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MANAGEMENT OF *AMRASCA BIGUTTULA BIGUTTULA* (ISHIDA) ON OKRA, *ABELMOSCHUS ESCULENTUS (L.)* MONECH

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Various control practices, viz., host plant resistance, release of *Chrysoperla* spp., seed-treatment with imidacloprid, use of yellow sticky trap, neem seed kernel extract, spray of imidacloprid were applied singly, and in their possible combinations, at three localities, on a comparatively jassid resistant genotype of okra, Punjab Selection for the control of jassid. The treatment effect, alone, and in their possible combinations, showed a significant difference with one another, regarding their effectiveness. A combination of treatments, viz., seed treatment, spray with imidacloprid and installation of yellow sticky traps, was found the most effective and resulted in a minimum population of jassid, per leaf, on okra; whereas, the effect of seed-treatment and installation of yellow sticky traps, alone, did not show distinctive effect on the pest population. A significant decrease in the jassid-population was observed in those plots, where imidacloprid was sprayed, alone, or in combination with other treatments. The seeds treated with imidacloprid, remained effective against the jassids up to 38 days, after sowing. The combination of seed-treatment + spray of imidacloprid + installation of yellow sticky traps, showed a maximum yield of okra.
Keywords: Jassid, seed treatment, imidachloprid, *Chrysoperla* spp., neem, yellow trap

INTRODUCTION

Okra, *Abelmoschus esculentus* (L.) Monech is the most important traditional/ popular vegetable of Pakistan and is extensively cultivated in `Kharif and `Rabi' season. In Pakistan, its production is exclusively handled by the small-scale farmers, while its economic importance is well established in internal trade. Okra is a very important food crop in Afghanistan, Bangladesh, India and Pakistan. Besides this, USA, Egypt, Turkey, Costa Rice, Iran, Iraq, Nigeria and Ghana are also some of the major producer of okra. Increasing crop loss, owing to the pests is a major constraint, in sustaining agricultural productivity. Ewete (1983) has reported 72 insect pest species that attack and damage okra. In recent years cotton jassid, *Amrasca biguttula biguttula* (Ishida) has become an increasingly severe pest of vegetables, as well as of other agronomic crops, and ornamental plants. This pest is dominant amongst the most important sucking insects that attack okra crop (Dhandapani *et al.,* 2003). Okra received the maximum number of leaf hopper eggs and is the most suitable host for the survival and feeding of its nymph (Sharma and Singh, 2002). *A. biguttula biguttula* causes damage right from an early seedling stage to the fruit setting stage, resulting in a loss of 50% in yield (Bindra and Mahal, 1981). Rawat and Sadu (1973) reported 49.8% and 45.1% reduction in the height and number of leaves, respectively, due to the attack of jassid. Okra is the most heavily sprayed summer vegetable (about 10-12 times) and due to lack of residual monitoring system, the farmers don't hesitate to send their produce to the market, one or two days after the last spray (Ahmad *et al.,* 1997). The frequent use of systemic insecticides, to manage insect pests, leads to the destabilization of ecosystem, disrupt the delicate balance between the insect pests and their natural enemies and enhance resistance to insecticides in the pests (Ahmad *et al.,* 1999), suggesting a clear need for alternatives. Studies were conducted on okra to find out the effectiveness of various control methods, alone and in possible combinations for reducing the damage of *A. biguttula biguttula.*

MATERIALS AND METHODS

Integrated Pest Management (IPM) was studied at three localities, i.e., Post-graduate Agricultural Research Station (PARS), University of Agriculture Faisalabad (UAF), Farm fields, University of Agriculture, Faisalabad and the Entomological Research Institute, Ayub Agricultural Research Institute (AARI), Faisalabad. Various control measures, like, the resistance variety Punjab-selection, seed treatment with imidacloprid 70 WP @ 5 g/kg of seed, biological control agents, like, release of *Chrysoperla* spp. @ 40000 larvae/hac/release, mechanical control, like, use of yellow sticky traps @ 1 trap/plot, neem-seed kernel extract

