Pakistan J. Zool., vol. 50(3), pp 1195-1198, 2018. **DOI**: http://dx.doi.org/10.17582/journal.pjz/2018.50.3.sc4

Short Communication

Re-Emergence of Wheat Seed Gall Nematode (*Anguina tritici*) in Punjab, Pakistan

Tariq Mukhtar,[1,*] Abdul Jabbar[1], Muhammad Usman Raja[1] and Humayun Javed[2]

[1]*Department of Plant Pathology, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi*

[2]*Department of Entomology, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi*

ABSTRACT

The objective of the present study was to determine the latest distribution of wheat seed gall nematode *Anguina tritici* (Steinbuch) in Sargodha division of the Punjab province of Pakistan. The overall incidence of ear cockle of wheat in the division was found to be 1.2% while the overall prevalence was 27%. As regards districts, the maximum incidence was recorded in district Bhakkar followed by Khushab. Similarly, the maximum prevalence was observed in district Bhakkar followed by Sargodha while it was the minimum in district Khushab. The incidence of the nematode was found to be variable on different wheat cultivars. The maximum incidence was recorded on cultivar Chakwal-50 followed by Faisalabad-2008 and Lasani-2008 whereas the minimum incidence was observed on cultivars Punjab-2011 and Millat-2011. No incidence of the nematode was recorded on Shafaq-2006 and Aas-2011 cultivars. As the nematode was found prevalent throughout Sargodha division with quite low incidence, therefore, it is imperative to keep the nematode under constant surveillance and stringent control strategies should be adopted to prevent the nematode from becoming a threat to wheat. Similarly, no incidence of the nematode was recorded on Shafaq-2006 and Aas-2011 cultivars, therefore, cultivation of these cultivars should be encouraged.

Article Information
Received 05 November 2017
Revised 02 December 2017
Accepted 12 December 2017
Available online 20 April 2018

Authors' Contributions
TM designed and supervised the study. AJ executed experimental work and analyzed the data. MUR and HJ assisted in writing the manuscript.

Key words
Seed gall nematode, Incidence, Prevalence, Distribution, Resurgence.

Wheat seed gall nematode, *Anguina tritici*, is commonly found where the practice of sowing clean seed is not followed. The disease caused by this nematode is known as ear cockle of wheat as the grains are converted into cockles. Its occurrence has been reported from North Africa, Western Asia, Indo-Pak subcontinent, China and some parts of Eastern Europe, Iraq, Turkey. It has also been known to be present in Australia, Brazil, Egypt, New Zealand, Russia and the United States of America (CABI/EPPO, 2002; EPPO, 2014, 2015; PERAL, 2015).

Wheat, rye and barley are the common hosts of *A. tritici* throughout the world but in India barley is not frequently attacked (Paruthi and Gupta, 1987). *A. tritici* is one of the important pests of wheat in Iraq and its infection on wheat has been reported up to 22.9% resulting in 30% reduction in yield. The nematode has been reported to infect barley from Iraq much later where its infestation reached up to 90% (Al-Talib *et al*., 1986; Stephan, 1988; Kassi et al., 2018; Nabeel et al., 2018; Rahoo et al., 2017, 2018). The nematode is one of the major pests of wheat in Pakistan and has been found prevalent in most of the wheat growing areas causing yield losses up to 3%. The yield losses were even more serious when the nematode was found associated with yellow ear rot causing bacterium on wheat (Maqbool, 1988). In wheat, losses up to 100% have been reported by Paruthi *et al*. (1987), 90% by Reddy (1983), up to 52% by Paruthi and Bhatti (1988) and 50 and 65% losses in wheat and rye respectively by Leukel (1957). In terms of money, losses worth Rs. 6.54 million have been reported in India (Sakhuja *et al*., 1990). Yield losses ranging from 10 to 30% have also been reported from China (Chu, 1945). An inoculum density of ten thousand juveniles of *A. tritici* must be present in one kilogram of soil to develop the disease. The severity of the disease increased significantly if the nematode galls are present at the depth of 2 to 6 cm.

