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Neem-based integrated management approaches for insect pests okra (*Abelmoschus esculentus* L. Moench.)

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ABSTRACT
A study was conducted during two successive summer seasons of 2000 and 2001 to assess the effectiveness of some neem based integrated management approaches against the Jassid and shoot and fruit borer on okra. The treatments comprised soil application of neem cake @ 200 kg ha^{-1} with 3 foliar application of neem seed kernel extract (5%)/neem oil (3%)/Amrutguard (0.5%)/neem leaf decoction @ 0.5 kg/Chlorpyriphos 20 EC @ 0.5 kg/Endosulfan 35 EC @ 0.5 kg and recommended insecticide of Monocrotophos 36 SL @ 0.4 kg. All the integrated treatments were found quite effective against the Jassid and shoot and fruit borer and were significantly superior over recommended insecticide. However, integrated neem cake treatments with inclusion of Endosulfan and Chlorpyriphos performed better than those with other integrated treatments in reducing the pests incidence and producing more marketable fruit yield. Also these integrated treatments proved profitable with the maximum cost benefit ratio.

Key words : Neem products, Insecticide, Okra, Jassid, Shoot and Fruit borer.

INTRODUCTION

Okra, *Abelmoschus esculentus* L. Moench. is the most important vegetable crop grown extensively in India. One of the major constraints for the low productivity of okra in India is that the crop is more vulnerable to the attack by as many as 13 major insect and non-insect pests during its different growth stages (Dhamdhere *et al*., 1984). Among all these insect pests, Jassid, *Amrasca biguttula biguttula* Ishida and shoot and fruit borer, *Earias vittella* Fabricius are the most serious pests and a major limiting factors in okra cultivation (Rahman, 1983).

Attempt to control these pests by insecticides is fraught with problems of resistance, resurgence, secondary infestation, phytotoxicity, toxicity to beneficial organisms, residues in food beyond the tolerance limits posing unwarranted health hazards to the consumers. The increasing concern for environment safety and global demand for pesticide residue free food have evoked keen interest to use neem products in pest control, which are easily biodegradable and do not leave any harmful toxic residue in fruits besides conserving the natural enemies. The efforts were, therefore made to asses the effectiveness of some neem-based integrated management practices against the insect pests on okra with a view to decrease the pesticide load in okra ecosystem.

MATERIALS AND METHODS

Experiments were conducted for two successive summer seasons during 2000 and 2001 at the University Apiary, Rajendra Agricultural University, Pusa Farm, Samastipur, Bihar to assess the effectiveness of some neem-based integrated management approaches against the insect pests on okra. The experiment was laid out in a randomized block design with six treatments (Table 1). Each treatment was replicated thrice, each plot measuring 3 m x 2 m. The okra (cv. Pusa Sawani) seeds were sown on 16th February in both the years with a spacing of 30 cm x 30 cm. Crops were raised following standard agronomic practices.

Methodology used in preparation of some neem products :

1. Neem seed kernel extract (NSKE 5%) -

500 grams of powdered neem seed kernel were soaked in 10 litres of water for 24 hrs, filtered and the aliquot was made up to 10 litre with water. In 10 litres of spray material, 100 gm of reetha or ordinary washing soap was added and thoroughly mixed before spraying.

2. Neem leaf decoction (NLD) -

The neem leaf decoction was prepared by boiling 1.65 kilo of fresh neem leaves in 10 litres of water for 30 minutes.

3. Neem oil (3%) -

In 10 litres of water, 300 ml of commercially available neem oil was dissolved and 100 gm of reetha or detergent cake was added to obtain 3 per cent spray solution and mixed thoroughly before spraying.

Insecticidal application :

Soil application of neem cake @ 200 kg ha^{-1} were applied at the time of last ploughing. First foliar applications of neem products and other safer insecticides including recommended insecticide were done on 22nd March after 20 days of the crop emergence followed by 2nd and 3rd foliar spray treatments on 12th April and 3rd May after 40 and 60 days of the crop emergence, respectively in both the years. Spraying was done late in the afternoon with high volume knapsack sprayer (ASPEE make) and a through coverage of leaf area, tender shoots and fruits was insured. Spraying were done @ 200-500 litre of water ha^{-1}, depending on the height of the crop. Control plot sprayed only water.

