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Extensive surveys of various locations of Sindh comprising Thatta, Hyderabad, Tando AallahYar, Matiari and Nawabshah (Benazirabad) were conducted during year 2013-2014. A total of 26 banana orchards, showing typical symptoms of banana wilt as well healthy ones were surveyed. The roots and soil samples from the banana rhizosphere were collected for the isolation and identification of suspected pathogen, *Fusarium oxysporum cubense* and the burrowing nematode (*Rhadopholus similis*) that are causing the Panama wilt in banana plantations.

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Nematode fauna of Kurram Agency, Pakistan

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The main aim of this study was to ascertain the diversity of plant parasitic nematodes at different locations of Kurram Agency, Pakistan. For this purpose, surveys were conducted and 150 samples of root and soil were collected from different locations of Kurram Agency. The detail morphological and taxonomical studies revealed a total of 26 species of plant parasitic nematodes belong to 17 genera, 13 families, 15 subfamilies and 2 orders while free-living soil nematodes revealed a total of 21 genera, 17 families and 8 orders. Overall percentage of plant parasitic and free-living nematodes was 40% and 60%, respectively. *Irantylenchus clavidorus* Kheiri, 1972 was encountered with highest occurrence (40%) followed by *Aphelenchus avenae* Bastian, 1865 (27.5%) and *Ditylenchus myceliophagus* Goodey, 1958 (10%). Morphological and detailed taxonomical studies of nematodes were carried out and six new records of plant parasitic nematodes viz., *Aphelenchoides richardsoni* Grewal, Siddiqi & Atkey, 1992, *Aphelenchoides unisexus* Jain & Singh, 1984, *Filenchus microdorus* Chawla, Prasad, Khan & Nand, 1969, *Helicotylenchus urobelus* Anderson, 1978, *Hemicriconemoides brachyurus* (Loos, 1949) Chitwood & Birchfield, 1957 and *Irantylenchus clavidorus* Kheiri, 1972 were reported. All these species were re-described with their measurements as well as illustrations. In addition, 17 new host records were reported viz., *Aphelenchoides besseyi* Christie, 1942, *Aphelenchoides goodeyi* Siddiqi & Franklin, 1967, *Aphelenchoides siddiqii* Fortuner, 1970, *Aphelenchus avenae* Bastian, 1865, *Basiria graminophila* Siddiqi, 1959, *Boleodorus pakistaniensis* Siddiqi, 1963, *Ditylenchus myceliophagus* Goodey, 1958, *Helicotylenchus willmottae* Siddiqi, 1972, *Heterodera schachtii* Schmidt, 1871, *Heterodera zaeae* Koshy, Swarup & Sethi, 1971, *Merlinius nagerensis* Sagir & Erum, 2017, *Pratylenchus flakkensis* Seinhorst, 1968, *Psilenchus hilarulus* de Man, 1921, *Quinisulcius capitatus* (Allen, 1955) Siddiqi, 1971, *Seinura oostenbrinki* Hussain & Khan, 1967, *Xiphinema brevicolle* Lordello & De Costa, 1961 and *X. index* Thorne & Allen, 1950. Population analysis of nematode fauna encountered from Kurram Agency was also determined.

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Relationship between plant density and population density of *Meloidogyne incognita* on eggplant

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The effect of different densities of eggplant (*Solanum melongena* L.) on the reproduction and population density of root-knot nematode, *Meloidogyne incognita* was studied under screen house conditions. It was found that there is a positive correlation between eggplant density and population density of root-knot nematode, *M. incognita* in roots i.e., when number of plants in the same pot increased (1-4 plants/pot), a higher number of nematode juveniles in plant roots occurred. Thus, plant density, such as 4 plants if produced

it promoted the number of the hatched juveniles, galls and egg-masses in roots as compared to the plant densities of 1, 2 and 3/pot. However, number of juveniles in soil decreased with increasing plant density.
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Effects of vermicompost, vermicompost tea and a bacterial bioagent against *Meloidogyne incognita* on banana in Egypt

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The nematicidal potential of vermicompost (VC), vermicompost tea (VCT) and the bacterial bioagent Nemaless[®] was evaluated against *Meloidogyne incognita* infecting banana (*Musa acuminata*) cv. “Grand Nain” as compared to the nematocide fenamiphos 40% EC under laboratory and field conditions. Experiments were carried-out during two successive seasons (2016 and 2017). Results of the laboratory tests showed that the toxicity of VCT and Nemaless[®] to *M. incognita* second-stage juveniles (J₂) was increased as their concentrations and exposure times were increased. The LC₅₀ of VCT ranged from 30.86×10^3 to 83.77×10^5 mg/l, while the LC₅₀ of Nemaless[®] ranged from 2.69×10^8 to 3.17×10^8 cell/ml. Results from the field experiments revealed that all of the tested treatments greatly suppressed ($P \leq 0.05$) the numbers of galls, egg-masses and nematode final populations. The most potent materials in reducing the numbers of *M. incognita* in banana soil, in a descending order, were: fenamiphos, Nemaless[®], vermicompost and vermicompost tea (VCT).

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Effectiveness of *Bacillussubtilis*, *B. pumilus*, *Pseudomonasfluorescens* on *Meloidogyneincognita* infecting cowpea

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Under screen house conditions, this experiment was conducted to investigate the effectiveness of single or combined application of bacterial inoculation of *Bacillussubtilis* (Bs), *B. pumilus* (Bp) and *Pseudomonasfluorescens* (Pf) on *M. incognita*, infecting cowpea cv. Baladi. Based on average percentages of nematode reduction, *P. fluorescens* (Pf) achieved (89.0%) followed by the combined treatments of Pf+Bs (88.5%) and Pf + Bs + Bp (86.3%) as compared to untreated positive and negative controls. As for cowpea vegetative growth, the highest plant growth increase (69.0%) was observed in combined treatment of Bs+Bp followed by 55.6% in single treatment of Pf and the least plant growth was obtained in combined treatment of Pf + Bs + Bp (54.8%). The highest percentage of yield increase (70.2%) was recorded in Bs+Bp treatment followed by 49.3% by *B. pumilus* (Bp). The highest percentage (116.7%) in the number of bacterial nodules on roots of cowpea was obtained by the combined treatment Pf + Bp, followed by the combined treatment Bs + Bp i.e. 88.9%. The combined treatments of Bs + Bp and Pf + Bp were responsible for increasing phenolic and soluble proteins, respectively. The effects of combined treatments of Pf+Bs and Pf +Bp were recorded for highest contents of photosynthetic pigments than the other treatments either as single or combined treatments.
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Combined efficacy of insecticides and entomopathogenic nematodes in the management of cotton leaf worm *Spodoptera littoralis*