(NSKE) @ 5% and spray of imidacloprid 20% SL @ 200 ml/hac, alone, and in possible combination were applied. The plot size, for each treatment, was maintained as 25m × 30m at each locality, with a spacing of 75 cm from row to row and a distance of plant to plant 30 cm. The okra crop was sown on July 03 as well as on July 05 and July 07 at the Farm fields of UAF, AARI and PARS, respectively following Randomized Complete Block Design, replicated thrice. For the count of jassid population, 15 plants, in each replication, were selected at random, and tagged. The leaves were observed, in such a way that one leaf from the upper part of the first plant, one from the middle part of the second plant and one from the bottom part of the third plant, of similar age, were taken in to account. So total of 15 leaves, were taken, per treatment. The yellow sticky traps were installed 18 days after the sowing (DAS). The data/effect of seed-treatment and yellow sticky-trap, on the jassid - population recorded, 24 DAS, at weekly intervals, up to 45 DAS, and was considered as pre-treatment counts/24 hours, before the 1 S` application/release. The effectiveness of control methods was assessed by estimating the pest-population, at 72 hours, 1 week and 2 week after each treatment. The pest-population, after 2 week of application/release was the pre-treatment counts for the 3rd application/release. After hand-picking the crop, the fruit obtained was weighed separately for each treatment. The data were analyzed for analysis of variance to determine the significance of treatments. IBM compatible computer was used for analyzing the data, with MSTAT package (Steel *et al.,* 1997). Means were separated by Duncan's New Multiple Range Test (DMRT) (Duncan, 1955). The data, however, were presented in the form of mean values and analyzed for the analysis of variance, to determine the significance of treatments. The comparative efficacy of the control methods was considered to be an indirect reflection of the jassid-population, per leaf.

RESULTS AND DISCUSSION

The results as shown in Table 1 are mean comparison of the data, regarding the treatment effect on jassid-population and percent reduction, at different post-treatment intervals. Also Table 2 shows that the cumulative effect of all the treatments was recorded to be minimum 24 days after sowing. All the treatments lost their effectiveness, as the population of jassid increased gradually and reached up to that of 2.13 jassid per leaf, 45 days, after sowing. A maximum of 2.30 jassid/ leaf was recorded 74 DAS (24 hours before 3rd spray). The results (Table 3) revealed that the minimum jassid-population was recorded in T14, followed by that of T9, T3 and in T12, respectively. The effectiveness of seed-treatment and an installation of yellow sticky traps, alone, were found to be the minimum with 2.20 and 2.19 jassid, per leaf, respectively as against 2.46 jassid per leaf in control treatment. All the other treatments were found to be intermediate in controlling jassid on okra with population range of 1.99 to 1.04 per leaf. From these results, it was concluded that T14, where the seed-treatment + spray of imidacloprid and yellow sticky traps, were applied together, was found to be the most effective and it resulted in a minimum jassid population, per leaf, at all the experimental localities and did not show a significant difference from each other. Variations were found to exist, among other treatments, in different localities. The effect of yellow sticky traps was lowest and found, at par, statistically with those plots, where seed treatment, was applied, at all the experimental locations. The application of seed-treatment and spray of imidacloprid (T9), showed a significant effect on the population of jassids, after T14. At all the dates of observation, the population of jassids remained above ETL, but had a significant effect against the control, after each release of *chrysoperla* spp. The present findings can partially be compared, with those of Pawar (1991), who recommended 100,000 larvae, per hectare, of *C. carnea,* thrice, at fortnight intervals, for controlling the sucking pests including jassids. The release of *Chrysoperla* larvae in conjunction with `neem' seed-extract, resulted in a maximum reduction in the population of jassids, on okra, and remained effective for eight days, after treatment and was at par, with those plots where *Chrysoperla* spp. in combination with seed-treatment and `neem' seed kernel-extract was released/applied and also remained effective up to eight days, after treatment, in each application. The present findings can, partially, be compared with those of Parveen and Dhandapani (2001), who reported that the application of *C. carnea* 25000 larvae, per hectare, per release + econeem 0.3%, for three times at an interval of 15 days was found effective, in reducing the population of sucking insect pests including *A. biguttula biguttula,* on okra.

