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Bio Efficacy of Different Acaricide Spray Schedules Against the Mite Population in Okra

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Abstract
The present study was tested for their efficacy against mites in okra and their efficacy was compared with control (untreated).Our results revealed that all the acaricides tested were effective to control mite population in okra and after 15 days of 1st and 2nd spray, Oberon (Bayer) resulted in the highest efficacy of 94.52 and 98.01 percent, respectively with the overall average efficacy of 96.27 percent. Nova Star (FMC) ranked 2nd in effectiveness with 91.00 and 92.20 percent efficacy after 15 days of 1st and 2nd sprays, respectively averaging 91.60 percent; while the efficacy of Polo (Syngenta) was 75.32 and 79.16 percent averaging 77.24 percent, Galit (Kanzo) displayed efficacy of 75.03 and 78.74 percent averaging 76.89 percent and the efficacy of Moral after 15 days of 1st and 2nd spray was 73.58 and 77.21 percent averaging 75.40 percent, respectively. The highest amount of additional income Rs. 46171 ha^{-1} was achieved from the plots sprayed with Oberon acaricide against mites; followed by an additional income of Rs. 32723 ha^{-1}, Rs. 30507 ha^{-1} and Rs. 20710 ha^{-1} realized from the plots sprayed with Nova Star, Polo, Galit, and Mortal, respectively over control; while the lowest additional income of Rs. 19255 ha^{-1} was realized from the plots as compared to income of Rs. 121715 ha^{-1} from plots sprayed with acaricide Mortal as compared to control.
Keywords: Okra, effectiveness, mites, acaricides

1. Introduction

Okra, Abelmoschus esculentus L., a popular vegetable, is cultivated in almost all parts of the world; but it thrives best in the tropical and warm temperate regions. It is a warm season crop that belongs to the family Malvaceae. The okra is domesticated in the Ethiopian region (Jacquelyn, 1999). The plant of okra is erect, herbaceous annual, 1-2 meter tall, stem green, leaves alternate, broadly chordate, palmately 3-7 lobed, hirsute, serrate, flowers solitary, axillary with about 2 cm long peduncle; epicalyx upto 10, calyx split longitudinally. Its tender green fruits are used as a vegetable and are generally marketed in the fresh state, but one times in canned or dehydrated form (Henry, 2001). It can be fried in butter or oil and cooked with necessary ingredients (Yadav et al., 2001). Okra crop is infested by numerous insect and mite pests (Kumar, 2004). Sucking pests in the early stage and the fruit borers in the later stage causes extensive damage to fruits and results in 69 percent yield loss (Mani et al., 2005; Jagtab et al., 2007). Application of insecticides had been found to provide acceptable solution to tackle these problems (Pawar et al., 1988; Verma, 1989; Priya and Misra, 2007; Mazumder et al., 2001). About 145 species of insect pests are recorded on cotton plant and almost all of these attack okra plant.

Mites belong to the subclass Acari. Mites are among the most diverse and successful of all the invertebrate groups; they have exploited an incredible array of habitats. Some of the plant pests include the so-called spider mites (family Tetranychidae), thread-footed mites (family Tarsonemidae), and the gall mites of the family Eriophyidae (Halliday et al., 2000). The mites are highly host specific and have only been recorded on plants of Malvaceae family. Damage of mites on okra, another member of the Malvaceae plant family has been reported in other countries. Plants can be infested with the pest with no visible symptoms. Once damage is evident, it is too late because the mites are already established within the plant tissue. However, Insecticides and miticides are effective for reducing crop damage during periods of pest outbreaks. Using selective insecticides/ miticides to kill the target pest without killing natural enemies helps maximize as well as integrate chemical and biological controls. Selectivity usually arises from the specific chemical aspects of the insecticide. Nonselective insecticides and miticides, however, can be made more selective by careful application rates and timings (Heethoff and Koerner, 2007). For most major cotton/okra insect and mite pests, a number of pesticides are available that differ in their toxicity to natural enemies. Botanical, microbial, oil, or soap insecticides are relatively nondisruptive to most natural enemies. In some cases, selective insecticides/miticides may not control pest populations as well as nonselective materials. However, use of selective materials for treatments, especially early in the season, allows natural enemies to survive, which in turn helps minimize outbreaks of pests such as mites and aphids later in the growing season. Nonselective insecticides/miticides leave residues on the plant that may be toxic to predators and parasites for days to weeks following application, depending on the persistence of the product (Klenerman and Lipworth, 2008).