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Effects of certain insecticides viz., Coragen, Nomolt, Ekio and Magic smart with two species of entomopathogenic nematodes, *Steinernema carpocapsae* and *Heterorhabditis bacteriophora* were tested against cotton leaf worm *Spodoptera littoralis*. All tested insecticides caused less mortality to the tested entomopathogenic nematodes. Magic smart significantly surpassed other insecticides causing the mortality of 11.6 and 13.8 % to the entomopathogenic nematodes *S. carpocapsae* and *H. bacteriophora*, respectively as compared to Coragen that caused slight mortality, 2.5 and 4.4%, respectively and did not differ significantly than the check. Nomolt and Ekio caused 5.4 and 8.8 % mortality of *S. carpocapsae* as well as 8.8 and 12.0 % to *H. bacteriophora*, respectively. These results show that the tested insecticides have less effect on entomopathogenic nematodes especially *S. carpocapsae*. *S. carpocapsae* exposed to Coragen, Nomolt, Ekio and Magic smart resulted in 5th instar larval mortality of cotton leaf worm by 92.5, 85.0, 80.0 and 75.0 %, respectively whereas *H. bacteriophora* caused mortality by 83.4, 77.2, 71.0 and 60.6 %, respectively. The experimental findings showed that combined efficacy of *S. carpocapsae* or *H. bacteriophora* with either of the insecticides viz., Coragen, Nomolt, Ekio and Magic smart at the quarter lethal concentration (LC₂₅) is effective in causing mortality of *S. littoralis*.

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***Bacillus cereus* a potential strain infested cereal cyst nematode (*Heterodera avenae*)**

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Bacterial strains were isolated from infested *Heterodera avenae* cysts and screened against the second stage juvenile (J₂) mortality assay *in vitro*. About 40.16 % isolates showed 40.0% J₂ mortality during 12 hours. Significantly increased upto 86.0% mortality was observed in 24 hour exposures. Among them twenty six *Bacillus* strains were identified by morphological, physiological and biochemical carbon source utilization using API 50CHB strips that belonged to *Bacillus cereus* group. *Bacillus cereus* strain B48 secondary metabolite with protease and chitinase activity was used as seed bacterization in green house experiments. In green house significant reduction in white female development was observed for avermectin (84.53%) followed by *B. cereus* strain B48 (78.10%) as compared to results of the untreated control treatment (P≤0.05).

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Response of tomato genotypes to *Meloidogyne javanica* and *Fusarium oxysporum* f.sp.*lycopersici* co-infestation under glasshouse conditions

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Tomato (*Solanum lycopersicum*) is an economically and nutritionally important vegetable crop grown worldwide. However, its yield in Ethiopia is very low as compared to the world and African average yield. Root-knot nematodes and *Fusarium* wilt are among the most economically important pathogens of tomato. A study was initiated with the objectives of determining the interaction effect of *M. javanica* (MJ) and *F. oxysporum* f. sp. *lycopersici* (FOL) disease complex and evaluating the response of selected tomato genotypes

against this disease complex under glasshouse condition. A glasshouse experiment was laid out in a factorial randomized design with 18 treatment combinations of three tomato genotypes (Assila, Cochoro, Marmande) and two pathogens (MJ and FOL) with four replications. At four true leaf stage, tomato seedlings were inoculated with the suspension of MJ at a rate of 3000 second-stage infective juveniles (J_2) and 10 ml FOL suspension (1×10^6 spores per milliliter) per pot around the root rhizosphere one week after transplanting except the control which was not inoculated. The result revealed that concomitant inoculation of MJ and FOL(NF) followed by MJ first and FOL ten days after inoculation (N1F2) was found to be highly significant in reducing the tomato growth, biomass and pathogen related parameters compared to the un-inoculated control or single pathogen inoculated treatments. Among the three tomato genotypes evaluated, Assila was found to be moderately resistant as measured by the lower number of root galls and egg-masses per plant compared to the susceptible Marmande genotype. Hence, further study is required to evaluate the performance of Assila genotype in hot spot areas of *Meloidogyne* species and *Fusarium* species infested farmer's field conditions.

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Arbuscular mycorrhizal fungi as potential bioprotectant against *Meloidogyne incognita* on *Lagenaria siceraria*

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The present investigation was carried out to determine the interrelationship of arbuscular mycorrhiza (AM) fungi with root-knot nematode *Meloidogyne incognita* and their effect on carbon and nitrogen metabolism of *Lagenaria siceraria* (Molina) Standley, a mycorrhizal plant of family Cucurbitaceae. Biochemical analysis including carbon and nitrogen profiles was taken into account. The estimation of carbon profile comprising of carbohydrate, glucose, sucrose and total soluble sugars and nitrogen profile comprising of proteins, amino acids, protease and proline. Results showed that carbon profile in plant treated with AM fungi have high to low and varied amount of carbohydrates, sucrose, glucose and total soluble sugars in different parts of the plant; amino acids and proline in nitrogen profile found in higher amount in AM treated plants.

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Assessment of photosynthetic fluorescence in tomato cultivars infested with root-knot nematode

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Biotic stresses caused by nematodes create restrictions in plant growth. In this article, the physiological effects of root-knot nematode (*Meloidogyne incognita* Race 2) stress was assessed on photosynthetic fluorescence attributes in two tomato cultivars, Falat Y as a susceptible, and Gina VF as a tolerant cultivar. The experiment was done in a completely randomized split plot design under greenhouse conditions with four nematode populations, 0 (as control), 500, 1000 and 2000 second stage juveniles, and four sampling times (20, 40, 60 and 80 days after inoculation). After sampling, purification, identification, and population of root-knot nematode species and race were determined, and after amplification of purified population on the tomato cultivar cv. Rutgers, inoculums were sufficiently obtained. In four-leaf stage of the plant growth, the nematode inoculum levels were introduced, and photosynthetic parameters were evaluated at different times. The results showed that by increasing levels of nematode inoculum, chlorophyll fluorescence parameters were highly affected. In general, the nematode-stressed plants under both light and dark conditions, amount of minimum and maximum fluorescence (F_0 and F_m) and the difference between them (F_v), rate of non-photochemical quenching, photochemical quenching and descriptive parameter of non-chemical quenching increased, while the efficiency rate of photosystem II under both conditions trended to a downward with

increasing nematode levels. The correlation between nematode levels and various sampling times had different effects on the measured characteristics. Overall, Falat Y cultivar had relatively greater photosynthetic parameters than Gina VF cultivar.