In the present study, the effect of seed-treatment, with imidacloprid 70 WP @ *5* g/kg seed was not so pronounced for the control of jassids, on okra, for the whole crop-season. The population of jassids, remained under ETL up to 38 days, after sowing the crop and the percentage reduction in the population of jassids, decreased steadily, on the subsequent dates of observation. The present findings are in conformity with those of Bhargava and Bhatnagar (2001), who reported that the jassids can be effectively controlled by using the seed-dressing with insecticides up to 35 days, after sowing. Similarly, according to Indumathi *et al.* (2001) imidacloprid was taken up by the plant, from its seed treatment, and the residues persisted in plants for more than 30 days, after germination. Gandhi *et al.* (2006) also found that imidacloprid, as seed treatment, was effective in reducing the homopterous sucking pests of okra. Rana *et al.* (2006)

Table 1. The jassid *(Amrasca biguttula biguttula* Ishida) population per leaf along with the percentage reduction in its population on okra, *Abelmoschus esculentus (L.)* as affected by different treatments at various intervals after sowing

Treatment	24 DAS		31 DAS		38 DAS		45 DAS		49 DAS		53 DAS	
	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction
T1 = *Chrysoperla* spp	0.20 b	0.13	0.51 c	0.12	1.31 a	0.04	2.55 a	0.03	1.86 d	0.27	2.02 d	0.42
T2 = Seed treatment	0.07 f	0.70	0.24 e	0.59	0.82 cde	0.40	1.94 c	0.26	1.97 c	0.23	3.02 b	0.13
T3 = Spray of imidacloprid	0.22 a	0.04	0.53 bc	0.09	1.32 a	0.03	2.54 a	0.03	0.07 j	0.97	0.38 j	0.89
T4 = Neem Extract	0.23 a	0.00	0.54 b	0.07	1.30 a	0.04	2.56 a	0.02	0.86 g	0.66	0.84 g	0.76
T5 = Yellow Sticky trap	0.16 d	0.30	0.47 d	0.19	1.18 b	0.13	2.34 b	0.11	2.32 b	0.09	3.07 b	0.12
T6 = T1+T2	0.09 e	0.61	0.25 e	0.57	0.84 c	0.38	1.88 cd	0.28	1.51 f	0.41	1.62 e	0.53
T7 = T1+ T4	0.20 b	0.13	0.52 bc	0.10	1.28 a	0.06	2.57 a	0.02	0.56 h	0.78	0.50 i	0.86
T8 = T1+ T5	0.18 c	0.22	0.48 d	0.17	1.19 b	0.13	2.31 b	0.12	1.76 e	0.31	1.67 e	0.52
T9 = T2 +T3	0.07 f	0.70	0.22 ef	0.62	0.80 cdef	0.41	1.88 cd	0.28	0.08 j	0.97	0.33 jk	0.91
T10 = T2 + T4	0.07 f	0.70	0.23 e	0.60	0.83 cd	0.39	1.89 cd	0.28	0.57 h	0.78	0.67 h	0.81
T11 = T2+ T5	0.07 f	0.70	0.20 f	0.66	0.74 ef	0.46	1.73 e	0.34	1.76 e	0.31	2.84 c	0.18
T12 = T1 + T2 + T4	0.07 f	0.70	0.23 e	0.60	0.84 c	0.38	1.78 de	0.32	0.44 i	0.83	0.39 ik	0.89
T13 = T1 + T2 + T5	0.07 f	0.70	0.22 ef	0.62	0.73 f	0.46	1.70 e	0.35	1.45 f	0.43	1.47 f	0.58
T14 = T2 + T3 + T5	0.06 f	0.74	0.20 f	0.66	0.75 def	0.45	1.68 e	0.36	0.05 j	0.98	0.25 k	0.93
T15 = Control	0.23 a	0.00	0.58 a	0.00	1.36 a	0.00	2.62 a	0.00	2.56 a	0.00	3.48 a	0.00
LSD at 5%	0.00937		0.02962		0.08887		0.1481		0.1026		0.1147	

