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Cost Effective Management of Leafhopper Amrasca Biguttula Biguttula (Ishida) Infesting Okra in Southern Punjab (Pakistan)

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Abstract

Leafhopper is a sap cell sucker of the okra plant. It damages the plants by inserting toxic materials in the leaves, as a result crop showed symptoms of discoloration of leaves and stunted growth of plants which result in yield losses. There was sufficient need for determining the action threshold level to avoid blind chemical sprays for the management of leafhopper. The present study examined the effect of different levels of leafhopper (*Amrasca biguttula biguttula*) infestation on okra (*Abelmoschus esculentus* L) yield to identify the economic threshold for leafhopper populations and the most appropriate timing of insecticide application. Field trials were conducted in Multan, Pakistan in 2010 and 2012 and in Bahawalpur, Pakistan in 2012. Crops were sprayed with imidacloprid when the mean population of leafhopper nymphs and adults reached 1-1.5, 1.5-2.5 and 2.5-3.5 per leaf. The total number of sprays required at different population thresholds varied between 2 and 5 sprays on per treatment plot.

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Based on the cost of spraying and increased net return due to reduced leafhopper damage, spraying crops when the infestation was 1-1.5 leafhoppers/leaf was found to be the most cost effective, giving the highest net returns compared with the untreated controls.

Keywords: Leafhopper; Amrasca biguttula biguttula; okra; Action threshold; Yield.

1. Introduction

Punjab is the most fertile agricultural province of Pakistan. Multan and Bahawalpur are two most important cities located at South of the Punjab province. These are the core areas for the agricultural crops like cotton, wheat and vegetables production. Vegetables are mostly grown near the cities due to easy access to Fruit and Vegetable Markets. Multan and Bahawalpur have main Fruit and Vegetable markets of Southern Punjab. In Pakistan vegetables were cultivated on an area of 6,11,700 hectares with total production 84,78,800 tons. Province wise share in terms of area, Punjab's share was more than 60% of the total area of vegetables, followed by Sindh 17%, Baluchistan 13% and KPK 10%. Punjab's contribution to country's vegetable production was 67%. In Pakistan, okra was grown on 13,900 hectares, which was 2.3% of total area of vegetables grown. Okra production was 1,02,600 tons, which was 1.2% of total production of vegetables. Punjab share in Pakistan's total okra production was 57.3% [1]. Okra production potential is much higher than we are getting now a days. One of possible reasons of low yield is insect pests that attacking okra crops. Its production could be increased through timely management of insect pests to avoid yield losses.

Chemical insecticides are one of the quick options to save crop from destructive insect pests like leafhopper. Chemical pesticide, are applied without knowing the economic threshold of the leaf hopper, *Amrasca bigutulla bigutulla*. The leafhopper damages crop plants by sucking cell sap in both nymphal and adult stages. It attacks a number of crop plants of economically important, such as okra, cotton and eggplant in South Asia, including Pakistan [2,3,4]. Insecticides remain essential components for pest management by vegetable growers where they are grown as cash crops [5,6]. However, indiscriminate use of insecticides leads to undesirable levels of pesticide residues in vegetables at harvest [7] and can be a potential risk to consumer health [8,9,10]. Therefore, due to their relative toxicity insecticides should be used at optimum level to help protect the environment and health hazards to human [11,12]. It is therefore important to determine crop-specific action thresholds for spraying of pesticides. The concept of an economic threshold (ET) for pesticides application is widely accepted alternate option to calendar sprays [13]. In India, the ET for leafhopper has been reported to vary with the agronomic and climatic conditions [14; 15]. The purpose of the present study was to work out the most cost effective ET for spraying leafhopper on okra with insecticides under the agronomic and climatic conditions of southern Punjab.