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Larval migration of *Ascaridia galli* causes traumatic and toxic effects in chicken liver

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Studies were conducted to assess the effects of infection on histological changes in liver of chicken, experimentally induced with *Ascaridia galli* round worm. The postmortem examinations of infected chicken revealed histo-pathological lesions of infected liver that showed traumatic and toxic effects produced by the migrating *A. galli* larvae. Except on the top, central veins were not obvious. Inflammatory tracts produced by migrating larvae were prominent. Large vein with portal sluggish consisted of fibrinous material and inflammatory cells, disarrangement of hepatici and shrinkage of hepatocytes were found to have resulted into dilation of sinusoids.

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Study of *Psilenchus* species in pistachio gardens of Khorasan Razavi Province, Iran

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To identify *Psilenchus* species in pistachio gardens of Khorasan Razavi Province of Iran, 50 soil and plant samples from pistachio roots rhizosphere (Depth 30-50 cm) were collected during years 2016-2017. Samples were transferred on ice to laboratory and nematodes were extracted by centrifugal methods. *Psilenchus* species were identified on morphological and morphometrical characters based on recent valid keys. Seven species from *Psilenchus* genus were identified viz., *Psilenchus curcumerus*, *P. aestuarius*, *P. iranicus*, *P. hilarus*, *P. bilineatus*, *P. pratensis* and *P. bahiablancae* of which *P. bilineatus*, *P. pratensis* and *P. bahiablancae* are new reports of these species for Iranian nematode fauna.

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Prevalence of plant parasitic nematodes associated with grapevine in Minia Governorate, Egypt

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Grapevine orchards were surveyed for the prevalence of plant parasitic nematodes in Maghagha, Samallot, Minia and Abokorkas Districts of Minia Governorate. Soil and root samples were collected during fruiting seasons of grapevine in 2012 and 2013. The nematodes encountered were identified as *Meloidogyne* spp., *Helicotylenchus* spp., *Longidorus* spp., *Pratylenchus* spp., *Tylenchulus semipenetrans* and *Hoplolaimus* spp. Community analysis of these plant parasitic nematodes showed variability in nematodes population densities, frequencies, biomass and importance values in different Districts during 2012 and 2013. Root-knot nematodes *Meloidogyne* spp. was the most prevalent genus in the entire plant parasitic nematode community having highest relative frequency (0.78 and 0.83) in both years, respectively. The lowest relative frequencies (0.31

and 0.40) were recorded for *Hoplolaimus* spp., and *Longidorus* spp., in 2012 and 2013, respectively, *Helicotylenchus* spp. (0.44) and *Meloidogyne* spp. (0.42) were found with highest relative density in 2012 and 2013, respectively while the lowest relative densities (0.01 and 0.02) was recorded for *Hoplolaimus* spp. in 2012 and 2013, respectively. The highest biomass (1.25) and the highest importance value (1.69) recorded for needle nematodes, *Longidorus* spp., during 2012 and 2013, respectively. The lowest relative biomass (0.056) in both years was observed for *Meloidogyne* spp. while *Hoplolaimus* spp. exhibited the least importance value (0.64 and 0.79) in 2012 and 2013, respectively.

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Distribution and management of root-knot nematodes (*Meloidogyne* spp.) in tomato (*Lycopersicum esculentum*) in North Shoa Zone, Ethiopia

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A survey was conducted to assess the incidence and distribution of *Meloidogyne* spp., in major tomato growing districts (Kewet and Efratana Gidim) of the North Shoa Zone, Ethiopia. Soil and root samples were collected from 30 tomato farms represents six different localities of the two districts. The results revealed that the highest incidence percentage (80%) of the *Meloidogyne* species from root samples were recorded from three farms of district Kewet and three farms of district Efratana Gidim. *Meloidogyne incognita* and *M. javanica* were found infecting 70% of the surveyed tomato farms in mixture. *Meloidogyne incognita* was more prevalent than *M. javanica* from the surveyed tomato farms across the six localities. In a glasshouse experiment the intercropping of tomato with the antagonistic marigold followed by tomato with garlic intercropping was found highly reducing root galls, egg-mass and J₂ per plant as compared to the inoculated tomato-sole cropping and with other antagonistic plants. Further research is needed to evaluate the effectiveness of the antagonistic plants in the management of root-knot nematodes under farmer's field conditions.

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Evaluation of some plant species for their resistance against root-knot nematode *Meloidogyne* spp.

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The resistance of 4 cotton, 2 sesame, and 6 flax cultivars to the root-knot nematodes *Meloidogyne arenaria* (Ma), *M. incognita* race 1 (Mil) and/or *M. javanica* (Mj) was determined in green house studies. The results showed that the cotton cvs Giza 77, Giza 85, Giza 88, Giza 89 and sesame cvs Shandwil 1 and Toshka 1 were resistant (R) to the tested nematode species. On the other hand, six flax cultivars were tested, among them Giza 1 and Giza 5 were susceptible (S) to all the tested nematode species; Giza 6 was susceptible to Ma and Mj, while Sakha 1 was susceptible to Ma only. Giza 6 was highly susceptible (HS) to Mj only whereas Sakha 1 was highly susceptible to Mi and Mj. The flax cultivars Giza 7 and Giza 8 were susceptible to Ma and Mi while these were moderately susceptible (MS) to Mj only. In three separate experiments the response of 4 banana cultivars (Baladi, Grand Naine, Magraby and Williams), 3 peach rootstocks (Bitter almond, Baladi, and Nemaguard), and 6 ornamental

palm trees (California Washington palm, Mexican Washington, Canary date palm, Queen palm, Common palmetto, and Date palm) were tested for resistance to Mil and Mj. The banana and peach rootstock Bitter almond were highly susceptible to Mil and Mj. Baladi peach rootstock was highly susceptible to Mj. but resistant to Mil, whereas Nemaguard rootstock was resistant to both Mil and Mj. The tested palm trees viz., date palm, California and Mexican Washington palms were susceptible to Mil and Mj. whereas Canary date palm was moderately susceptible to both nematode species. The Queen palm was susceptible to Mil but moderately resistant to Mj. Common palmetto palm was moderately resistant to both Mil and Mj.

