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Seasonal incidence of leaf hopper on okra in correlation with abiotic factors and Evaluation of some neonicotinoid insecticides against okra leaf hopper *Amrasca biguttula biguttula* (Ishida)

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ABSTRACT

Leaf hopper infestation was recorded during first and second week of July but its population build-up starts from third week of July (2.51 leaf hoppers/3 leaves), the first peak population was recorded during second week of august (12.78 leaf hoppers/3 leaves) and it reached its highest peak during first week of September and recorded maximum leaf hoppers population (16.45 leaf hoppers/3 leaves) respectively. Maximum temperature was positively correlated (r=+0.129) and rainfall was negatively correlated (r= -0.095) with leaf hopper population. In respect of comparing the efficacy of neonicotinoid insecticides against leaf hopper population; acetamiprid 20% SP @ 40 g. a.i./ha was recorded as the most effective insecticidal treatment which recorded lowest leaf hopper population/plant (3.01 leaf hopper/3 leaves) along with 81.27 % protection over control which was followed by thiamethoxam and imidacloprid, dimethoate and acephate 77.71%, 76.43%, 69.56% and 67.10% protection over control respectively. Acetamiprid also recorded highest marketable yield (113.35 q/ha), followed by imidacloprid (110.54 q/ha), thiamethoxam (109.02 q/ha).

Key words : *Leaf hopper, Neonicotinoid, Okra, Weather variable*

Introduction

Okra [*Abelmoschus esenlentus* (L.) Moench] is an important vegetable crop valued for its immature, tender and green fruits in India. Efforts are being made to increase the yield of okra crop by adopting improved agricultural practices, such as use of high yielding varieties, balanced fertilizer, supplement irrigation etc. However these composite efforts are nullified if the crop is not protected from the ravages of insect pests. One of the major bottlenecks in successful production of okra is the damage caused by early season sucking pests and fruit borers. Among the sucking pests, okra jassids (*Amrasca biguttula biguttulla* Ishida), white fly (*Bemisia tabaci* Guenn.) and aphids (*Aphis gossypii* Glover) are of major sucking pests causing heavy losses (Devasthali and Saran, 1997). Climatic factors are effective on the survival, development and reproductive capacity of insect pests. Timings of the management activities are crucial for the implementation of pest management tactics. Like other insects, the population of *A.*

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biguttula biguttula is governed by their innate ability to increase, under the influence of various environmental factors. Amongst various physical factors, temperature, humidity and rainfall are considered to be the most important cause of population fluctuations (Patel *et al.*, 1997). Leaf hopper remains active all over the year excluding two months of winter season and the infestation of leaf hopper increases with the increase of crop age. High humidity favours the leaf hopper population growth and maximum population is observed during the month of July and August (Lohar, 2001). Considering the seriousness of the pest, the present studies were, therefore, initiated to study the impact of weather variable on the population and seasonal abundance of leaf hopper on okra.

There is a vast range of chemical insecticides belonging to organophosphate, organochlorine, carbamates and pyrethroid groups used for controlling the insect pests of okra which confers a huge pesticides load to the environment thus causing adverse effect like pest resurgence, resistance, mortality of natural enemies and pollinators etc. Therefore it is utmost important to reduce the pesticide load with successful pest suppression. Neonicotinoids are the new group of crop protection agents highly effective against sucking pests (Nath and Sinha, 2011) which affects acetylcholine receptor of insect central nervous system. It has excellent systemic and translaminar activity and hence gives excellent efficacy against sucking pest complex and assures the protection of young growing shoots. Keeping this in view our objective is to study the bio-efficacy of three neonicotinoid insecticides namely imidacloprid, thiamethoxam and acetamiprid against leaf hopper infesting okra under irrigated condition.