A. tritici is a large nematode and measures about 3 to 5 mm in length. It is an ectoparasite and becomes endoparasitic after entering the floral primordia. The nematode survives in the galls or in plants infected in the fall. Seeds infested with galls or the galls fallen to the fields act as the inoculum of the disease. In the presence of suitable moisture and temperature, the galls soften; infective second stage juveniles emerge and swim upward in a thin film of water. On wheat it causes stunting of plants, distortion, wrinkling and twisting of leaves. Seeds

* Corresponding author: drtmukhtar@uaar.edu.pk
0030-9923/2018/0003-1195 $ 9.00/0

are transformed into galls which contain a dried mass of nematodes. If compared to normal wheat seeds, galls are smaller in size, lighter, and their color ranges from light brown to black.

During routine filed surveys, the disease was found in some fields. So it was planned to conduct a comprehensive survey of wheat fields in Sargodha division to record the incidence and prevalence of seed gall nematode. The study will help in designing strategies to prevent the disease from becoming a major threat.

Table I.- Incidence and prevalence of ear cockle of wheat in Sargodha division.

District	Tehsil	% Incidence	% Prevalence
Sargodha		1.0	31
	Sahiwal	1.1	40
	Sillanwali	1.0	34
	Shahpur	1.0	30
	Sargodha	1.2	30
	Bhalwal	0.7	31
Khushab		1.2	18
	Khushab	1.0	30
	Quaid Abad	0.5	10
	Nur pur thal	1.7	15
Bhakkar		1.5	37
	Kloor Kot	2.1	60
	Darya Khan	2.0	50
	Bhakkar	0.8	20
	Mankera	1.2	20
Mianwali		1.0	20
	Piplan	0.8	20
	Mianwali	1.0	20
Overall		1.2	27

Materials and methods

In order to record the incidence of ear cockle of wheat in Sargodha division, fields were randomly selected from 14 tehsils of four districts (Sargodha, Khushab, Bhakkar and Mianwali) of Sargodha division of the Punjab province. A total of 149 villages were visited and from each tehsil of each district 10-11 fields were randomly selected. The fields were visited only once during the survey when the crop was at actively growth stage. From each field four quadrates of 1 m^2 each were taken and total numbers of healthy and infected plants were counted. The incidence in each field was determined by the method described by Mukhtar *et al.* (2017). During surveys different factors *i.e.* age of crop, variety cultivated, area under cultivation, date of sowing, number of irrigations, fertilizers and pesticides were also recorded. Similarly, incidence in each field of each district was recorded and the individual incidence in each tehsil and district was calculated. The prevalence of seed gall nematode in each tehsil and district was determined as described by Fateh *et al*. (2017). The incidence on each cultivar in each district and overall incidence on each cultivar was also calculated. All the graphs were made in Microsoft Excel 2007.

Results

The overall incidence of ear cockle of wheat in Sargodha division was found to be 1.2% while the overall prevalence was 27%. As regards districts, the maximum incidence was recorded in district Bhakkar followed by Khushab. Similarly, the maximum prevalence was observed in district Bhakkar followed by Sargodha while it was the minimum in district Khushab as shown in Table I, which also shows Tehsil-wise incidence and prevalence in the four districts. The incidence of the nematode was found variable on different cultivars. The maximum incidence was recorded on cultivar Chakwal-50 followed by Faisalabad-2008 and Lasani-2008 whereas the minimum incidence was observed on cultivars Punjab-2011 and Millat-2011. No incidence of the nematode was recorded on Shafaq-2006 and Aas-2011 cultivars as shown in Table II. The variety wise incidence in the four districts has also been given in Table II.

Table II.- Variety wise incidence of ear cockle of wheat in four districts of Sargodha division.

Cultivar	% Incidence of ear cockle in				
	SGD	KSB	BKR	MWL	Overall
Faisalabad-2008	1.0	2.3	2.3	-	1.9
Galaxy-2013	1.0	1.3	2.0	0.8	1.3
Seher-2006	0.2	-	0.0	0.0	0.1
Lasani-2008	1.1	2.5	-	-	1.8
AARI-2011	0.0	-	1.5	0.0	0.5
Millat-2011	0.6	-	-	-	0.6
Punjab-2011	0.4	0.0	0.0	-	0.2
Shafaq-2006	-	0.0	-	-	0.0
Aas-2011	-	0.0	-	-	0.0
Ujala-2016	-	0.0	2.3	1.5	1.3
Chakwal-50	-	-	1.5	2.5	2.0
Uran	-	-	0.8	-	0.8

SGD, Sargodha; KSB, Khushab; BKR, Bhakkar; MWL, Mianwali.