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Reaction of fodder beet varieties to *Meloidogyne incognita* based on quantitative and qualitative yield characteristics

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This study was conducted to evaluate six fodder beet genotypes for their resistance to infestation under naturally infected root-knot nematode, *Meloidogyne incognita* during the 2015/2016 and 2016/2017 seasons in Nubaria region, El-Behera Governorate, Egypt. Highly significant differences among the genotypes were detected for all studied traits except for fresh foliage weight. The relative susceptibility to root-knot nematode parameters (gall index, gall size, gall area and damage index) indicated that two fodder beet genotypes Beta Rozsa and Jamon were considered as the best with high yield and resistant reaction to *M. incognita*; in contrast Starmon genotype had highly susceptible reaction while Jary, Mnro and Vorosch genotypes had moderately resistant. Fodder root yield was positively and significantly correlated with root weight; meanwhile, it was negatively and significantly correlated with damage index and gall index, respectively. These findings indicate that selection for root weight and infestation involved in this study affected the variability of root yield. Stepwise multiple regression linear analysis for fodder beet yield showed that root weight per plant, gall index, number of leaves per plant and dry weight per plant were the most important contributing traits to root yield ($R^2 = 94.76\%$). Hence, the selection among these traits would be accompanied by high yielding and more effective for the improvement of fodder root yield in the same conditions.

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Quantitative changes of chitinase and β 1, 3 glucanase in cucumber roots pre-colonized by VAM fungus against *Meloidogyne incognita*

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Chitinase and β 1, 3 glucanase activities in susceptible and tolerant cucumber roots pre-colonized with *Funneliformis mosseae* against root knot-nematode *Meloidogyne incognita* were studied. Mycorrhizal plants which pre-colonized for 7 weeks inoculated with 1500 J₂ per 1 kg soil. The quantitative activity of chitinase and β 1, 3 glucanase enzymes was assessed on 2, 4, 6 and 8th days after *M. incognita* inoculation based on split-plot in time design. Also the results showed that AMF pre-inoculation caused a significant decrease in RKN pathogenicity factors (number of galls, eggs, egg sacs and J₂) in both tolerant and susceptible

cultivars. Inoculation of susceptible roots with AMF significantly reduced the nematode pathogenicity factors. Also the results indicated that the activity of both enzymes increased in the plant with AMF compared with the cucumber roots inoculated with *M. incognita* alone. Cucumber mycorrhizal roots showed the highest mean activity of chitinase and β 1, 3 glucanase respectively on the 4th and 6th days after M.i inoculation. Preinoculation of AMF increased significantly the activity of both enzymes in cucumber cultivars inoculated with nematode. Although, the level of chitinase and β 1, 3 glucanase enzymes in tolerant cucumber was significantly higher than susceptible on different days. We concluded that 'increasing cucumber tolerance to root-knot nematode can be related to involvement of chitinase and beta-1,3-glucanase. So vesicular arbuscular mycorrhizae can be considered as a suitable option for biocontrol of the root-knot nematodes

2019, Vol. 37(2): 149-160

Management of *Meloidogyne incognita* on tomato with different biocontrol organisms

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The effect of biocontrol agents comprising *Bacillus* sp., and *Streptomyces rubrogriseus* on the management of the root-knot nematode *Meloidogyne incognita* was investigated along with a nematicide Fosthiazate on tomato susceptible cultivar cv. Baiguqiangfeng. The *S. rubrogriseus* culture filtrates (CF) showed maximum mortality of second stage juvenile (J₂) followed by *Bacillus* sp., at 12 h and 24 h duration of exposure time as compared to the control treatment containing medium (L.B). In the green house experiments Fosthiazate had significant increased the root length, shoot length and reduced the number of root-knot nematode galls on tomato roots followed by biocontrol agent *S. rubrogriseus* and *Bacillus* sp., as compared to the untreated control treatment after 60 DPI and 90 DPI.

2019, Vol. 37(2): 161-170

Overview of the nematode fauna of Pakistan

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This research publication provides a comprehensive indexed resource of plant parasitic, soil, marine and entomopathogenic nematode species described and reported during last sixty nine years (1952-2019) from Pakistan. The information compiled in this paper came gradually from many and diverse sources. It is the product of the efforts of several authors who contributed to gather knowledge on the biological diversity through systematics and faunistic studies. Information published in different scientific journals, newsletters, reports, book chapters, books booklets and proceedings have been considered. Those records contained in abstracts of conferences/ congresses, doctoral theses were not included. A total of 749 species belonging to 261 genera of 81 subfamilies, 85 families of 24 Superfamilies, 19 suborders of 12 orders have been described and reported so far from Pakistan in which 232 species are new to science. The paper includes i) new nematode species described from Pakistan in chronological order; ii) species of plant parasitic nematodes; iii) species of free-living soil nematodes; iv) species of marine nematodes; v) species of entomopathogenic nematodes all in alphabetical order and vi) taxonomic position of the all nematode species of Pakistan.

2019, Vol. 37(2): 171-243

***Tylenchorhynchus usmanensis* Khurma & Mahajan, 1987, a new record of plant parasitic nematode from Pakistan**

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The soil samples were collected from underground vegetable fields of Punjab and Khyber Pukhtunkhwa provinces. The plant parasitic nematodes were extracted from soil samples by Cobb's sieving and decanting method (Cobb, 1918) followed by modified Baermann technique (Baermann, 1917). After processing, the nematode genera and species were identified (Siddiqi, 2000). *Tylenchorhynchus usmanensis* is reported from the first time from Pakistan is briefly redescribed and illustrated.

2019, Vol. 37(2): 245-247

Short Note

Host-suitability of maize varieties to *Meloidogyne incognita*

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As *Meloidogyne incognita* is an economically important pest parasitizing maize crop therefore, a study was carried out under plant house condition to assess the reaction of three maize varieties viz., Abeleehi, Mamaba and Obaatanpa to *M. incognita* parasitism between May and July 2017. Asontem, okra variety was used as a positive control. A pot experiment was carried out in a Completely Randomized Design with five replications. Average temperature of $25 \pm 1^\circ\text{C}$, 12 h photoperiod and relative humidity of $87 \pm 1\%$ were observed in the plant house during the study period. Mamaba, Obaatanpa and Abeleehi maize varieties exhibited resistance potential by suppressing reproduction, development and establishment of the obligate parasite. Gall index, stem girth, plant height, reproduction factor and shoot dry matter weights were not significantly affected. In the current study high gall indices recorded on the positive control (okra) is due to okra's susceptibility to *Meloidogyne incognita* infestation.