Means sharing similar letter in columns not significantly different by DMRT; DAS = Days after Sowing

60 DAS		64 DAS		68 DAS		74 DAS		78 DAS		82 DAS		89 DAS	
Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction	Jassid pop./leaf	% reduction
1.72 cd	0.16	1.23 e	0.41	1.49 c	0.58	2.51 c	0.22	1.90 c	0.42	1.67 c	0.58	2.11 c	0.30
1.92 ab	0.06	1.98 b	0.06	3.43 a	0.03	3.17 a	0.02	3.14 a	0.03	3.93 a	0.02	2.96 a	0.02
1.56 ef	0.24	0.09 j	0.96	0.39 g	0.89	1.36 g	0.58	0.89 g	0.73	0.36 f	0.91	0.91 f	0.70
1.70 cd	0.17	0.94 gh	0.55	1.32 de	0.63	2.47 cd	0.23	1.30 e	0.60	1.36 d	0.66	2.11 c	0.30
1.79 bc	0.12	1.82 c	0.13	3.20 b	0.09	2.90 b	0.10	2.85 b	0.12	3.59 b	0.10	2.73 b	0.10
1.67 cde	0.18	1.19 e	0.43	1.43 cd	0.59	2.55 c	0.21	1.91 c	0.41	1.64 c	0.59	2.17 c	0.28
1.61 def	0.21	0.48 i	0.77	0.58 f	0.84	1.95 f	0.39	0.71 f	0.78	0.77 e	0.81	1.83 e	0.39
1.56 ef	0.24	1.09 f	0.48	1.26 e	0.64	2.31 de	0.28	1.62 d	0.50	1.41 d	0.65	1.89 e	0.37
1.37 g	0.33	0.08 j	0.96	0.35 gh	0.90	1.30 gh	0.60	0.09 g	0.97	0.29 f	0.93	0.90 f	0.70
1.77 c	0.13	0.90 h	0.57	1.26 e	0.64	2.42 cde	0.25	1.39 e	0.57	1.47 d	0.63	2.07 cd	0.31
1.71 cd	0.16	1.70 d	0.19	3.13 b	0.11	2.89 b	0.10	2.84 b	0.13	3.54 b	0.11	2.76 b	0.09
1.50 f	0.26	0.44 i	0.79	1.24 e	0.65	1.98 f	0.39	0.76 f	0.77	0.87 e	0.78	1.94 de	0.36
1.49 fg	0.27	1.02 fg	0.51	1.19 e	0.66	2.27 e	0.30	1.63 d	0.50	1.36 d	0.66	1.88 e	0.38
1.22 h	0.40	0.05 j	0.98	0.25 h	0.93	1.16 h	0.64	0.07 g	0.98	0.25 f	0.94	0.76 g	0.75
2.04 a	0.00	2.10 a	0.00	3.53 a	0.00	3.22 a	0.00	3.25 a	0.00	3.99 a	0.00	3.02 a	0.00
0.1257		**0.08887**		**0.1257**		**0.1568**		**0.1221**		**0.1291**		**0.1390**	

Means sharing similar letter in columns not significantly different by DMRT; DAS = Days after Sowing

Table 2. The means comparison period effect on jassid (*A. Biguttulla Biguttula* Ishida) population, per leaf, at different days on okra in different treatments and localities

