Research Article

An Environment Friendly Pest Management Strategy through Biorational Insecticides against *Amrasca Devastans* Dist. on Brinjal Crop

Muhammad Shoaib Saleem*, Muhammad Faheem Akbar, Amjad Sultan and Saqib Ali

Department of Agriculture and Agribusiness Management, University of Karachi, Pakistan.

Abstract | A field study was carried out in the experimental field of Department of Agriculture and Agribusiness Management, University of Karachi to evaluate the efficacy of Neonicotinoids and Insect growth Regulators (IGRs) against jassid (*Amrasca devastans* Dist.) on eggplant crop. The crops were grown in a Randomized Complete Block Design (RCBD) with three replications, each have five treatments inclusive of control. The recommended doses of Nitenpyram, Clothianidin, Momentum (combination of Nitenpyram+Chlorfenapyr) and Buprofezin were applied when population of insect pests reached at economic threshold level (ETL). Pre-treatment data were taken before 24 hours and post-treatment data were recorded after 24, 72, 168 and 336 hours of each spray. In this manner the data of three sprays were collected. Amongst neonicotinoids Clothianidin was found to be very effective with 84% reduction in jassid population even after 7 days of application, followed by Nitenpyram 71% and Momentum 67%, while buprofezin showed moderate effectiveness with 65% reduction. The mean data of three consecutive sprays after 14 days, revealed that the effectiveness decreased with the time increased of all the insecticides (Clothianidin> Nitenpyram> Monetum) 61, 59 and 52 % respectively, as compared to Insect Growth Regualtor (IGR) buprofezin which showed less reduction (44%) in jassid population.

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***Correspondence** | Muhammad Shoaib Saleem, Department of Agriculture and Agribusiness Management, University of Karachi, Pakistan; **Email:** shoaibsaleemkhan@gmail.com
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Introduction

Brinjal (*Solanum melongena* L.) also known as eggplant or aubergine is an important vegetable crop in the family Solanaceae after tomato and potato (FAO, 2000). Being most important Solanum crop native to the Old World, it is ranked as 6th most important vegetable after onion, cabbage, and cucumber (FAO, 2016). It is cultivated everywhere throughout the globe (Daunay et al., 2001) and mostly grown in China, Indonesia, India Turkey, Iraq, Egypt and Pakistan.

In Pakistan, it is cultivated more than 8465 hectares with the production of 84149 tons per annum, out of which Punjab has the most eminent share in stipulations of acreage (4617 hectares) and production (55216 tones), followed by Baluchistan, Sindh and KPK with 11548, 8159 and 9226 tons respectively. Pakistan exported 4000 kgs. fresh brinjal worth of 0.6 million rupees in 2012-14 (PBS, 2013-14). Vegetables plays a vital role in our daily diet intake because they are the important source of many minerals and vitamins. Eggplant is the most popular and common vegetable from the genus solanum and rich with the dietary fiber, minerals like iron, magnesium potassium etc. vitamins such as K-niacin, B6 (USDA, 2008) and the valuable addition of supplements in the diet plans of poor.

The production of eggplant is extremely constrained by many insect pests, out of these jassid, *Amrasca devastans Dist*. is the second most destructive insect pest after Brinjal fruit and shoot borer (Nagia et al., 1993). This is the most rigorous pest in Pakistan (Mahmood et al., 1990) and also in Bangladesh and India (Kumar and Singh, 2002). Jassid can harm from seedling stage to the fruit setting stage, bringing about 50% loss in final production (Bindra and Mahal, 1981). It was also observed by (Rawat and Sahu, 1975) that jassids can lessen 49.8% and 45.1% number of leaves and decrease the plant height.

Insecticides application is the rapid control solution for the effective management of the insect pest (Mehmood et al., 2001). Approximately 27% of the total insecticides are used on fruits and vegetables in Pakistan (Hussain et al., 2002). However, injudicious pesticide application on fruits and vegetable crops has not only increased the cost of production but also resulted in undesirable residues in fresh vegetables and food commodities with significant hazards (Das, 1959; Gurusubramanian et al., 2005; Sarnaik et al., 2006).