Materials and Methods

A field study was conducted to determine the role of weather in fluctuation of leaf hopper population and to evaluate the efficacy of different neonicotinoid insecticides in suppressing the leaf hopper population on Okra during the pre *kharif* season of 2010 and 2011 at University Instructional Farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal. Healthy fungicide treated pre soaked seeds of okra (F_1 Hybrid Okra 152) were sown during second week of March with 30x50 cm spacing. To evaluate the effect of weather variable (temperature, rainfall, relative humidity etc.) on leaf hopper population; observation was recorded from each three leaves per plant, one each from top, middle and bottom region, and from five plants from a 12 sq m plot grown separately selected at random leaving border rows.

To evaluate the efficacy of the insecticides, experiments were conducted separate in a randomized block design (RBD) and replicated thrice with 6 numbers of insecticides namely Acetamiprid 20% SP (Pride), Spinosad 45%SC (Spintor), Thiamethoxam 25% WG (Actara), Acephate 75% SP (Asataf), Imidacloprid 17.8 SL (Confidor), Dimethoate 30% EC (Rogor). The total numbers of treatments were 7 including control. Treatments were imposed when the pests crossed the economic threshold level (ETL-2 nymphs/leaf). Two sprays were given with a pneumatic knapsack sprayer with a spray volume of 500 litres. The pre treatment and post treatment observations on l, 7 and 14 days were recorded on the incidence of leaf hopper from three leaves per plant, one each from top, middle and bottom region, and from five plants per plot (8 m^2 each) selected at random leaving border rows.

Results and Discussion

Seasonal incidence of leaf hopper on Okra

No leaf hopper population was recorded during first and second week of july but its population build-up starts from third week of July (2.51 leaf hopper/3 leaves) and subsequently increasing its population, thus attaining the first peak during second week of August (12.78 leaf hopper/3 leaves) with the increase of max temperature (33.41^{0}C), very high relative humidity (98.42%) and no rainfall. Leaf hopper population reached its highest peak during first week of September and recorded maximum leaf hopper population (16.45 leaf hopper/3 leaves) when maximum temperature was recorded 33.50°C, minimum temperature 26.10°C, an average temperature 29.8°C and relative humidity 85.07% (Table 1). The population of leaf hopper starts declining (12.08 leaf hopper/3 leaves) with the increase of rainfall (6.85mm) from September second week, but another peak was recorded during last month of September (11.23 leaf hopper/3 leaves) with the decreasing rainfall (2.91mm). The data regarding leaf hopper population during the course of study were correlated with the weather factors as well as on cumulative basis, to study the influence of weather factors on the population fluctuation of leaf hopper per plant on okra. Maximum temperature (r= 0.129) and maximum relative humidity (r= 0.702) on cumulative basis showed a positive correlation with the leaf hopper population (Table 2), whereas total sunshine hour, on cumulative basis showed positive correlation (r= 0.042) and rainfall showed negative correlation with the leaf hopper population (r= -0.095). Patel *et al.* (1997) also reported the analogous result who reported that significant positive relationship between leaf hopper population and maximum temperature (r= 0.76) as well as of bright sunshine hour (r= 0.82). The present findings are in conformity with Kumawat *et al.* (2000) who also reported that the infestation of leaf hopper started in the fourth week of July and reached peaks in the second and fourth weeks of September, respectively and maximum temperature was significantly correlated with leaf hopper population on okra. The present findings can be compared with the report showed by Srinivasan *et al.* (1981) who reported that rainfall reduced the mean density and increased the aggregation among leaf hopper on the okra crop. Similar results were also reported by Lal *et al.* (1990) who concluded that continuous rainfall was unfavourable for the population build-up of leaf hopper. Prasad and Logiswaran (1997) found that the rainfall had a significant and negative association with the leaf hopper population.