Observation on population density of the pests :

Jassid :

Observations on the pest activity were recorded in each plot of the replicates, a day preceding and 3 and 7 days following the foliar treatments in both the years. Jassid nymphs as well as adults population were observed from three leaves consisting of 2nd, 3rd and 4th each of the 10 randomly selected tagged plants in each of the replicates after Krishnaiah *et al*. (1979). Both the Jassid nymphs and adults were counted on lower surface of leaves in boarder area of plots in the early morning (7 AM to 9 AM), the time during which the Jassids were found inactive. The population of Jassids counts in all the replicates were taken together and average population per 30 leaves per 10 plants was worked out and transformed into square root, x + 0.5 value for analysis of variance.

Shoot and fruit borers :

All the plants in a plot were considered for recording shoot and fruit borer incidence. Harvesting of okra fruits was done at weekly interval. Observations on the pest incidence, viz., shoot damage (total number of shoots and damaged shoots) and fruit damage (total number and total weight of healthy and damaged fruits) were recorded on weekly basis and ultimately pooled together, separately for the respective parameters after tabulating replication wise at each observation to worked out mean value of the pest

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incidence calculated by unitary method by using the following formula:

$$\text{(i) Per cent shoot damage} = \frac{\text{No. of damaged shoots}}{\text{Total no. of (healthy + damaged) shoots}} \times 100$$

$$\text{(ii) Per cent fruit damage by no.} = \frac{\text{No. of damaged fruits}}{\text{Total no. of (healthy + damaged) fruits}} \times 100$$

$$\text{(iii) Per cent fruit damage by wt.} = \frac{\text{Wt. of damaged fruits}}{\text{Total wt. of (healthy + damaged) fruits}} \times 100$$

Larval population :

The larval population of *E. vittella* per hundred fruits was taken at each picking. Larvae were either crawling on the infested fruits or were present inside the infested fruits of okra. The larvae in infested fruits were counted by cutting them longitudinally. Larval populations were counted at each weekly pickings and average population per hundred fruits was worked out.

Shoot and fruit infestation (number and weight basis of fruits) and larvae per hundred fruits were transformed into Arc Sin transformation in replication wise. Data were subjected to statistical analysis by bifurcating them into crop(s) and insecticide(s) for the purpose of data interpretation and drawing conclusion pertaining to their respective influence independently on reduction of the pest incidence.

The yield data of marketable fruits were recorded at weekly picking and converted into quintal per hectare. Thus, the data were taken subjected to statistical analysis.

Cost benefit ratio was calculated by considering additional cost (cost of insecticide and operational charge) and benefit (compared to untreated control) in the respective treatments.

RESULTS AND DISCUSSION

Results indicated that neem-based integrated treatments were very effective against the Jassid and shoot and fruit borer and kept the pest population and shoot as well as fruit damage at significantly low level in both the years (Table 1).

***Jassid* :**

On the basis of pooled means of Jassid population (Table 1), all the neem-based integrated treatments were significantly superior over recommended insecticides as monocrotophos and untreated control. The minimum Jassid population (6.85/30 leaves) was recorded in the neem-based integrated treatment with soil application of neem cake @ 200 kg ha^{-1} alongwith three foliar sprays of endosulfan (35 EC) @ 0.5 kg ha^{-1} after 20, 40 and 60 days of the crop emergence respectively. It was however, differed significantly with NC + Neem oil (8.18/30 leaves), NC + Amruguard (8.00/30 leaves), NC + Chlorpyriphos (7.57/30 leaves) except NC + NSKE (8.59/30 leaves) and NC + NLD (8.56/30leaves) and they were found statistically at par with one another (Table 1). Monocrotophos (36 SL) recorded maximum of 9.01 Jassid population per 30 leaves and found to be least effective. The findings on the effect of neem-based integrated treatments used in the schedule confirm to those recorded by other workers (Parmar and Dutta, 1986; Srinivasan and Sundra Babu, 2000). Similarly, effectiveness of the insecticides against the Jassids were shown by many worker (Yadav and Singh, 1989; Radadia and Patel, 1998).

Shoot and fruit borer :

The pest incidence, interms of the per cent shoot and fruit infestation (by number and weight) as well as the larval population per hundred fruits (Table 1) are described below:

Shoot infestation :

The data on shoot infestation (Table 1) revealed that all the neem-based integrated treatments were significantly superior over the recommendation of monocrotophos and untreated control. The integrated treatment with soil application of neem cake @ 200 kg ha^{-1} + 3 foliar sprays of Endosulfan (35 EC) @ 0.5 kg ha^{-1} was most effective and gave minimum shoot infestation (5.87%). It was followed by NC + Chlorpyriphos (6.68%), NC +Amrutguard (8.93%), NC + NLD (9.88%), NC + Neem oil (10.80%) and NC + NSKE (11.92%). Recommendation of monocrotophos (36 SL) @ 0.4 kg ha^{-1} recorded maximum shoot infestation (14.44%) and was observed to be the least effective treatment.