Generally, the pesticides are toxic in nature and their continuous intake by human may result in accumulation in the body tissues with rigorous health problems (Handa et al., 1999). It was also reported by (Akbar et al., 2011a; Akbar et al., 2010) that residues of organochlorine and organophosphate insecticides in different vegetable crops, higher than maximum residue limits (MRLs) set by EU and codex (FAO). (Masud and Hasan, 1992) also recorded higher levels of insecticide residues in different vegetables above MRLs.

Among the different Strategies adopted by farmers, Insecticide application is the cutting-edge safeguard sources against the insect pests, regardless of numerous drawbacks like insect resurgence, resistance, harmful effects on natural enemies, pollinators, wildlife and humans. Various methods are being sought to counter the detrimental effects of insecticides. Bio-rational insecticides are the best alternatives and effective pest management tool, and are being used as safe option to their synthetic counterparts. Neonicotinoids and insect growth regulators (IGRs), with low mammalian toxicity and comparatively safe to human health and the ecosystem.

Keeping in view the importance of export and economic value of the brinjal crop, and other threats to environment and non-target organisms by broad spectrum insecticides; present study was planned to evaluate the efficacy of neonicotinoids and insect growth regulators (IGRs) against jassid for sustainability in brinjal production.

Materials and Methods

Field experiments were conducted to evaluate the efficacy of four insecticides (Table 1) against Jassid on the brinjal crop during the winter season (2016-17) at Agricultural Experimental Fields of Department of Agriculture and Agribusiness Management, University of Karachi. Brinjal Seedling were transplanted with 75x60 cm spacing, in a randomized complete block design (RCBD). There were three replicates each having five treatments including control. Three sprays were made with a pneumatic knapsack sprayer when Economic Threshold Level (ETL) found to be achieved. The pretreatment and post treatment observations were taken after l, 3, 7 and 14 days. From each treatment ten plants were selected and tagged for the purpose of insect counts. For insect counts three leaves from each plant were observed from top, middle and bottom. The population reduction percentage of jassid was calculated through Henderson-Tilton's formula i.e. (Henderson and TILTON, 1955).

$$\%\ \text{reduction in population} = 100 \times 1 - \frac{T_a \times C_b}{T_b \times C_a}$$

Where;

T a = insect population after treatment; T b = insect population before treatment; C a = insect population in control plot after treatment; Cb = Insect population in control plot before treatment

The collected data were administered to statistical analysis through analysis of variance (ANOVA) by using SPSS Version 16.0. Significant differences among various treatment means were tested with Turkeys' HSD test using 5% significant level. The pest population in different treatments was used as a pointer of insecticide effectiveness i.e. lower population of insect pest show higher toxicity of insecticides and vice versa.

Results and Discussion

The mean percentage reduction of jassid population recorded at different time intervals after the first, second and third application of various insecticides is presented in Table 1. Both the neonicotinoids viz; clothianidin and nitenpyram were more effective than the Momentum (a combination of Nitenpyram+Chlorfenapyr), while Insect Growth regulators (IGRs) Buprofezin was moderately effective. However, all the insecticides significantly reduced the jassids population.

Table 1: *Insecticides used against Jassid on brinjal crop.*

Insecticides				
Common Name	**Trade Name**	**Type**	**Source**	**Dose g ha^{-1} a.i**
Nitenpyram	Pyramid 10% SL	Neonicotinoids	Kanzo AG	49.4
Clothianidin 20% SC	Telsta 20% SC	Neonicotinoids	Sun Crop	24.7
Nitenpyram+ Chlorfenapyr	Momentum 50% WDG	Neonicotinoids and Pyrroles	Kanzo AG	7.41
Buprofezin	Applaud 25 WP	IGRs	Arysta	59.28