Effect of neonicotinoid insecticides on leaf hopper

Non-significant and uniform distribution of leaf hopper population was recorded during pre-treatment count with the range of 12.25 to 13.25 per three leaves during 2010 and varied from 10.25 to 13.15 population per three leaves during 2011 well above the ETL. During the experimental year 2010, acetamiprid 20% SP @ 40 g a.i./ha recorded most effective treatment against leaf hopper which showed a significant reduction of leaf hopper population at 1, 7 and 14 days after spraying (1.06, 0 and 1.01 after first spray and recorded 0, 0, 0.45 per three leaves per plant respectively after second spray). The other two neonicotinoids also provided a good remarkable reduction of leaf hopper population. Imidacloprid recorded next lowest mean leaf hopper population at 1 days after first spray (1.78 num-

Table 1. Average weekly record of incidence pattern of leaf hopper and different abiotic factors throughout the period of experiment

Monthly Week	Leaf hopper population/3 leaves/plant	Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	Total Sunshine hour
		Max	Min	Max	Min		
July-I	0	32.62	26.07	95.00	73.28	3.02	6.52
II	0	33.00	26.37	95.57	82.57	6.65	4.94
III	2.51	33.77	26.77	97.00	80.28	0.31	6.35
IV	6.32	33.14	26.30	98.85	71.85	2.71	5.88
August-I	8.35	32.12	25.67	97.42	77.00	15.85	6.08
II	12.78	33.41	26.68	98.42	75.71	0	5.70
III	11.24	32.78	25.88	99.71	70.42	4.82	4.78
IV	13.01	33.47	26.42	99.14	73.28	2.88	5.42
September-I	16.45	33.50	26.10	97.57	72.57	1.60	7.92
II	12.08	32.37	25.75	99.57	80.28	6.85	4.41
III	8.09	31.34	25.30	99.71	83.42	6.79	3.91
IV	11.23	33.45	24.98	100.0	77.00	2.91	4.80

Table 2. Correlation matrix of leaf hopper in relation with different abiotic factors

Pest	Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	Total Sunshine hour
	Max	Min	Max	Min		
Leaf hopper population/3 leaves/plant	0.129	-0.224	0.702	-0.353	-0.095	0.042

Table 3. Effect of the insecticides on leaf hopper *Amrasca biguttula biguttula* (Ishida) on Okra during 2010

Treatments	Dose g.a.i/ha	Mean Population of leaf hopper/3 leaves (1st spray)				Mean Population of leaf hopper/3 leaves (2nd spray)				Overall mean infestation (leaf hopper/ 3 leaves)	% protection over control	Marketable fruit (q/ha)	Increased yield over control (q/ha)
		Before spray	1 days	7 days	14 days	Before spray	1 days	7 days	14 days				
Acetamiprid 20% SP	40	12.32 (3.58)	1.06 (1.24)	0 (0.70)	1.01 (1.22)	10.24 (3.27)	0 (0.70)	0 (0.70)	0.45 (0.97)	3.14	81.85	112.65	82.4
Spinosad 45%SC	75	12.80 (3.65)	8.25 (2.95)	8.75 (3.04)	8.88 (3.06)	12.45 (3.59)	6.39 (2.56)	6.85 (2.71)	6.92 (2.72)	8.91	48.41	65.21	34.96
Thiamethoxam 25% WG	50	12.25 (3.58)	2.05 (1.59)	1.12 (1.27)	2.35 (1.68)	11.32 (3.43)	0.26 (0.87)	0 (0.70)	0.76 (1.12)	3.76	78.21	108.45	78.2
Acephate 75% SP	250	13.01 (3.68)	4.02 (2.12)	3.58 (2.01)	3.84 (2.08)	12.36 (3.58)	1.75 (1.5)	1.86 (1.53)	2.21 (1.64)	5.33	69.15	88.57	58.32
Imidacloprid 17.8 SL	50	12.85 (3.65)	1.78 (1.51)	1.79 (1.51)	1.88 (1.54)	11.05 (3.39)	0.09 (0.76)	0 (0.70)	0.79 (1.29)	3.78	78.12	109.74	79.49
Dimethoate 30% EC	300	13.15 (3.70)	3.06 (1.89)	3.19 (1.92)	3.35 (1.96)	11.21 (3.41)	1.21 (1.30)	1.25 (1.32)	1.45 (1.39)	4.73	72.59	90.21	59.96
Untreated		13.25 (3.71)	16.25 (4.09)	17.85 (4.28)	18.57 (4.36)	16.85 (4.17)	17.89 (4.28)	18.25 (4.33)	19.27 (4.44)	17.27	-	30.25	-
SE. m ±		-	0.17	0.25	0.31	-	0.45	032	0.51	-	0.95	6.63	-
CD at 5%		NS	1.52	1.73	0.97	NS	1.22	0.99	1.21	-	2.98	20.54	-