Spraying is carried out to protect the crop at monthly intervals throughout the season are reported to provide protection. More frequent sprays may be needed during the main growth period. Existing galls will

persist on the plant until the affected tissue dies, making it difficult to judge the success of any spray program. The number of effective pest control materials for controlling mites is limited (Halliday et al., 2000). Pesticide products with translaminar properties are best. Foliar application of insecticides Newmectin 1.8 EC and/or Cure 1.8 EC (a.i. abamectin) and Confidor 70WG (a.i. Imidaclorpid), Diafelatheron (50%) and Profenophos (45%) showed good results in controlling mites infestation (Redes, 2011). Miticides also known as Acaricides control unwanted mite pests and protect crops from their damaging effects. Acramite 50WS is a broad-spectrum miticide for controlling mites of field crops and horticyltural plants; and Omite 30WS miticide controls a broad-spectrum of mite species while being easy on beneficial insects and mite predators. Floramite SC miticide provides outstanding control of a variety of mite pests on vegetables and ornamental plants; while Temprano is a Acaricide/insecticide effective means to control a host of crop damaging pest mites, as well as leaf feeding worms and beetles, psyllids, thrips, and leaf miners. Consult the label for a complete list of different crops and pests (Redes, 2011).the objective of the present study (1).To identify the most effective acaricide for the control of mites in okra.(2)To determine residual toxicity of acaricides.

MATERIALS AND METHODS

This study was conducted during 2012 at the experimental fields of Entomology Section Agriculture research institute (ARI) Tandojam. The land was prepared by giving 2 dry plowings; and when the land was ploughed up, the clods were crushed, and leveling of land was carried out to eradicate the weeds and to make the soil surface leveled for uniform distribution of irrigation water during soaking dose. Finally ridges were prepared according to the plan of work. The test was conducted using a randomized block design with three replications of each treatment. Plots were 8m long by 3m wide rows with one border row between treated plots. After soaking dose, the crop was planted by manually on ridges. Five Acaricides were applied to okra crop to evaluate their efficacy against mites. A single variety (Subz pari) of okra vegetable was grown. The following Acaricides were used to evaluate their efficacy against target pests on okra.

Treatments (Acaricides) 6

1. Polo (Syngenta)
2. Nova Star (FMC)
3. Galit (Kanzo)
4. Oberon (Bayer)
5. Mortal (Ali Akbar)
6. Control (untreated)

The recommended dose of NPK fertilizers was applied. The nitrogen was applied in the form of urea, phosphorus in the form of single super phosphate (SSP) and potash in the form of sulphate of potash (SOP). 1/3rd of N alongwith all P and K was applied at the time of land preparation and preparation of ridges by mixing in the soil, while the remaining N was divided into two equal doses and was applied with a fortnight interval after first harvest. The first irrigation was applied after 10 days of sowing and subsequent irrigations at weekly intervals.Acaricides were applied in 25 gal of water per hactare using TX-4 hollow cone nozzles. In all two sprays were carried out when it was felt that the insect population is crossing economic injury level. The population dynamics of the target insect pest, mites were counted visually using magnifying glass at 2, 4, 6, and 15 days of application by collecting five main-stems leaves (four nodes below the terminal selected zigzag mthod) per plot.

Data from each plot were averaged and the plot means were analyzed using analysis of variance and least significant difference.

Results

1st spray

The data (Table-1) indicated that okra crop spraying with acaricide Oberon (Bayer) showed tremendous effect to suppress mites infestation and mite population was 2.81, 1.83, 0.99 and 0.24/leaf after 2, 4, 6 and 15 days of spray, respectively as compared to pre-treatment mite population of 4.33/leaf (Table-1); while the population of mites on okra crop sprayed with Nova Star was 3.18, 2.19, 1.34 and 0.42/leaf after 2, 4, 6 and 15 days of first spray, respectively as compared to pre-treatment population of 4.61/leaf. The population of mites on okra sprayed with Polo, Galit and Mortal after 14 days of first spray was 1.18/leaf, 1.13/leaf and 1.30/leaf, respectively as compared to 4.74/leaf, 4.57/leaf and 4.92/leaf, respectively. In control (untreated) plots, the mites population was in the range of 4.61/leaf to 5.21/leaf during 14 days after spray. It was observed that all the acaricides were found to be effective in reducing the mite population in okra. However, Oberon proved to be highly effective to suppress mite infestation maximally.

2nd spray

The results (Table-2) showed that okra crop spraying with acaricide Oberon (Bayer) displayed marvelous control of mites and mite population was 1.81, 1.09, 0.45 and 0.06/leaf after 2, 4, 6 and 15 days of spray, respectively as

compared to pre-treatment mite population of 3.14/leaf; while the population of mites on okra crop sprayed with Nova Star was 2.10, 1.45, 0.89 and 0.27/leaf after 2, 4, 6 and 15 days of second spray, respectively as compared to pre-treatment population of 3.52/leaf. The population of mites on okra sprayed with Polo, Galit and Mortal ranked 3rd, 4th and 5th with 0.76/leaf, 0.79/leaf and 0.87/leaf after 14 days of second spray as compared to 3.65/leaf, 3.73/leaf and 3.83/leaf, respectively. In control (untreated) plots, the mites population was in the range of 3.62/leaf to 3.93/leaf during 14 days after spray. It was observed that all the acaricides were found effective in reducing the mite population in okra. However, Oberon displayed high performance with minimizing the mite population upto the negligible level.

Efficacy (%)

The results of the study indicated that Oberon ranked 1st being most effective acaricide to control mites in okra, followed by Nova Star; while Polo, Galit and Mortal showed sort of similarity in the effectiveness with slight variation.