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Description of *Discolaimus miniodontii* n.sp. and *Laevides hunderansis* n. sp. with notes on *Discolaimoides spatilabium* (Nematoda: Dorylaimida) from District Ghizer, Gilgit-Baltistan, Pakistan

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Soil samples collected from District Ghizer, Gilgit, Baltistan, Pakistan, yielded two new and a known nematode species of the order Dorylaimida viz., *Discolaimus miniodontii* n. sp. and *Laevides manilkarii* n. sp.; and a new report of a known species *Discolaimoides spatilabium* from District Ghizer, Gilgit-Baltistan, Pakistan. *Discolaimus miniodontii* n. sp., is characterized by having smallest odontostyle (9-10µm); relatively smaller and slender body (L=1.0-1.14mm; a= 38.5-45.8); sclerotized odontostyle, its aperture occupying 50-55% of its length; oesophagus with conspicuous muscular sheath in the expended part of oesophagus; basal part of oesophagus expended gradually 51-54% of the total neck length. *Laevides hunderansis* n. sp.,

collected from district Ghizer village, Hunder of Gilgit-Baltistan is characterized by the smallest body (0.7-0.8mm), small moral tooth (7-8 μ m), short spicule, gubernaculum and tail length (24, 5, 14 μ m, respectively) and by the presence of one supplement within the spicular range.

2020, Vol. 38(1): 1-13

Biochemical and molecular characterization of *Photorhabdus akhurstii* associated with *Heterorhabditis indica* from Meerut, India

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A population of *Heterorhabditis* (DH3) was isolated from agricultural fields from Meerut district, India by insect baiting technique. The isolate was identified as *Heterorhabditis indica* based on morpho-taxometrical and molecular analyses. The present populations were identical to the original description; however, the size of the 3rd stages was longer than the topotype populations. Analysis of ITS-rDNA sequences showed 1 nucleotide base pair difference in aligned data with type description, however, no nucleotide base pair difference was seen in the D2D3 domain. The associated bacterial symbiont of the DH3 strain was identified as *Photorhabdus akhurstii* based on phenotypic, biochemical and 16S rDNA data. Most of the biochemical tests were negative and only three tests were found positive viz., Urease, Nitrogen reduction and Oxidase. Further, we evaluated its pathogenicity against *Galleria mellonella* and *Helicoverpa armigera*. The LD50 value of strain DH3 against *G. mellonella* larvae at 48 hours was 8 IJs/larva for 50% larval mortality whereas in *Helicoverpa armigera* it needed 13 IJs/larva, to kill 50% of the larvae.

2020, Vol. 38(1): 15-24

Diversity of nematode fauna associated with cotton fields of high temperature areas of Sindh, Pakistan

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Diversity of nematode fauna in relation to their occurrence in high temperature cotton growing areas of Sindh by using Euclidean distance has been estimated. The fauna obtained in June 2017 and June 2018 surveys of cotton fields of five Districts Sanghar, Mirpurkhas, Umerkot, Mitari and Tando Allah Yar of Sindh where temperature in May to July raised up to 40°C -50°C. The data was subjected to construct the dendrogram for interpretation on the basis of their prevalence. In order to estimate nematode species diversity, richness and evenness, the data has been submitted for calculating the diversity parameters such as Dominance (D), Simpson's diversity index (1-D), Shannon diversity index (H'), Evenness (e), Brillouin Diversity Index (HB), Menhinik Diversity, Margalef's richness index, Equitability (J) and Fisher's alpha. All estimated parameters of diversity has interrelation among all nematode genera in particular but no correlation have been found establish between genera with reference to temperature fluctuation during studied years

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Occurrence of entomopathogenic nematodes in Osun State, Southwestern Nigeria

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In this study the occurrence of entomopathogenic nematodes (EPNs) was determined in three senatorial districts of Osun State in relation to soil texture, vegetation, moisture and pH. A total of 110 soil samples were randomly collected from various cultivated fields in different locations. The soil samples were baited twice using last instar larvae of the *Galleria mellonella* (greater wax moth) for presence of entomopathogenic nematodes. Four EPN isolates were recovered viz., *Heterorhabditis indica*, *Heterorhabditis bacteriophora*, *Steinernema karii* and *Steinernema wieseri*. Of a total of 110 soil samples examined, EPNs were found in 90.90% soil samples, they belonged to the genera *Steinernema* and *Heterorhabditis*. *Steinernema* spp. was found prevalent in both cultivated and undisturbed soils. Frequency of occurrence of EPNs in the sampled soils from the different senatorial zones was determined: soil samples from the Central zone recorded the lowest prevalence 87.50% while the soil samples from Western senatorial zone revealed 91.43% presence of the EPNs. The highest frequency of occurrence of EPNs-94.29% was recorded in the soil samples from Eastern senatorial zone. Nematode distribution and frequency was found to be related to soil pH (pH<4.5 to pH>7.2) and soil moisture. This is the first report of these nematodes from Osun State, Nigeria. 2020, Vol. 38(1): 37-43

Evaluation of media for mass production and fermentation of *Pseudomonas* spp. for integrated management of cereal cyst nematode (*Heterodera avenae*)