Figures in the parenthesis are square root transformed value, NS - non significant

ber of leaf hoppers/ 3 leaves) closely followed by thiamethoxam (2.05 hopper/ 3 leaves), dimethoate (3.06 hopper/ 3 leaves), acephate (4.02 hopper/ 3 leaves) and spinosad (8.25 hopper/ 3 leaves). But at 14 days after first spray and consecutively thiamethoxam provided better result as compared to imidacloprid in respect of leaf hopper population count and therefore considered as the next best effective treatment after acetamiprid. Same trend was followed in second spray also. During 7 days after second spray acetamiprid, thiamethoxam and imidacloprid recorded 100% reduction of leaf hopper population. It is clear from the (Table 3) that acetamiprid recorded minimum leaf hopper population (3.14 hopper/ 3 leaves) closely followed by the other two neonicotinoids; thiamethoxam and imidacloprid (3.76 and 3.78 hopper/ 3 leaves respectively) both the treatments were on par with each other. On the other hand a steady increase of leaf hopper population was recorded in untreated control plot (17.27 leaf hopper).

During the year 2011 analogous result was recorded, again this year acetamiprid recorded the lowest overall mean infestation after two spray (2.87 hopper/ 3 leaves) and considered as best treatment which is closely followed by thiamethoxam (3.38 hopper/ 3 leaves) and imidacloprid (3.75 hopper/ 3 leaves) (Table 4). Comparing the mean data of the two year it is unambiguous that acetamiprid was considered as the best treatment against leaf hopper which recorded lowest leaf hopper population 3.01/ three leaves and highest per cent protection over control plot. The efficacy of acetamiprid against leaf hopper was also reported by Reddy and Gowdar, 2006 who reported that acetamiprid 20 SP was superior to monocrotophos and triazophos in controlling Jassids. The other two neonicotinoids thiamethoxam and chloro-nicotinoid imidacloprid recorded 3.57 hopper/ 3 leaves and 3.77 hopper/ 3 leaves. Spinosad was recorded as moderately effective treatment com-

Table 4. Effect of the insecticides on leaf hopper *Amrasca biguttula biguttula* (Ishida) on Okra during 2011

Treatments	Dose g.a.i/ha	Mean Population of leaf hopper/3 leaves (1st spray)				Mean Population of leaf hopper/3 leaves (2nd spray)				Overall mean infestation (leaf hopper/ 3 leaves)	% protection over control	Marketable fruit (q/ha)	Increased yield over control (q/ha)
		Before spray	1 days	7 days	14 days	Before spray	1 days	7 days	14 days				
Acetamiprid 20% SP	40	10.32 (3.28)	0.81 (1.31)	0 (0.70)	0.78 (1.13)	11.02 (3.39)	0 (0.70)	0 (0.70)	0 (0.70)	2.87	80.68	114.05	84.2
Spinosad 45%SC	75	10.25 (3.27)	6.15 (2.55)	6.71 (2.68)	6.98 (2.73)	12.32 (3.58)	7.39 (2.80)	8.01 (2.91)	8.21 (2.95)	8.25	44.65	68.29	38.44
Thiamethoxam 25% WG	50	11.25 (3.42)	1.05 (1.24)	1.02 (1.23)	1.16 (1.24)	2.01 (1.58)	0.46 (0.97)	0 (0.70)	0.6 (1.04)	3.38	77.20	109.58	79.73
Acephate 75% SP	250	13.01 (3.68)	4.02 (2.12)	3.58 (2.01)	3.84 (2.08)	4.25 (2.17)	1.75 (1.5)	1.86 (1.53)	2.21 (1.64)	5.19	65.04	91.07	61.22
Imidacloprid 17.8 SL	50	12.85 (3.65)	1.78 (2.28)	1.79 (1.51)	1.88 (1.54)	2.05 (1.59)	0.09 (0.76)	0 (0.70)	0.79 (1.13)	3.75	74.74	111.34	81.49
Dimethoate 30% EC	300	13.15 (3.68)	3.06 (1.88)	3.19 (1.89)	3.35 (1.96)	3.85 (2.08)	1.21 (1.30)	1.25 (1.32)	1.45 (1.39)	4.96	66.53	92.16	62.31
Untreated	-	10.25 (3.27)	12.26 (3.57)	13.01 (3.67)	15.95 (4.05)	15.42 (3.98)	16.56 (4.13)	16.62 (4.13)	18.59 (4.36)	14.83	-	29.85	-
SE. m ±	-	-	0.12	0.37	0.51	-	0.55	0.26	0.56	-	1.04	5.27	-
CD at 5%	-	NS	1.32	1.69	1.82	NS	1.22	0.91	1.89	-	5.11	19.36	-