Dates		Locality x Date			Means for Treatments
		PARS	UAF	AARI	
24 DAS		O.l6 y	0.10 z	0.15 yz	0.131
31 DAS		0.40 w	0.33 x	0.36 wx	0.36 k
38 DAS		1.15 t	0.89 v	1.01 u	1.02 j
45 DAS	(24 hours before 1st spray)	2.20 d	1.89 gh	2.31 b	2.13 b
49 DAS	(72 hours after 1st spray)	1.23 s	1.05 u	1.29 r	1.19 i
53 DAS	(1 week after 1st spray)	1.56 m	1.42 q	1.54 mn	1.50 h
60 DAS	(24 hours before 2nd spray)	1.70 k	1.46 pq	1.77 j	1.64 e
64 DAS	(72 hours after 2nd spray)	1.01 u	0.88 v	1.14 t	1.01 j
68 DAS	(1 week after 2nd spray)	1.62 1	1.51 no	1.68 k	1.60 f
74 DAS	(24 hours before 3rd spray)	2.26 c	2.10 e	2.54 a	2.30 a
78 DAS	(72 hours after 3rd spray)	1.41 q	1.48 op	1.82 i	1.57 g
82 DAS	(1 week after 3rd spray)	1.87 hi	1.56 mn	1.88 gh	1.77 d
89 DAS	(2 week after 3rd spray)	2.04 f	1.93 g	2.05 f	2.00 c
LSD at 5%		0.05066			0.02925
Means for Localities		1.274 c	1.430 b	1.502 a	
LSD at 5%		0.01405			

Means sharing similar letter in columns and rows for interaction, in column for treatments and in rows for location means are not significantly different by DMRT.

PARS = Post Graduate Agriculture Research Station; UAF = University of Agriculture Faisalabad; AARI = Ayub Agricultural Research Institute

reported that imidacloprid at the rate of 2 ml/kg of seed, was effective in controlling jassids, on okra, while Tomar (2008) found that the seed treatment with imidacloprid 70 WS @ 10 g/kg seed, was effective in suppressing the jassid-population below ETL up to sixty days, after sowing, while imidacloprid @ 7.5 g/kg seed, was effective up to *50* days after sowing. The present findings can not be compared with those of Parveen *et al.* (2007) reported that the seed-treatment with imidacloprid @ 12 ml per kg seed, showed an effective control of leaf hopper on okra. From these results it was also observed that the seed treatment in conjunction with a spray of insecticides gave the best results for the control of jassids, on okra. The present findings are not in conformity with those of Misra (2002), who reported that imidacloprid used @ 25g a.i./ hectare, proved significantly superior in controlling jassids on okra, as compared to Azadirachtin @ 3g. a. i./hectare. In the present study the seed-treatment with imidacloprid, alone did not show a significant effect on the population of jassids, on okra, but some significant control was, however, observed in conjunction with the bio-product, i.e., 'Neem' seed kernel-extract. Spray of imidacloprid 20% SL, alone at the rate of 200 ml/hac, in combination with seed-treatment and with seed treatment + installation of yellow sticky traps, showed the most effective control of jassids on okra on all the applications, *which* remained effective up to one week of the post treatment interval. The present findings can, partially, be compared with those of Sunitha *et al.* (2005) and Solangi and Lohar (2007) who found that sprays of imidacloprid were the most effective, in reducing jassid population, on okra. According to Solangi and Lohar (2007), that amongst Confidor, Sundaphos, Polo and Mospilan, Confidor was proved to be the most effective for the control of jassids on okra.