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In this study investigation of different carbon and nitrogen sources in various types of media compositions was made to optimize the fermentation and mass production of *Pseudomonas* spp. Among all the media compositions, the suitable media containing carbon and nitrogen sources were found as media No.9 (Corn flour 50g/L, Glucose 8g/L, Soybean Cake Powder 20g/L, Wheat bran 20g/L, NaCl 4g/L) followed by No.10 (Corn flour 40g/L, Soybean Cake Powder 30g/L, Yeast Extract 5g/L, Wheat bran 20g/L, NaCl 4g/L, KH₂PO₄ 5/L, MgSO₄ 1.5g/L), No.08 (Corn flour 17g/L, Glucose 10g/L, Soybean Cake Powder 25g/L, Maltose 10g/L, Yeast Extract 5g/L) and No.05 (Corn flour 5g/L, Yeast Extract 1.5g/L, Fish Peptone 2.5g/L, Soybean Cake Powder 20g/L, Peptone 0.75g/L, KH₂PO₄ 3g/L, CaCO₃ 0.5g/L, MgSO₄ 0.3g/L) for the mass production of *Pseudomonas* spp., after 100 hours (4days). The bacterial culture filtrates produced during fermentation in different media compositions showed varied results on the bioassay against the second stage juvenile mortality (J₂) of *H. avenae*. The culture filtrates formed in media No.8 (Corn flour 17g/L, Glucose 10g/L, Soybean Cake Powder 25g/L, Maltose 10g/L, Yeast Extract 5g/L) and media No.5 (Corn flour 5g/L, Yeast Extract 1.5g/L, Fish Peptone 2.5g/L, Soybean Cake Powder 20g/L, Peptone 0.75g/L, KH₂PO₄ 3g/L, CaCO₃ 0.5g/L, MgSO₄ 0.3g/L) has more toxic effects on the second stage juvenile (J₂) mortality as compared to rest of secondary metabolites produced in different media and control treatments. All tested strains of *Pseudomonas* spp. showed stability on pH ranges from acidic pH5 to neutral pH7 and towards basic pH8 against the second stage juvenile (J₂) mortality assay. 2020, Vol. 38(1): 45-55

Evaluation of biological seed treatments for management of *Rotylenchulus reniformis* on cotton

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Greenhouse experiments were conducted to assess the effectiveness of potential biological control products to manage and evaluate the development of *Rotylenchulus reniformis* on cotton. Tests included seeds treated

with the Abamectin, ILeVo, and a non-treated control. Results showed that seed treatment with Abamectin and *Burkholderia* sp., suppressed the numbers of *R. reniformis* eggs significantly. Seeds treated with Abamectin and bacteria had fewer vermiform adults in the soil in comparison with the non-treated seeds. The bacteria and *Burkholderia* spp., seeds treatments drastically suppressed the number of eggs isolated from cotton roots compared with the non-treated control. Abamectin also inhibited the number of vermiform life-stages found in the soil as compared to the non-treated control. Biological seed treatments produced no negative effects on plant growth. The use of different biological control agents as seed treatments can manage plant-parasitic nematodes and limit the crop damage.
2020, Vol. 38(1): 57-65

Control of root-knot nematodes using wild plants colonized Sinai, Egypt

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The antinematodal activity of some wild plant extracts located in North and South Sinai, Egypt was examined against root-knot nematode (RKN). The selected seven plants viz., *Artemisia judaica*, *A. monosperma*, *Bassia muricata*, *Cornulaca monacantha*, *Salsola kali* and *Zygophyllum album* with different dilutions (25%, 50%, 75% & 100%). The potent nematocidal efficacy observed in the extract of *A. judaica* followed by *A. monosperma*. *In vivo* trial post inoculation treatments were effective than pre one, the maximum reduction in nematode population was recorded by *A. judaica* (87.0%) followed by *A. monosperma* (83.0%) then *Z. album* (79.0%), while the lowest suppressor was *C. monacantha* (60.4%) at stock concentration. The addition of extracts as soil drench was better than spraying them. The stock solution showed the highest reduction in nematode reproduction but the differences between 100% and 75% concentrations were non-significant. Our finding offers a non-poisonous tool that can insert in combating nematode programs especially for small-holder growers colonized Sinai Peninsula.

2020, Vol. 38(1): 67-80

Description of new nematode species *Rhabdochona (Rhabdochona) sindhicus* of genus *Rhabdochona* (Railliet, 1916) from Indus River Pakistan

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New nematode species of genus *Rhabdochona* collected from host catfishes *Rita rita* of Indus River, Jamshoro, Sindh, Pakistan. Collected nematodes were processed with standard method for feature research. New species *Rhabdochona (Rhabdochona) sindhicus* differs from other species of genus with body shape and size, buccal capsule shape, prostomal teeth arrangement, nerve ring position, 18 pairs of caudal papillae, spicules shape curved and broad anteriorly and pointed posteriorly, female genital structures, shape of posterior end in male and female, eggs shape and boundary. Due to morphometric differences between present and previously described species of *Rhabdochona* the *Rhabdochona sindhicus* n. sp. is proposed.

2020, Vol. 38(1): 81-91

Chitinase activity of biocontrol fungi cultured from the golden potato cyst nematode, *Globodera rostochiensis*

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One hundred and fifty-four fungal isolates were compared for their ability to degrade chitin by the *N*-acetylglucosamine-dinitrosalicylate method. Ten isolates with high chitinase activity were selected for further characterization. Of the 10 selected isolates, three chitinase enzymes were evaluated using three substrates. Based on the results of our chitinase assay, *Beauveria bassiana*, *Lecanicillium muscarium*, *Paecilomyces* sp. and *Trichoderma atroviridae* had the highest activity. We selected these four isolates to determine the optimum pH, temperature, and reaction time. Zymography was also used to demonstrate the chitinase activity of the four isolates. The biocontrol potential of 10 selected isolates was assayed in water-agar *in vitro* and under greenhouse conditions. *L. muscarium* had the most potential and *Fusarium solani* was the least based on the number of parasitized juveniles and eggs in water-agar. Greenhouse trials showed *T. atroviridae* and *B. bassiana* had the highest dry root weight and tuber yield.

2020, Vol. 38(1): 93-101

Short Note

Biochar effect on nematodes and insects population density, soil improvement and yield of okra

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The biochar used for the studies was obtained from two different feed stocks; rice husk and corn cob, respectively. These feed stocks were carbonized at a temperature of 650-700°C as measured with a thermocouple in a process known as Pyrolysis. Pyrolysis time was two days using a simplified reactor. The treatment, Corn cob at 4t/ha consistently had reduced nematodes population densities at both locations. Untreated plots had higher nematode populations during the period of experimentation. Six treatments: Rice husk biochar @ 4tons/ha, rice husk biochar @ 2 tons/ha, corn cob biochar @ 4tons/ha, corn cob biochar @ 2tons/ha, recommended fertilizer (150 kg NPK/ha) and control (no treatment) were tested on a local okra var. (Project Manager). The treatments were laid out in a randomized complete block design and replicated 4 times at each location. Biochar was applied in-situ at both locations. The recommended fertilizer was however applied barely two weeks after germination. Both rice husk and corn cob biochar were antagonistic to root-knot nematodes. Application of the biochar material resulted in significant population reductions and root galling indices which reflected in significant yield increases compared with the control treatment.