The percentage reduction in jassid population was found higher with clothianidin and Nitenpyram, followed by momentum. While Buprofezin (IGR) showed moderate effectiveness. Nitenpyram was highly effective with 56% reduction in jassid population followed by clothianidin (54%) and Buprofezin (41%) after 24 hours of application. Momentum gave 37% reduction in jassid population. After 72, 168 and 336 hours clothianidin showed increasing trend with 70, 81 and 81% reduction in jassid population followed by nitenpyram 70, 70 and 76% and momentum 67, 67 and 60% reduction. buprofezin also performed well with 40, 71 and 61% reduction at 72, 168 and 336 hours post-application.

Similar trend was observed after 2nd spray. clothianidin maintained its superiority over rest of insecticides with rising trend with 80, 85 and 92 reductions in jassid population after 24, 72 and 168 hours of 2nd spray, while effectiveness decreased after 336 hours of spray as the time increased. Although nitenpyram and momentum were effective with 82, 84 and 87% and 79, 78 and 80% reduction respectively. Buprofezin performed well as compared to 1st spray with 67, 58 and 60% insect mortality.

Clothianidin sustained its dominance with the increasing trend till 3rd spray and reduced jassid population by 45, 39 and 80%. Nitenpyram and momentum gave similar results with gradual decrease in effectiveness as compared to previous treatments with 61, 40 and 54% and 39, 52 and 55% insect mortality. However, buprofezin gave satisfactory results with the gradual increasing trend in effectiveness with 12, 41 and 63% reduction in jassid population. After 336 hours of 2nd and 3rd spray all the insecticides decreased their effectiveness.

After three consecutive sprays, an overall performance of all the insecticides (Table 2) represent that both the clothianidin and nitenpyram were more effective than momentum, while buprofezin was least effective.

Table 2: *Percentage reduction in jassid population on brinjal crop.*

First Spray					
Treatments	24 Hrs	72 Hrs	168 Hrs	336 Hrs	Mean
Nitenpyram	56 ± 17^{a}	70 ± 12^{b}	70 ± 9^{a}	76 ± 9^{a}	68 ± 8.4^{a}
Clothianidin	54 ± 7^{a}	70 ± 3^{b}	81 ± 9^{a}	81 ± 12^{a}	71 ± 1.2^{a}
Nitenpyram+ Chlorfenapyr	37 ± 23^{a}	67 ± 1^{ab}	67 ± 9^{a}	60 ± 20^{a}	57 ± 1.3^{a}
Buprofezin	41 ± 12^{a}	40 ± 17^{a}	71 ± 31^{a}	61 ± 23^{a}	53 ± 1.5^{a}
Second Spray					
Treatments	24 Hrs	72 Hrs	168 Hrs	336 Hrs	Mean
Nitenpyram	82 ± 9^{a}	84 ± 8^{a}	87 ± 5^{a}	7 ± 125^{a}	65 ± 3.8^{a}
Clothianidin	80 ± 21^{a}	85 ± 14^{a}	92 ± 3^{a}	1 ± 131^{a}	65 ± 4.2^{a}
Nitenpyram+ Chlorfenapyr	79 ± 10^{a}	78 ± 11^{a}	80 ± 1.5^{a}	8.18 ± 105	61 ± 55
Buprofezin	67 ± 50^{a}	58 ± 61^{a}	60 ± 54^{a}	6.87 ± 72	48 ± 57
Third Spray					
Treatments	24 Hrs	72 Hrs	168 Hrs	336 Hrs	Mean
Nitenpyram	61 ± 9^{a}	40 ± 47^{a}	54 ± 39^{a}	22 ± 17^{a}	44 ± 1.6^{a}
Clothianidin	45 ± 40^{a}	39 ± 17^{a}	80 ± 7^{a}	31 ± 68^{a}	48 ± 2.1^{a}
Nitenpyram+ Chlorfenapyr	39 ± 19^{a}	52 ± 21^{a}	55 ± 25^{a}	13.8 ± 39	40 ± 29
Buprofezin	12 ± 64^{a}	41 ± 32^{a}	63 ± 18^{a}	8.88 ± 78	32 ± 51
Overall Percent Efficacy					
Nitenpyram			59 ± 13		
Clothianidin			61 ± 13		
Nitenpyram+Chlorfenapyr			52 ± 12		
Buprofezin			44 ± 11		