2. Materials and Methods

Field studies were carried out at a research farm of Bahauddin Zakariya University, Multan (2010 and 2012), and at the Regional Agriculture Research Institute (RARI), Bahawalpur (2012). The okra variety 'Sabz Pari' was sown on three dates, at 15-day intervals [S_1= mid-February; S_2= late February; S_3= mid-March] in each experimental year. Complete randomized block design (CRBD) was adopted with three replications per treatment for each sowing. Each treatment plot had four rows with R-R 75 cm apart, with P-P 15 cm. Recommended agronomic practices for okra were used for all the treatments. Three predetermined action thresholds (AT) for insecticide application were compared with an untreated control (T0). Insecticide was applied at AT levels of 1-1.5l (T1), 1.5-2.5 (T2), and 2.5-3.5 (T3) leafhopper nymphs and adults per leaf. Insect sampling was done on a weekly basis, and only subplots in which the particular AT was exceeded were treated with insecticide.

The neonicotinoid insecticide Imidachloprid (Confidor™, 20% a.i. soluble liquid, Bayer Crop Science) was obtained from a local distributor in Multan and applied by knapsack sprayer @ of 59 g a.i. per ha. The number of leafhopper adults and nymphs was recorded from six randomly-selected plants from the inner two rows of each subplot at weekly intervals. Initially, the total number of leaves and the total number of leafhoppers was counted from each selected plant. After 2 weeks, data were recorded from the top, middle and bottom leaves of selected plants and insects per leaf calculated [16] (16. Singh and Kaushik, 1990). Fruit yields (fresh weight of fruit to the nearest g) were also recorded on weekly bases from the six plants selected for leafhopper assessment each week per replicate (18 plants per treatment). The mean fruit weight per plant was calculated for yield.

Yield / Acre = Fruit weight per plant × 50,000 (plants per ha)

Application cost of Imidachloprid was determined separately for calculating the control cost of *A. biguttula biguttula*.

Control cost (PKRs) = (number of sprays × 400) + (number of pesticide applications × 300)

Yield data were analyzed using the generalized linear model (GLM) procedure in R (http://www.r-project.org) to determine the significant difference between the yields in each treatment and subsequently analyze the economic return.

3. Results

There were significant differences in yield between predetermined levels (AT) for leafhoppers in the field trial in Multan in 2010 (Table 1). The mean number of leafhoppers per leaf was found to be 1.25, 1.1 and 1.3 in AT T1; 1.8, 2.1 and 2.2 in AT T2; 3.1, 3.2 and 2.6 in AT T3, and 5.3, 5.1 and 5.9 in T0 (untreated) for mid-February, late February and mid-March sowings of okra, respectively. Treatment T1 with five sprays resulted in significantly greater yield compared to T2, T3 and T0 in mid-February, late February and mid-March sowings of okra. The greatest fruit yield (kg/ha) was found in T1 followed consecutively by T2, T3 and T0 (Table 1).

As in 2010, the predetermined AT level for leafhoppers significantly affected yield in the field trial in Multan in 2012 (Table 2). The population of leafhopper remained under the predetermined level in T1, T2 and T3 while mean leafhopper populations were 4.7, 4.9 and 5.2 in T0 for mid-February, late February and mid-March sowings, respectively. The treatment T1 sprayed five times resulted in significantly greater yield compared to T2, T3 and T0 in all date of sowing. The greatest fruit yield (kg/ha) was found in T1 followed by T2, T3 and T0

(Table 2).

Table 1: Economic analysis for the development of leafhopper per leaf action threshold (AT) for okra in Multan (2010).