2020, Vol. 38(1): 103-106

Effect of some temperature changes on the population density of some plant parasitic nematode species

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The numerical fluctuations in plant parasitic nematode population densities naturally found in clay loam soil and roots at a depth of 60-cm from the soil surface and at a distance of 1m from trunk of date palm of Zaghoul cultivar (Youssef & Eissa, 1994) were studied. Seasonal fluctuation in population density of the

reniform nematode, *Rotylenchulus reniformis* in soil and roots were negatively correlated with the prevailing soil temperature and were positively correlated with percentage soil moisture at different sampling months and seasons. Spiral nematode, *Helicotylenchus* population was found in soil because its most species act as ectoparasites in soil, feeding on the outer layers of roots. Its numbers reached the peak in July and September which directly and positively correlated with the medium soil temperatures (28 and 24°C, respectively) and the lowest numbers were observed in March as the soil temperature was relatively moderate (20°C). This degree seemed to be relatively moderate at this period on the basis that soil temperature is higher than air temperature. The population of root-knot nematode, *Meloidogyne incognita*, fluctuated without a significant increase throughout the study year.

2020, Vol. 38(1): 107-109

Description of seven new species and one new record of plant-parasitic nematodes (Nematoda: Tylenchida) associated with economically important crops of Kashmir Valley, Jammu and Kashmir (Part-1 of the series)

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During the survey of soil and plant-parasitic nematodes of vegetable and fruit crops of Kashmir valley, Jammu and Kashmir, seven new species and one new record of following species were recovered: *Helicotylenchus siddiqii* sp. nov. from soil around roots of *Glycine max* L. Miller, from Kashmir University Campus, Hazratbal, Srinagar, Kashmir; *H. fotedariensis* sp. nov. from soil around roots of *Brassica oleracea* var. *botrytis* L. from Zadibal, Srinagar, Kashmir; *H. harwaniensis* sp. nov. from soil around roots of *Lycopersicon esculentum* Miller, in Harwan, Srinagar, Kashmir; *H. mushtaqi* sp. nov. from soil around roots of *Brassica oleracea* var. *capitata* L. in Darbagh, Harwan, Kashmir; *Pratylenchus badamwariensis* sp. nov. from the roots of *Prunus amygdalus* Batsch, in Badarnwari, Hawal, Srinagar, Kashmir; *Boleodorus seshadrii* sp. nov. from soil around roots of *Glycine max* (L) Miller, in Aru, Pahalgam, Jammu and Kashmir; *Macroposthonia iqbalii* sp. nov. from soil around roots of *Pyrus malus* L., from Kashmir University Campus, Srinagar, Kashmir and *Pratylenchus ekrami* Bajaj and Bhatti, 1984 from the roots of *Solanum tuberosum* L. in Narwara, Srinagar, Kashmir represents a new record of this species from the State of Jammu and Kashmir. Morphological and morphometric details, line drawings along with description, characteristics, diagnosis and relationships of each new species with its closely related species are given.

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Compendium of the genus *Psilenchus* de Man, 1921 (Tylenchida: Psilenchidae)

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The compendium of the genus *Psilenchus* de Man, 1921 comprised of 19 species based on the characteristics of the total body length, ratio of a, b, c, c', V%, stylet, MB, head shape, tail length, DGO, oesophagus, excretory pore, spicules and gubernaculum. The allometric and morphometric characteristics were derived from the original descriptions. An updated list of valid species of *Psilenchus* de Man, 1921 along with illustrations of the anterior and posterior regions taken either from the original descriptions or subsequent re-descriptions is also incorporated herein. A total of seven species have so far been reported from Pakistan.

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Soybean genotypes response to root-gall nematode

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Twenty local and imported soybean (*Glycine max*) genotypes were evaluated for susceptibility to root-gall nematode (RGN), *Meloidogyne incognita* race 2, under greenhouse conditions. Significant differences among the genotypes resistance degrees were achieved. Substantial variations existed among the soybean genetic resources with regard to the evaluated parameters. According to reduction percentage in reproduction factor (RPRF), the tested genotypes were ranked as resistant or susceptible to challenge nematode genus. The genotypes viz., G22, G111(100% RF) were found to be highly resistant (HR), genotypes ranked as resistant (R) viz., C97, H2, CV1, Clark, A7 (99.97, 99.96, 98.73, 98.29 and 97.06% RF, respectively), moderately resistant (MR) category was achieved by seven genotypes (G21, CV2, Carford, Katler, G35, C11 and AG in which RF values varied between 76.01-91.72%). Two genetic resources (Tano and A10) reacted as low resistant (LR) their RF were 65.22 and 72.20%, successively. Susceptible (S) reaction was possessed by two genotypes (G82 and A11), also highly susceptible (HS) response was registered by the rest two genotypes, L2b3 and Holiday which were the most suitable one that recorded the highest rates of reproduction 17.26, 23.23 and used as susceptible standard. In general, growth of the tested genotypes was negative to nematode infection. Results obtained in the present study could be used for the planning of crop rotation systems as well as the identification of resistance sources for breeding purposes.

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Virulence and distribution trends of root-knot nematode (RKN) fauna on summer vegetables in district Bagh, Azad Jammu and Kashmir (Pakistan)

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Root-knot nematodes (RKNs) are important group of plant parasitic nematodes belong to genus *Meloidogyne* with extensive host range. A comprehensive survey study was carried out to document host and non-host plants in cultivated fields of Bagh district, Azad Jammu and Kashmir. Total of 111 vegetable fields from 82 locations of study areas was surveyed during summer 2013, 2014, 2016 and 2017. Okra, eggplant, tomato, cucumber, chilies, beans and cucurbits were found most frequently cultivated vegetables in the area. RKN was found on 80 fields, with 68 out of 82 surveyed locations with 72% field incidence. Okra was found with highest field infestation with 47.3% followed by cucurbits on 20% and tomato on 17.4% while zero infestation on chilies. Species were identified based on perineal pattern morphology. *M. javanica* was identified as predominant species of the study area. RKN tropical species was found on *M. incognita* 37%, *M. javanica* 38% and *M. arenaria* 28% sites parasitizing vegetable crops. Host preference of *M. javanica* and *M. incognita* was detected in mixed field conditions as *M. javanica* preferred okra as host while *M. incognita* reproduced maximum on tomato. Common beans were found most susceptible host providing survival opportunity to RKN due its heavy intercropping with field crops and vegetables. Understanding regarding pathogen survival under adverse conditions will help the scientists to develop new approaches for sustainable yield.