**Values sharing the same letter (s) in a column are not significantly different at P<0.05; **Values are percentage reduction in a respective treatment.*

The findings of present study showed that nitenpyram and Clothianidin followed by Momentum performed best among the different insecticides against jassid population. This has been supported by the findings of many previous studies (Asi et al., 2008; Aslam et al., 2004; Awan and Saleem, 2012; Khattak et al., 2004; Raghuraman and Gupta, 2006). (Asif et al., 2017) also confirmed that neonicotinoids i.e. nitenpyram are very effective in reducing the population of jassid below economic threshold level. Moreover, (Irshad et al., 2015) reported that nitenpyram reduced the jassid population below ETL after seven days of application. Whereas (Kadam et al., 2014) observed that nitenpyram significantly reduced jassid population over a span of 14 days. Pachundkar et al., 2013 reported that the higher effectiveness was observed with the application of clothianidin 50 WDG (0.025%) against the jassid. Akbar et al., 2010; 2014 and 2008 reported imidacloprid (neonicotinoid) very efficient against *Myzus persicae* (Sulzer) on various crops including mustard, cabbage and cauliflower when compared with endosulfan. They also endorsed its outstanding effectiveness against *Bemicia tabaci* Genn. on okra and brinjal (Akbar et al., 2015a; Akbar et al., 2011b; Akbar et al., 2009) and *Amrasca devastans* Distt. on potato, okra and brinjal (Akbar et al., 2012b; Akbar et al., 2012a; Akbar et al., 2015b). Another study proved that Momentum was effective against jassid till one week after application (Anonymous, 2016).

Buprofezin, being environment-friendly is a commanding endocrine-based bio rational insecticide has been commonly used against different vegetable and field crops' pests for its target action (Sohrabi et al., 2011). It is also reported that buprofezin is highly effective against sucking pests like aphid, green leafhopper (GLH), brown plant hopper (BPH) etc (Ishaaya et al., 1988; Yasui et al., 1985). In the present study, buprofezin had significant effect on the jassid population but the action was slower i.e. the mortality was gradually increased with significant difference over control where the maximum reduction was observed at 7 days after spraying. This result is consisted with the mode of action of buprofezin that once jassids poisoned with buprofezin, they become unable to produce new cuticle, thereby effectively preventing them from molting to the next stage and finally died by taking somewhat longer time.

Figure 1 presents the time wise effectiveness of all four tested insecticides. Increasing trend was observed in all the insecticides till 168 hours post application, while effectiveness decreased at 336 hours. Whereas, the spray wise efficacy of the tested insecticide (Figure 2) showed higher mortality of jassids after the first spray while second and third spray showed less effectiveness.

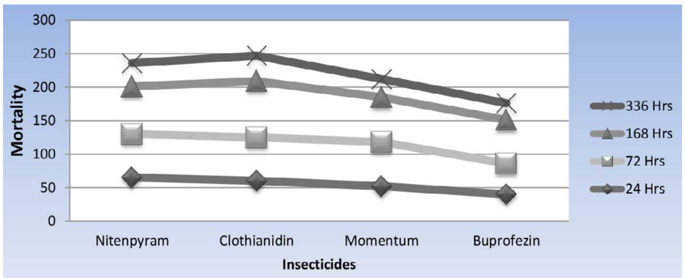

Figure 1: *Time wise efficacy of various insecticides against jassid on brinjal crop.*