Table 1 : Neem-based integrated management approaches against okra insect pests (pooled mean, 2000 and 2001)

Sl. No.	Treatment [Kg/%(conc.)/ha]	*Mean number of Jassids/ 30 leaves	**Mean percentage of shoot infestation	**Mean percentage of fruit in festation by		**Mean number of larvae/ 100 fruits	Average Marketable fruit yield (q ha^{-1})	Percent increase in yield over untreated control
				Number	Weight			
1.	NC+NSKE (200 Kg + 5%)	8.59 (73.32)	11.91 (3.52)	19.59 (11.32)	18.19 (9.82)	35.22 (33.29)	101.96	20.09
2.	NC+Neem Oil (200 Kg + 3%)	8.18 (66.52)	10.80 (3.36)	21.12 (13.03)	19.26 (10.90)	33.78 (30.95)	105.60	24.38
3.	NC + Amrutguard (200 kg + 0.5%)	8.00 (63.54)	8.93 (3.07)	18.32 (9.95)	16.28 (7.89)	30.59 (25.93)	107.46	26.57
4.	NC + NLD (200kg + 0.5 kg)	8.56 (72.90)	9.88 (3.22)	21.46 (13.48)	19.18 (10.83)	35.38 (33.55)	103.94	22.42
5.	NC + Chlorpyriphos 20 EC (200 kg + 0.5 kg)	7.57 (56.91)	6.68 (2.67)	18.24 (9.84)	16.30 (7.90)	28.79 (23.24)	113.21	33.34
6.	NC + Endosulfan 35 EC (200 kg+0.5 kg)	6.85 (46.51)	5.87 (2.52)	16.10 (7.75)	14.98 (6.71)	26.50 (19.95)	115.35	35.86
7.	Monocrotophos 36 SL (0.4 kg) (recommended)	9.01 (80.77)	16.10 (4.07)	26.68 (20.23)	23.69 (16.18)	38.12 (38.18)	95.14	12.06
8.	Untreated control (water treatment)	11.02 (121.15)	20.63 (4.59)	31.62 (27.55)	30.93 (26.47)	41.42 (43.80)	84.90	-
	SEm	0.057	0.06	0.467	0.529	0.695	0.752	-
	CD (P=0.05)	0.162	0.192	1.342	1.520	2.331	2.164	

*Square root transformed values ; **Arc Sin transformed values; Figures in the parentheses original values
NC – Neem cake; NSKE – Neem seed kernel extract; NLD – Neem leaf decoction

Fruit infestation :

The results revealed that the neem based integrated treatment with soil application of neem cake alongwith three folior sprays of endosulfan (35 EC) and chlorpyriphos (20 EC) each at 0.5 kg ha^{-1} significantly reduced the per cent infestation of fruits; 16.10 and 18.24 based on fruit number and 14.98 and 16.30 based on fruit weight, respectively. These integrated treatments were found to be the best and at par with one another. The rest neem-based integrated treatments viz., NC + Amrutguard, NC + NSKE, NC + Neem oil and NC + NLD recorded fruit infestation to the tug of 18.32, 19.59, 21.12 and 21.46 per cent on fruit number and 16.28, 18.19, 19.26 and 19.18 per cent on fruit weight basis, respectively (Table 1). Monocrotophos recorded maximum of 20.23 and 16.18 per cent fruit infestation both by number and weight basis, respectively and was found to be the least effective treatment.

Larval population :

The pooled results of the larval population in per hundred fruits in various neem-based integrated treatment ranged from 26.50 to 35.22 as against 41.42 per hundred fruits in untreated control (Table 1) except the recommendation of monocrotophos (38.12 larvae/100 fruits). All the treatments were significantly superior over untreated control (Table 1). The neem-based integrated treatment with NC + Endosulfan was found to be the most effective exhibiting minimum larval population of 26.50 per hundred fruits and proved to be the best. It was however, at par with NC + Chlorpyriphos (28.79 larvae/ 100 fruits).