Discussion

Anguina tritici was the first plant parasitic nematode to be discovered in England by Needham. Since its first report in 1743, the nematode was subsequently found in numerous countries and states of the world on wheat (Al-Talib *et al*., 1986; Brown, 1987; Gotke and Swarup, 1988; Esser *et al*., 1991; Kalha *et al*., 1992; Nath and

Patkak, 1993; Riley and Reardon, 1995; CABI/EPPO, 2002; EPPO, 2014, 2015; Mohamedova and Piperkova, 2013; PERAL, 2015). In the present survey incidence of ear cockle was observed up to 1.5% in Sargodha division. Incidence of ear cockle is affected by many factors. Midha and Swarup (1972) reported that the larval population of the nematode affects the infection and incidence. The depth of galls in the soil has also been found to affect the symptom expression. Midha and Swarup (1972) reported maximum ear cockle symptoms when the galls and seeds were placed at a soil depth of 2 cm. Leukel (1924) had earlier reported a decrease in infection when the galls were placed deeper than the seeds. The disease is favored by cool and moist weather. As the wheat plants grow more rapidly in hot weather so they can escape the susceptible period more quickly. The release of juveniles from the galls has been reported to be influenced by soil moisture and temperature and also the thickness of gall's walls (Leukel, 1924). Cairne (1926) recorded that germination of wheat seed always preceded the release of juveniles from galls. Pathak and Swarup (1983) agreed with Cairne (1926) when they observed that wheat seeds normally start sprouting within three days after planting and the earliest release of juveniles from galls occurs on the 4th day under alternate drying and welting conditions. Pathak and Swarup (1983) also observed that the number of tillers infected with juveniles had a relation with the inoculum level, number and size of galls produced.

Similarly, the main source of disease spread is the infected seeds. Modern agricultural practices, including use of clean seed and crop rotation, have all but eliminated *A. tritici* in countries which have adopted these practices, and the nematode has not been found in the United States since 1975 (PERAL, 2015). However, *A. tritici* is still a problem in third world countries where such practices are not widely adapted. In addition, trade issues have arisen due to conflicting records of *A. tritici* in the United States (PERAL, 2015). *A. tritici* has been listed as a harmful organism in 21 countries (USDA-PCIT, 2016). There may be trade implications with these countries due to historical records showing the presence of the nematode and/or if *A. tritici* is discovered again. Brazil has halted shipments of U.S. wheat based on general literature describing the nematode as "widespread in the United States" (PERAL, 2015).

Cultural practices have also affected incidence of seed gall nematode. The incidence was less or no-where the farmers followed crop rotation. Due to crop rotation the nematodes in the soil die and could not cause infection in the following season. Varieties also affect incidence of ear cockle (Anwar *et al*., 2011). The incidence was low on resistant varieties while it was higher on susceptible varieties. Midha and Swarup (1972) could not obtain ear cockle infection on two wheat varieties Sonara 64 and C591.

Conclusion

It is concluded that wheat seed gall nematode (*Anguina tritici*) was found prevalent throughout Sargodha division and the incidence was quite low. It is, therefore, imperative to keep the nematode under constant surveillance and to adopt stringent control strategies to prevent this nematode from becoming a threat to wheat. As no incidence of the nematode was recorded on Shafaq-2006 and Aas-2011 cultivars, therefore, cultivation of these cultivars should be encouraged.

Statement of conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this article.

References

Al-Talib, N.Y., Al-Taae, A.K.M., Nimer, S.M., Stephen, Z.A. and Al-Beldawi, A.S., 1986. *Int. Nematol. Network Newsl*., **3**: 25-27.

Anwar, S.A., McKenry, M.V., Riaz, A. and Khan, M.S.A., 2011. *Int. J. Nematol*., **11**: 150-156.

Brown, R.H., 1987. In: *Principles and practice of nematode control in crops* (eds. R.H. Brown and B.R. Kerry). NSW, Academic Press, Australia.

CABI/EPPO, 2002. *Anguina tritici*. Distribution maps of plant diseases, No. 848. CAB International, Wallingford, UK.

Cairne, W.M., 1926. *J. Dept. Agric. W. Aust*., **3**: 508–512.

Chu, V.M., 1945. *Phytopathology*, **35**: 288–295.