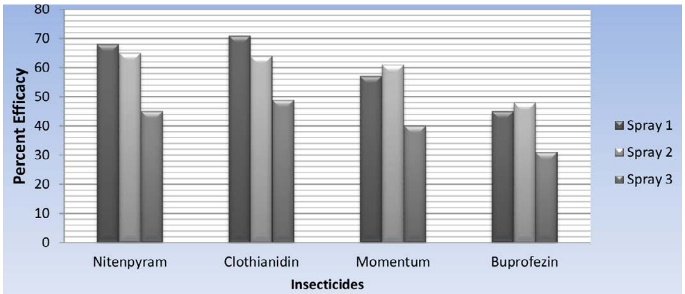

Figure 2: *Spray wise efficacy of various insecticides against jassid on brinjal crop.*

Conclusions

It is concluded that Clothianidin, Nitenpyram and Momentum, being bio rational insecticides, could be the potential tool for controlling jassids on brinjal crop. Therefore, the selected neonicotinoid chemistries may be an effective approach in Integrated Pest Management (IPM) strategy for better plant protection. However, their impact on beneficial insects, particularly on pollinators need to be studied.

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Author's Contribution

Muhammad Shoaib Saleem: Conducted experiment, collected the data, analysed the data and wrote the article.
Muhammad Faheem Akbar: Conceived the idea, did overall management of the article and wrote Methodology.
Amjad Sultan: Reviewed the Manuscript and analysed the data.
Saqib Ali: Conducted experiment and collected the data.

References

Akbar, M.F., N. Yasmin, F. Naz and M.A. Haq. 2008. Efficacy of imidacloprid and endosulfan in comparison with biosal (Biopesticide) against *Myzus persicae* (sulzer) on mustard crop. Pak. J. Entomol. Karachi. 23(1 and 2): 27-30.

Akbar, M.F., N. Yasmin, F. Naz and Latif T.A. 2009. Effectiveness of different spray schedules against population of whitefly, *Bemisia tabaci* (Genn.) on okra crop. Pak. J. Entomol. Karachi. 24(1 and 2): 45-48.

Akbar, M.F., M.A. Haq, F. Parveen, N. Yasmin and S.A. Sayeed. 2010. Determination of synthetic and bio-insecticides residues during aphid, *Myzus persicae* (Sulzer) control on cabbage crop through high performance liquid chromatography. Pak. Entomol. 32(2): 155-162.

Akbar, M.F., M.A. Haq, N. Yasmin, M.F. Khan and M.A. Azmi. 2011a. Efficacy of bio-insecticides as compared to conventional insecticides against white fly (*Bimisia tabaci* Genn.) on okra crop. Pak. J. Ent. Karachi. 26(1): 16-23.

Akbar, M.F., M.A. Haq, N. Yasmin, M.F. Khan and M.A. Azmi. 2011b. Efficacy of bio-insecticides as compared to conventional insecticides against white fly (*Bimisia tabaci* Genn.) on okra crop. Pak. J. Ent. Karachi. 26(2): 16-23.

Akbar, M.F., M.A. Haq, N. Yasmin and M.F. Khan. 2012a. Degradation analysis of some synthetic and bio-insecticides sprayed on okra crop using HPLC. J. Che. Soc. Pak. 34(2): 306-311.

Akbar, M.F., M.A. Haq and N. Yasmin. 2012b. Effectiveness of bio-insecticides as compared to conventional insecticides against jassid (*Amrasca devastans* Dist.) on okra (*Abelmoschus esculentus* L.) crop. Pak. Entomol. 34(2): 161-164.

Akbar, M.F., H.U. Rana and F. Perveen. 2014. Management of cauliflower aphid (*Myzus persicae* (Sulzer) Aphididae: Hemiptera) through environment friendly bioinsecticides. Pak. Entomol. 36(1): 25-30.

Akbar, M.F., M.A. Haq, H.U. Rana and M.F. Khan. 2015a. Role of bio-rational insecticides in controlling amrasca devastans dist. On *Solanum melongena* L. Crop. Int. J. Bio. Biotech. 12(1): 401-406.