Thus, the results showed that the neem-based integraed treatments with soil application of neem cake @ 200 kg ha^{-1} alongwith three foliar sprays of endosulfan 35 EC and chlorpyriphos 20 EC each @ 0.5 kg ha^{-1} proved most effective and showed minimum shoot and fruit per cent infestation and also minimum larval population per hundred fruits. Rest of neem-based integrated treatments were also found effective against the pest (Table 1).Significant reduction in the per cent infestation of the pest on each yardstick basis might be due to antifeedant activity of neem products. The study indicated that toxicity was directly proportional to the concentration of the toxicant. The findings on the effectiveness of some neem-based integration of neem products with half dose of insecticides used in the schedule confirm of those recorded by other workers (Sarode and Gabhane, 1994; Patil and Sarode, 1996 and Ahmad, 1998). Similarly, integrated approach with soil application of neem cake alongwith three spray of NSKE, neem oil, NLD and Amrutguard were found very effective against the borer pest and were safer alternative to the synthetic chemicals based management approaches for okra insect pests. Results obtained in the present study are in general agreement with Singh (2000) and Gowri *et al*. (2002). However, the effectiveness of monocrotophos against the borer pest was recorded by other workers (Singh, 1991; Balasubramani and Swamiappan, 1993).

Economics of neem based management approaches:

The yield data (Table-2) revealed that all the neem-based integrated treatments were significantly superior (101.96 to 115.35 q ha^{-1}) over untreated control (84.90 q ha^{-1}). The treatment, neem cake alongwith endosulfan recorded the highest yield (115.35 q ha^{-1}). It was at par with NC + Chlorpyriphos (113.21 q ha^{-1}). The rest neem-based integrated treatments viz., NC + NSKE, NC + NLD, NC + Neem oil and NC + Amrutguard recorded 101.96, 103.94, 105.60 and 107.96 q ha^{-1}, respectively and they differed statistically in producing yield (Table 1). Whereas, the recommendation of monocrotophos recorded minimum yield (84.90 q ha^{-1}). It appeared that integrated approach with inclusion of soil application of neem cake alongwith three foliar application of NSKE/Neem oil/Amrutguard/NLD/ Chlorpyriphos/Endosulfan were quite effective in checking the pest incidence and the yields were fairly good. Results of the present investigation are in conformity with the earlier reports of Patil and Sarode (1996) and Chakraborti (2001).

The data on increase in okra fruit yield over untreated control due to the control of Jassid and the borer pests in different neem-based integrated treatments and the recommendation of monocrotophos gave from 12.06% to 35.86%. The highest 53.36% increased in yield over untreated control was obtained with soil application of neem cake alongwith three foliar spray application of endosulfan followed by NC + Chlorpyriphos (33.34%), NC + Amrutguard (26.57%), NC + Neem oil (24.38%), NC + NSKE (20.09%) and monocrotophos (12.06%).

Cost benefit ratio :

The maximum cost benefit ratio (1:5.16) was recorded in the plots treated with NC + Endosulfan integrated treatment and followed by NC + Chlorpyriphos (1:4.37), Monocrotophos (1:4.24), NC + Amrutguard (1:3.55) while minimum cost benefit ratio (1:2.01) was recorded in NC + Neem oil.

Table 2 : Economics of neem-based integrated management approaches against okra insect pests (Pooled mean, 2000 and 2001)

Sl. No.	Treatment [kg%(Conc.)/ha]	Marketable fruit yield (q ha^{-1})	Increase in yield over untreated control (q ha^{-1})	Gross income (Rs. ha^{-1})	Cost of Treatment (Rs. ha^{-1})	Net income (rs ha^{-1})	Cost benefit ratio
1.	NC+NSKE (200 Kg + 5%)	101.96	17.06	7250.50	2106.00	5144.00	1:2.44
2.	NC+Neem Oil (200 Kg + 3%)	105.60	20.70	8797.50	2915.00	5882.50	1:2.01
3.	NC + Amrutguard (200 kg + 0.5%)	107.46	22.56	958.00	2105.00	7483.00	1:3.55
4.	NC + NLD (200kg + 0.5 kg)	103.94	19.04	8092.00	2031.00	6061.00	1:2.98
5.	NC + Chlorpyriphos 20 EC (200 kg + 0.5 kg)	113.21	28.31	12031.75	2240.00	9791.75	1:4.37
6.	NC + Endosulfan 35 EC (200 kg+0.5 kg)	115.35	30.45	12941.25	2097.50	10843.75	1:5.16
7.	Monocrotophos 36 SL (0.4 kg) (recommended)	95.14	10.24	4352.00	830.00	3522.00	1:4.24
8.	Untreated control (water treatment)	84.90	-	-	-	-	-

Market price of okra halthy fruits @ Rs. 425/q (during, 2000 and 2001)

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