From these results, it was concluded that the application of NSKE in conjunction with other treatments, had more effect, on the pest population as compared to NSKE applied, alone. The present findings are in conformity with those of Parvez *et al.* (1998), who reported that NSKE gave a significant reduction in the population of jassids on okra. The present findings are not in conformity with those of Satpathy and Rai (1999), who recommended a combination of neem and half dose of endosulfan for the control of jassid population on okra. Furthermore, according to Thakar and Singh (1998) the Neem compound, failed to provide an effective decrease, on okra, but, in the present study, although the population of jassids did not go below the ETL in NSKE, the application of Neem product showed a significant control compared with the control treatment. Very low reduction percentage of jassid-population was observed on okra crop, in those plots where yellow sticky traps, were installed throughout the crop season. The population remained above the ETL level, which was closed to the plots, where no treatment was applied. The present findings neither be compared with those of Budnik *et al.* (1996), who reported that yellow sticky plastic traps had a significant beneficial effect on the yield of pepper crop, nor with those of Green and Venter (2007),

Table 3. The means comparison of the jassid *(A. biguttula biguttula* Ishida) population per leaf on okra, *Abelmoschus Esculentus (L.)* in different treatments and localities

Treatments	Locality x Treatment			Means for Localities	
	PARS	UAF	AARI	Jassid pop./leaf	% reduction
T1 = *Chrysoperla* spp	1.63 j	1.47 l	1.76 i	1.62 d	0.34
T2 = Seed treatment	2.26 d	1.99 gh	2.34 c	2.20 b	0.11
T3 = Spray of imidacloprid	0.78 v	0.68 w	0.80 v	0.76 k	0.69
T4 = Neem Extract	1.40 mn	1.21 q	1.44 lmn	1.35 f	0.45
T5 = Yellow Sticky trap	2.26 d	1.97 h	2.34 c	2.19 b	0.11
T6 = T1+T2	1.42 lmn	1.33 o	1.57 k	1.44 e	0.41
T7 = T1+ T4	1.09 s	0.92 u	1.12 rs	1.04 i	0.58
T8 = T1+ T5	1.46 lm	1.30 op	1.56 k	1.44 e	0.41
T9 = T2 +T3	0.62 x	0.55 y	0.62 x	0.60 l	0.76
T10 = T2 + T4	1.21 q	1.09 rs	1.29 op	1.20 h	0.51
T11 = T2+ T5	2.04 g	1.80 i	2.14 f	1.99 c	0.19
T12 = T1 + T2 + T4	0.93 u	0.97 tu	0.98 t	0.96 j	0.61
T13 = T1 + T2 + T5	1.26 pq	1.15 r	1.40 n	1.27 g	0.48
T14 = T2 + T3 + T5	0.54 yz	0.48 z	0.53 yz	0.52 m	0.79
T15 = Control	2.55 b	2.20 e	2.64 a	2.46 a	0.00
LSD at 5%		0.05442		0.03142	

Means sharing similar letter in columns and rows for interaction, in column for treatments and in rows for location means are not significantly different by DMRT.

PARS = Post Graduate Agriculture Research Station; UAF = University of Agriculture Faisalabad; AARI = Ayub Agricultural Research Institute

Karut and Kazak (2007) and Held and Boyd (2008), due to the differences in their materials and methods.

It is evident from the results (Table 4) that maximum yield of okra fruit, was recorded in T14, followed by that in T9, T3, T12 and that in T7, respectively. The installation of yellow sticky traps did not show a good effect on the yield of okra. All the other treatments were found to be intermediate in response to the yield of okra. A similar trend was observed between the interaction of treatments and localities, with a little variation. The effects on localities, was, however, significantly different. The experiments sown in the research area of the University of Agriculture, showed maximum yield and differed significantly from that harvested in other localities. The minimum yield was observed in the research area of AARI and it showed a significant difference with other localities. The experiment at PARS showed an intermediate response in yields. This variation might be due to difference in the soil nutrition. In the present study, it was observed that a combination of seed treatment + spray of imidacloprid and installation of yellow sticky trap were found to be the most effective followed by seed treatment + Spray of imidacloprid.

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