Akbar, M.F., H.U. Rana and M.F. Khan. 2015b. Management of *Bemicia tabaci* (Genn.) On *solanum melongena* L. Through environmental friendly bio insecticides. Int. J. Bio. Biotech. 12(3): 393-399.

Anonymous. 2016. Annual summary progress report central cotton research institute. In Annual summary progress report central cotton research institute, 73-75. Old Shujaabad Road Multan.

Asi, M.R., M. Afzal, S.A. Anwar and M.H. Bashir. 2008. Comparative Efficacy 0f Insecticides Against Sucking Insect Pests of Cotton. Pak. J. Life Soc. Sci. 6 (2): 140-142.

Asif, M.U., R. Muhammad, W. Akber and M. Tofique. 2017. Relative efficacy of some insecticides against the sucking insect pest complex of cotton. The Nucleus. 53(2): 140-146.

Aslam, M., M. Razaq, S.A. Shah and F. Ahmad. 2014. Comparative efficacy of different insecticides against sucking pests of cotton. J. Res. Sci. 15(1): 53-58.

Awan, D.A. and M.A. Saleem. 2012. Comparative efficacy of different insecticides on sucking and chewing insect pests of cotton. Acad. Res. Int. 3(2): 210.

Bindra, O.S. and M.S. Mahal. 1981. Varietal resistance in eggplant (brinjal) (*Solanum melongena*) to the cotton jassid (*Amrasca biguttula biguttula*). Phytoparasitica. 9(2): 119-131. https://doi.org/10.1007/BF03158454

Das, G.M. 1959. Bionomics of the tea red spider, *Oligonychus coffeae* (Nietner). Bulletin Ent. Res. 50(2): 265-274. https://doi.org/10.1017/S0007485300054572

Daunay, M.C., R.N. Lester, C. Gebhardt, J.W. Hennart, M. Jahn, A. Frary et al. 2001. Genetic resources of eggplant (*Solanum melongena* L.) and allied species: a new challenge for molecular geneticists and eggplant breeders: In: R.G. van den Berg, G.W.M. Barendse, G.M. van der Weerden and C.Mariani (eds.), *Solanaceae V, Advances in Taxonomy and Utilization*. Nijmegen University Press, Nijmegen, the Netherlands. 251 -274.

FAO. 2000. Agricultural production data collection. Feinstein, L. (1952). Insecticides from plants. Insects (The Year Book). Agric. Prod. data collect. (available from http://apps.fao.org).

FAO. 2016. FAO STAT Production Databases. In FAO STAT Production Databases. Feinstein, L. (1952). Insecticides from plants. Insects (The Year Book), United States Depart. Agric. Washington D. C. pp 222-229.

Gurusubramanian, G., M. Borthakur, M. Sarmah and A. Rahman. 2005. Pesticide selection, precautions, regulatory measures and usage. Plant Protection in tea: Proc. Plant Protection Work shop. Tocklai Experimental Station, TRA, Jorhat Assam Printing Works Private Limited, Jorhat, Assam, India. pp 81-91.

Handa, S.K., N.P. Agnihotr and G. Kulshrestha. 1999. Pesticides residues; significance management and analysis, research periodicals and book publishing home. Texas, USA, Hardcover. pp 226.

Henderson, C.F. and E.W. Tilton. 1955. Tests with acaricides against the brown wheat mite. J. Econ. Entomol. 48(2): 157-161. https://doi.org/10.1093/jee/48.2.157

Hussain, S., T. Masud and K. Ahad. 2002. Determination of pesticides residues in selected varieties of mango. Pak. J. Nut. 1(1): 41-42. https://doi.org/10.3923/pjn.2002.41.42

Ishaaya, I., Z. Mendelson and V. Melamed-Madjar. 1988. Effect of buprofezin on embryo genesis and progeny formation of sweet potato whitefly (Homoptera: Aleyrodidae). J. Eco. Entomol. 81(3): 781-784. https://doi.org/10.1093/jee/81.3.781

Kadam, D.B., D.R. Kadam, S.M. Umate and R.S. Lekurwale. 2014. Bioefficacy of newer neonicotenoids against sucking insect pests of Bt cotton. Int. J. Plant Prot. 7(2): 415-419. https://doi.org/10.15740/HAS/IJPP/7.2/415-419

Khattak, M.K., S. Ali, J.I. Chishti, A.R. Saljiki and A.S. Hussain. 2004. Efficacy of certain insecticides against some sucking insect pests of mungbean (*Vigna radiata* L.). Pak. Entomol. 26(1): 75-80.