Figures in the parenthesis are square root transformed value, NS - non significant

pared to the neonicotinoids which recorded 8.58 leaf hopper population/ three leaves and other two conventional insecticides acephate and dimethoate also proved effective against leaf hopper (Table 5). Kalawate and Dethe (2012) also reported spinosad is moderately effective against leaf hoppers. Acetamiprid recorded 81.27% protection over control plot followed by thiamethoxam (77.71%), imidacloprid (76.43%), dimethoate (69.56%), acephate (67.10%) and spinosad (46.53%). Same trend was followed in case of marketable fruit yield also where acetamiprid treated plot was recorded as the highest yield giving plot (113.35 q/ha) with 83.3 q/ha increased yield over control. The other two neonicotinoids; thiamethoxam and imidacloprid was on par in respect of marketable yield of fruits (109.02 and 110.54 q/ha) with 78.97 and 80.49 q/ha increased yield over untreated plot respectively. Imidacloprid @ 50 g a.i./ha was considered as one of the best insecticidal treatment during the present study which are in agreement with the observations of Misra and Senapati (2003), Meena (2003) and Singh *et al*. (1993). As reported by Krishna Kumar *et al*. (2001), acetamiprid, thiamethoxam 25 WG and imidacloprid were the best insecticides in controlling okra leafhopper up to 3 weeks after spray which strongly supports the present findings. Dimethoate and Acephate also provide much higher yield than the control plot and provide a good check over leaf hopper during the couse of study which is in the line with the findings of Kalyan *et al*. (2012), who reported that acephate 75 SP was also found effective in controlling leaf hopper population and at par with dimethoate 30 EC (standard check).

Conclusion

It is unambiguous to conclude that leaf hopper population was highly active during August-September and

Table 5. Effect of the insecticides on leaf hopper *Amrasca biguttula biguttula* (Ishida) (mean of 2010 and 2011)

Treatments	Dose g.a.i/ha	Overall mean leaf hopper infestation/3 leaves	% protection over control	Marketable fruit (q/ha)	Increased yield over control (q/ha)
Acetamiprid 20% SP	40	3.01	81.27	113.35	83.3
Spinosad 45%SC	75	8.58	46.53	66.75	36.7
Thiamethoxam 25% WG	50	3.57	77.71	109.02	78.97
Acephate 75% SP	250	5.26	67.10	89.82	59.77
Imidacloprid 17.8 SL	50	3.77	76.43	110.54	80.49
Dimethoate 30% EC	300	4.85	69.56	91.19	61.14
Untreated	-	16.05	-	30.05	-

Neonicotinoids are highly effective in controlling the leaf hopper infesting okra, and as these insecticides are non-phytotoxic, and relatively safer to the non target beneficial coccinelids and chrysoperla and other natural parasite predators they can effectively be used in okra, one should be cautious that application should not be done during flowering season to avoid bee toxicity.

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