EPPO, 2014. *PQR database*. European and Mediterranean Plant Protection Organization, Paris, France. http://www.eppo.int/DATABASES/pqr/pqr.htm

EPPO, 2015. *PQR-EPPO database on quarantine pests*. http://www.eppo.int

Esser, R.P., O'Bannon, J.H. and Clark, R.A., 1991. *Nematol. Circ. (Gainesville)*, **186**: 4.

Fateh, F.S., Mukhtar, T., Kazmi, M.R., Abbassi, N.A. and Arif, A.M., 2017. *Pak. J. agric. Sci*., **54**: 9-13.

Gokte, N. and Swarup, G., 1988. *Ind. J. Nematol*., **18**: 78-83.

Kalha, C.S., Chib, H.S. and Tikoo, M.L., 1992. *Pl. Dis. Res*., **7**: 254..

Kassi, A.K., Javed, H. and Mukhtar, T., 2018. *Pakistan J. Zool.,* **50**: 91-95.

Leukel, R.W., 1924. *J. agric. Res*., **27**: 925-953.

Leukel, R.W., 1957. *Nematode Disease of wheat and*

rye. USDA Farmers Bulletin, 1607.
Maqbool, M.A., 1988. In: *Nematodes parasitic to cereals and legumes in temperate semi-arid regions* (eds. M.C. Saxena, R.A. Sikora and J.P. Srivastava). ICARDA, Aleppo, Syria, pp. 173-180.
Midha, S.K. and Swarup, G., 1972. *Ind. J. Nematol*., **2**: 97-104.
Mohamedova, M. and Piperkova, N., 2013. *AgroLife Sci. J*., **2**: 15-19.
Mukhtar, T., Hussain, M.A. and Kayani, M.Z., 2017. *Bragantia*, **75**: 108-112. https://doi.org/10.1590/1678-4499.005
Nabeel, M., Javed, H. and Mukhtar, T., 2018. *Pakistan J. Zool.,* **50**: 317-323. http://dx.doi.org/10.17582/journal.pjz/2018.50.1.317.323
Nath, R.P. and Patkak, K.N., 1993. *Ind. J. Nematol*., **23**: 129-130.
Paruthi, I.J. and Bhatti, D.S., 1988. *Haryana Agric. Uni. J. Res*., **18**: 173-176.
Paruthi, I.J. and Gupta, D.C., 1987. *Harayana Agric. Uni. J. Res*., **17**: 78-79.
Paruthi, I.J., Singh, M. and Gupta, D.C., 1987. *Seed Res*., **15**: 83-86.
Pathak, K.N. and Swarup, G., 1983. *Ind. . Nematol*., **13**: 155-160.
PERAL, 2015. *Qualitative pest risk analysis for the wheat gall nematode,* Anguina tritici, *in U.S. wheat for export*, 1-50. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Center for Plant Health Science and Technology, Plant Epidemiology and Risk Analysis Laboratory.
Rahoo, A.M., Mukhtar, T., Abro, S.I., Bughio, B.A. and Rahoo, R.K., 2018. *Pakistan J. Zool.,* **50**: 679-684. http://dx.doi.org/10.17582/journal.pjz/2018.50.2.679.684
Rahoo, A.M., Mukhtar, T., Gowen, S.R., Rahoo, R.K. and Abro, S.I., 2017. *Pakistan J. Zool.,* **49**: 241-247. http://dx.doi.org/10.17582/journal.pjz/2017.49.1.241.247
Reddy, P.P., 1983. *Plant nematology*. Agricole Publishing Academy, New Delhi, India, pp. 287.
Riley, I.T. and Reardon, T.B., 1995. *Pl. Pathol*., **44**: 805-810. https://doi.org/10.1111/j.1365-3059.1995.tb02739.x
Sakhuja, P.K., Singh, I., Kang, L.S. and Kang, M.S., 1990. *Pl. Dis. Res*., **5**: 182-185.
Stephan, Z.A., 1988. In: *Nematodes Parasitic to cereals and legumes in temperate semi-arid regions* (eds. M.C. Saxena, R.A. Sikora and J.P. Srivastava). ICARDA, Aleppo, Syria, pp. 155-159.
USDA-PCIT, 2016. *Phytosanitary export database*. Queried February 16, 2016 from, https://pcit.aphis.usda.gov/pcit/