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Performance of cereal varieties against cereal cyst nematode (*Heterodera avenae*)

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The soilborne pathogen cereal cyst nematode (CCN) *Heterodera avenae* is one of the biotic stress factors that directly affects the crop physiology from seed germination to crop maturity and limits the cereal production in different agro-ecologies of the world. In China, this pathogen is widespread in more than 20 Provinces and infects the major cereal varieties and germplasm being adopted for cereal crop production annually. We tested number of cereal accessions to see the host pathogen interaction; among 15 wheat lines from Zhongnongyuan Sun (CAAS) CIMMYT Beijing and 10 lines of oats from Jilin Province were screened against *H. avenae*. The results showed that 5 wheat and 7 oat lines ranked as resistant genotypes while 9 wheat and 3 oat lines were ranked as moderately resistant and 1 wheat line and the local check were highly susceptible to *H. avenae*. These genotypes need to be exploited in breeding program to introduce the resistance gene pool in local cereal cultivars for resistance to *H. avenae* in China.

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Status of phytonematodes in a main commercial banana production of Upper Egypt

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The fields of banana (*Musa sapientum* L.) cultivations were surveyed for the prevalence of phytonematodes in Assiut governorate at middle of Upper Egypt. The encountered phytonematodes were identified during the survey belong to sixteen genera comprising sixteen genera belonging to nine families viz., *Criconemella*, *Criconemoides*, *Ditylenchus*, *Helicotylenchus*, *Heterodera*, *Hoplolaimus*, *Longidorus*, *Meloidogyne*, *Paratylenchus*, *Pratylenchus*, *Radopholus*, *Rotylenchulus*, *Rotylenchus*, *Tylenchorhynchus*, *Tylenchus* and *Xiphinema*. It was observed that there was variability in population density, frequency of occurrence and prominence value of some plant parasitic genera e.g., *Meloidogyne* in Abo-Teg and East Mangabad has the most prominence value (17.20 and 19.80) followed by *Longidorus* and *Radopholus* in Manfalot (17.20 and 15.36), respectively. The lowest prevalent genus was *Heterodera* which was absent in two surveyed localities viz., Abo-Teg and Assiut regions but present in Manfalot and East Mangabad with the prominence value 1.82 and 0.22 and population densities 43 and 11, respectively.

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Description of *Aphelenchoides acacia* n. sp. and *Aphelenchoides naurangiensis* n. sp. (Nematoda: Aphelenchoididae) with observation on *Aphelenchoides saprophilus* Franklin, 1957 from District Lakki Marwat, Khyber Pakhtunkhwa, Pakistan

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Two new species belonging to genus *Aphelenchoides* viz *Aphelenchoides acacia* n. sp. retrieved from soil sample of kikar (*Acacia nilotica* L.), ber (*Ziziphus mauritiana* L.) and paper flower (*Bougainvillea*

spectabilis L.) and *Aphelenchoides naurangi* n. sp. recovered from soil samples of wheat (*Triticum aestivum* L.), thoroughly described and illustrated from District Lakki Marwat, Khyber Pakhtunkhwa, Pakistan. The new species namely *Aphelenchoides acacia* n. sp. belongs to the Group 2 of *Aphelenchoides* Species Sensu Shahina is characterized by small body length 358-496 µm; cephalic region non offset from the body. Cuticle weakly annulated, approximately 1µm apart in mid body region with transverse striae. Lateral field with four incisures; stylet 11-13µm long having small basal thickening at the base; tail ventrally curved J- shaped; terminus with very tiny smooth mucro (1µm). *Aphelenchoides naurangi* n. sp. belongs to Group 1 of *Aphelenchoides* species and is characterized by small body length 406-492 µm; cephalic region clearly offset from rest of the body; cuticles finely annulated approximately 1µm apart. The lateral field with four incisures; stylet short 09-10 µm long having clear basal knobs at its base; tail cylindrical, conoid with a rounded terminus. In addition, morphometrics and morphological details are given for *Aphelenchoides saprophilus* which is the first record for Pakistani nematode fauna.
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Study of plant parasitic nematodes and description of new record (*Rotylenchus alius*) associated with barley (*Hordium vulgare* L.) in Khorasan Razavi Province, Northeast Iran

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Surveys were conducted in barley (*Hordium vulgare* L.) fields of Khorasan Razavi Province, Northeast Iran, during 2015-2017. A total of 120 soil and root samples were collected to examine the prevalence of plant parasitic nematodes. In morphological and morphometrical identification 18 species were recorded belonging to nine genera. Among these species, *Rotylenchus alius* was found as a new record from Iran and *Basiria gracilis*, *Boleodorus thylactus*, *Ditylenchus apus* and *Meloidogyne arenaria* were reported as new host record from barley fields of Iran. *Meloidogyne arenaria*, was selected for detailed investigation at molecular level. Molecular traits on *Meloidogyne arenaria* species done by partial 18s ribosomal DNA primer and sequence results verified the morphometric studies and showed 99 percent resemblance to AB905316 sequence from Japan. In addition, scanning electron microscope (SEM) assay on infected roots by *Meloidogyne arenaria* showed that this species has been able to create gall in barley root and disrupt on cellular metabolism.

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The role of genetic engineering in management of plant parasitic nematodes with emphasis on root-knot nematodes: A Review

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Genetic engineering can be defined as the formation of new combination of heritable material (DNA) by the insertion of nucleic acid molecules produced outside the cells into any virus, bacteria, plasmid or other vector system in which they are capable of continued propagation. *Azotobacter* spp. with nematicidal activity could control root-knot nematode, *Meloidogyne incognita*. The development of such strains by genetic manipulation by transferring gene (s) required for saponins production is effective in increasing crop yield together with fixing nitrogen. *Escherichia coli* is still used as a host for the recombinant DNA technology – based industrial production of proteins and peptides to manage root-knot nematode. Mi gene resistance in tomato plants has

been utilized to manage *M. incognita* and *M. javanica*. Also, protoplast fusion between *Pseudomonas fluorescens* and *P. aeruginosa* to manage *M. incognita* was utilized. Many genes expressed in nematode feeding cells or the regulatory regions that control these genes have been isolated. Transproteins toxic to different plant parasitic nematodes can be expressed into tissues and cells feed upon by nematodes. Transgenic products with a potential to interfere with nematode physiology such as digestive enzymes or structural proteins of the intestine are considered.

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