	AT	Mean Leaf hopper/leaf	Mean Yield/ ha (kg)	Gross income (PKRs)	No. of sprays	Control Cost (PKRs)	Income (PKRs)
Mid Feb.	T1	1.25	1761a	53475	5	3500	49975
	T2	1.8	1398b	42450	3.5	2450	40000
	T3	3.1	1230b	37350	2	1400	35950
	T0	5.3	975c	29625	0	0	29625
Late Feb.	T1	1.1	1721a	52275	5	3500	48775
	T2	2.1	1353b	41100	3.7	2590	38510
	T3	3.2	1260b	38250	2.3	1610	36640
	T0	5.1	963c	29250	0	0	29250
MidMarch	T1	1.3	1682a	51075	5	3500	47575
	T2	2.2	1321b	40125	3.5	2450	37675
	T3	2.6	1128b	34275	2.3	1610	32665
	T0	5.9	911c	27675	0	0	27703

Means within a column with common letter are not significantly different ($P \leq 0.05$).
Fruit price = 75 rupee/kg. T1= 1-1.5, T2= 1.5-2.5, T3= 2.5-3.5 leafhoppers/leaf ; T0= unsprayed control
Control cost (Rs) = (Number of sprays × 400) + (Number of pesticide applications × 300).

Predetermined levels (AT) for leafhoppers also significantly influenced yield in the field trial in Bahawalpur in 2012 (Table 3). The means number of leafhoppers per leaf was found to be 1.11, 1.15 and 1.20 in AT T1; 1.94, 1.71 and 1.99 in AT T2; 2.62, 2.26 and 3.33 in AT T3; 3.68, 3.56 and 3.35 T0 (untreated) for mid-February, late February and mid-March sowings of okra, respectively. The treatment T1 with 4.7 sprays; T2 with 4 sprays and T3 with 4.3 sprays while treatment T1 resulted in significantly greater yield compared T2, T3 and T0 in mid-February, late February and mid-March sowings of okra. The greatest fruit yield was found to in T1 followed by T2, T3 and T0 (Table 3).

4. Discussion

As action threshold is dependent of different factors like market value of product, cost of pesticide, application cost and efficacy of insecticide [17], we took the average rate of okra fruit during early summer which could be different with area of cultivation and increased supply of okra while other factors remained almost same all-round the year. So, it is advised that before determining the action threshold, market value of crop must be kept in mind for any crop in particular okra.

Table 2: Economic analysis for the development of leafhopper per leaf action threshold (AT) for okra in Multan (2012).

	AT	Mean Leaf hopper/leaf	Mean Yield/ ha (kg)	Gross income (PKRs)	No. of sprays	Control Cost (PKRs)	Income (PKRs)
Mid-Feb.	T1	1.31	1470a	47600	5	3500	44100
	T2	1.93	1299b	42080	3	2100	39980
	T3	2.9	1027b	33280	2	1400	31880
	T0	4.7	887c	28720	0	0	28720
Late Feb.	T1	1.22	1450a	46960	5	3500	43460
	T2	2.3	1281b	41520	3.3	2310	39210
	T3	3.1	1099b	35600	2.3	1610	33990
	T0	4.9	938c	30400	0	0	30400
Mid-March	T1	0.93	1407a	45600	5	3500	42100
	T2	1.9	1321b	42800	2.7	1890	40910
	T3	3.3	1050c	34000	2	1400	32600
	T0	5.2	913c	29600	0	0	27703.5

Means within a column with a common letter in common are not significantly different ($P \leq 0.05$). Fruit price = 80 rupee/kg. T1= 1-1.5, T2= 1.5-2.5, T3= 2.5-3.5 leafhoppers /leaf; T0= unsprayed control.
Control cost (Rs) = (Number of sprays × 400) + (Number of pesticide applications × 300).

There is common practice most of the farmers do not know the proper time of insecticides application, sometimes even do not know the level of infestation of a particular pest and as a result they had to bear losses due to unplanned pest management which result into development of insecticide resistance, resurgence, hence economic losses to farming community [18].