Kumar, M. and A.K. Singh. 2002. Varietal resistance of okra against cotton jassid, *Amrasca biguttula biguttula* under field conditions. Ann. Plant Prot. Sci. 10(2): 381-383.

Irshad, M., G. Abbas, M. Amer, M.B. Khokhar, M. Ahmad, M. Zakria and G.A. Khan. 2015. Efficacy of different pesticides for the control of cotton jassid under the changing arid envirnoment of Thal zone. Int. J. Adv. Res. Biol. Sci. 2(1): 121-126.

Mahmood, T., K.M. Khokhar, M. Banaras and M. Ashraf. 1990. Effect of environmental factors on the density of leaf hopper, *Amrasca devastans* (Distant) on okra. Int. J. Pest Manage. 36(6): 282-284. https://doi.org/10.1080/09670879009371488

Masud, S.Z. and N. Hasan. 1992. Pesticide residues in foodstuffs in Pakistan-Organochlorine, Organophosphorus and Pyrethroid insecticides in fruits and vegetables. Pak. J. Sci. Ind. Res. 35(1): 499-499.

Mehmood, K., M. Afzal and M. Amjad. 2001. Non-traditional insecticides: a new approach for the control of okra jassid. J. Biolog. Sci. 1(2): 36-37.

Nagia, D.K., F. Malik, S. Kumar, M.D. Saleem, M.L. Sani and A. Kumar. 1993. Studies on control of cotton jassid and leaf blight on brinjal crop. Plant Prot. Bull. Faridabad. 45(1):16-18.

Pachundkar, N.N., P.K. Borad and P.A. Patil. 2013. Evaluation of various synthetic insecticides against sucking insect pests of cluster bean. Int. J. Sci. Res. Pub. 3(8): 1-6.

Pakistan Beaureu of Statistics. 2014. Area and production of Important crops. Area Prod. Important crops. pp 37-38.

Raghuraman, M. and G.P. Gupta. 2006. Effect of neonicotinoids on jassid, Amrasca devastans (Ishida) in cotton. Ann. Plant Prot. Sci. 14(1): 17-21.

Rawat, R.R. and H.R. Sahu. 1975. Estimation of losses in growth and yield of okra due to Empoasca devastans Distant and Earias species (India). India. J. Entomol. 35(3): 252-254.

Sarnaik, S.S., P.P. Kanekar, V.M. Raut, S.P. Taware, K.S. Chavan and B.J. Bhadbhade. 2006. Effect of application of different pesticides to soybean on the soil microflora. J. Environ. Biol. 37(2): 423-426.

Sohrabi, F., P. Shishehbor, M. Saber and M.S. Mosaddegh. 2011. Lethal and sublethal effects of buprofezin and imidacloprid on Bemisia tabaci (Hemiptera: Aleyrodidae). Crop Prot. 30(9):1190-1195. https://doi.org/10.1016/j.cropro.2011.05.004

USDA. 2008. Eggplant (raw) nutrient values and weights for edible portion (NDB No: 11209). USDA National Nutrient Database for Standard Reference, Release 21. In Eggplant (raw) nutrient values and weights for edible portion (NDB No: 11209).

Yasui, M., M. Fukada and S. Maekawa. 1985. Effects of buprofezin on different developmental stages of the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood)(Homoptera: Aleyrodidae). Appl. Ent. Zool. 20(3): 340-347. https://doi.org/10.1303/aez.20.340