The results of present study indicated that there were statistically significant differences between yield due to the different AT of leafhoppers at Multan and Bahawalpur. The maximum numbers of insecticide applications were required to maintain the predetermined AT of T1 (1-1.5 leafhopper/ leaf) in mid-February, late February and mid-March as compared to T2 and T3 with T2 being intermediate having less insecticide application than T3. The maximum yield was found in T1 followed by T2, T3 and T0. The yield was greatly influenced by numbers of leafhoppers. Higher AT level of leafhoppers resulted, more losses in yield. Leafhopper nymph and adults cause destruction in okra yield [19]. The rigorous feeding started as the crop reaches to reproductive stage [20]. Leafhopper feed on leaves by sucking cell sap and can cause hopper burn, which resulted into leaf chlorosis, stunted growth of plants and low yield [21]. Leafhopper has been reported to cause up to a 41% reduction in fruit yield in okra [22]. In our current study the leafhopper AT level in T1 (1-1.5 leafhopper/ leaf) was found to be better with highest net return compared to T2 (1.5-2.5 leafhopper/ leaf), T3 (2.5-3.5 leafhopper/ plant) and T0 (Untreated). Similar findings were reported by different researchers. [14] studied different population of leafhopper (2, 5, 8, 12, or 15 per leaf) and conclude that population 5 per leaf was most effective with high yield in okra. One *Amrasca biguttula biguttula* per leaf in cotton is the economic threshold and best time of insecticide application in Pakistan [23], in India [24] and Sudan [25].

Table 3: Economic analysis for the development of leafhopper per leaf action threshold (AT) for okra in Bahawalpur (2012).

	AT	Mean Leaf hopper/leaf	Mean Yield/ ha (kg)	Gross income (PKRs)	No. of sprays	Control Cost (PKRs)	Income (PKRs)
Mid-February	T1	1.11	1835a	59440	4.7	3290	56150
	T2	1.94	1684b	54560	3.3	2310	52250
	T3	2.62	1185c	38400	3	2100	36300
	T0	3.68	1010d	32720	0	0	32720
Late February	T1	1.15	1842a	59680	4	2800	56880
	T2	1.71	1425b	46160	3	2100	44060
	T3	2.26	1284b	41600	2.7	1890	39710
	T0	3.56	1186c	38400	0	0	38400
Mid-March	T1	1.20	1539a	49840	4.3	3010	46830
	T2	1.99	1304b	42240	3	2100	40140
	T3	3.33	1042c	33760	2.6	1820	31940
	T0	3.35	897c	29040	0	0	29040

Means within a column with a common letter are not significantly different ($P \leq 0.05$). Fruit price = 80 rupee/kg.
T1= 1-1.5, T2= 1.5-2.5, T3= 2.5-3.5 leafhoppers/leaf; T0= unsprayed control.
Control cost (Rs) = (Number of sprays × 400) + (Number of pesticide applications × 300).

These results will help the vegetable growers and crop managers for quick decision making to timely tackle this pest through chemical spray application. Although chemical sprays are not the best option on vegetables, so we recommend farmers to use the insecticides which are environmentally degradable, safer to natural enemies, and have less residual activities to avoid health hazards [26].

5. Conclusion

To achieve a high yield of okra, it is suggested that control measures against leafhopper on okra should be initiated when its levels are still between 1-1.5 leafhopper per leaf. Above this level, heavy losses in yield of okra are experienced.

Table4: Economic analysis for the development of leafhopper per leaf action threshold (AT) for okra in Bahawalpur (2012).

	AT	Mean Leaf hopper/leaf	Mean Yield/ ha (kg)	Gross income (PKRs)	No. of sprays	Control Cost (PKRs)	Income (PKRs)
Mid-February	T1	1.11	1835a	59440	4.7	3290	56150
	T2	1.94	1684b	54560	3.3	2310	52250
	T3	2.62	1185c	38400	3	2100	36300
	T0	3.68	1010d	32720	0	0	32720
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	T0	3.56	1186c	38400	0	0	38400
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Means within a column with a common letter are not significantly different ($P \leq 0.05$). Fruit price = 80 rupee/kg. T1= 1-1.5, T2= 1.5-2.5, T3= 2.5-3.5 leafhoppers/leaf; T0= unsprayed control. Control cost (Rs) = (Number of sprays × 400) + (Number of pesticide applications × 300).

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