Average okra yield

The data regarding okra pod yield was gathered on weekly basis for 10 weeks period and the results (Table-4) indicated that green pod yield was remarkably higher (8252 kg ha-1) in plots sprayed with Oberon acaricide against mites; followed by the plots sprayed with Nova Star (7588 kg ha-1), Polo (7492 kg ha-1), Galit (6994 kg ha-1) and Mortal (6923 kg ha-1) as compared pod yield of control (untreated) plots of 5960 kg ha-1. This indicated that Oberon acaricide resulted in more positive impact on the crop yield as compared to rest of the acaricides.

Income received (Rs. ha^{-1})

The income received from the marketing of green pods of okra was worked out on the basis of actual marketing price of the okra edible green pods on weekly basis and the results (Table-5) indicated that the highest income of Rs. 167886 ha-1 was achieved from the plots sprayed with Oberon acaricide against mites; followed by the plots sprayed with Nova Star (Rs. 154438 ha-1), Polo (Rs. 152222 ha-1), Galit (Rs. 142425 ha-1) and Mortal (Rs. 140970 ha-1) as compared to income of Rs. 121715 ha-1 from control plots.

Additional income (Rs. ha-1) received over control

The additional income was worked out by subtracting the income received in the control plots from the income received from the plots treated with various acaricides and the data is presented in Table-6. It was observed that the highest amount of additional income Rs. 46171 ha-1 was achieved from the plots sprayed with Oberon acaricide against mites; followed by an additional income of Rs. 32723 ha-1, Rs. 30507 ha-1 and Rs. 20710 ha-1 realized from the plots sprayed with Nova Star, Polo, Galit and Mortal, respectively over control; while the lowest additional income of Rs. 19255 ha-1 was realized from the plots as compared to income of Rs. 121715 ha-1 from plots sprayed with acaricide Mortal as compared to control.

DISCUSSION

Okra is a vegetable liked by rich and poor alike; while this crop is infested by many insect pests including mites and are among the most diverse and successful of all the invertebrate groups; they have exploited an incredible array of habitats (Halliday et al., 2000). The mites are highly host specific and have only been recorded on plants of Malvaceae family. Damage of mites on okra, another member of the Malvaceae plant family has been reported in other countries (Heethoff and Koerner, 2007). Specific insecticides have been developed for controlling mites and generally these named as Acaricides (Klenerman and Lipworth, 2008). The present study was carried out to investigate the efficacy of different acaricides to control mites in okra. Five acaricides including Polo (Syngenta), Nova Star (FMC), Galit (Kanzo), Oberon (Bayer) and Mortal (Ali Akbar) were tested for their efficacy against mites in okra and their efficacy was compared with control (untreated).

The findings of the present research indicated that all the acaricides tested were effective to control mite population in okra and after 15 days of 1st and 2nd spray, Oberon (Bayer) resulted in the highest efficacy of 94.52 and 98.01 percent, respectively with overall average efficacy of 96.27 percent. Nova Star (FMC) ranked 2nd in effectiveness with 91.00 and 92.00 percent efficacy after 15 days of 1st and 2nd sprays, respectively averaging 91.60 percent; while the efficacy of Polo (Syngenta) was 75.32 and 79.16 percent averaging 77.24 percent, Galit (Kanzo) displayed efficacy of 75.03 and 78.74 percent averaging 76.89 percent and the efficacy of Moral after 15 days of 1st and 2nd spray was 73.58 and 77.21 percent averaging 75.40 percent, respectively. The highest amount of additional income Rs. 46171 ha-1 was achieved from the plots sprayed with Oberon acaricide against mites; followed by an additional income of Rs. 32723 ha-1, Rs. 30507 ha-1 and Rs. 20710 ha-1 realized from the plots sprayed with Nova Star, Polo, Galit and Mortal, respectively over control; while the lowest additional income of Rs. 19255 ha-1 was realized from the plots as compared to income of Rs. 121715 ha-1 from plots sprayed with acaricide Mortal as compared to control. These results are further supported by the studies of Halliday et al. (2000) who concluded that application of acaricides against mites protects the crop throughout the season and more frequent sprays may be needed during the main growth period. Foliar application of different miticides against mites has been reported by (Redes, 2011) and reported good results in controlling mite

infestation. Miticides control unwanted mite pests and protect crops from their damaging effects. However, these miticides are marketed with brand names and their brand names are changed and registered time to time. Kumar and Sharma (1991) examined the effect of different acaricides against mites in okra and reported that in summer, maximum mortality (68 to78%) was obtained with dicofol (0.02%), sulphur (0.25%) and NSKE (0.05%) against spider mite, Tetranychus ludeni Zecher on okra at Pusa (Samastipur). Kumar and Sharma (1993) studied the population dynamics and control of the mite, Tetranychus ludeni Zecher on Okra at Samastlpur in Bihar. The mite appeared in the first week of April. Population peak was recorded in June, and a sharp decline in mite density was observed in July. The mites disappeared in September. The predatory mites, Amblyseius spp. appeared in second week of June. Sulphur, dlcofol, tetradlfon, and neem seed kernel extract were most effective for controlling this mite on Okra. Patel et al. (1993) investigated the efficacy of different materials used as acaricides against mites on okra and concluded that plant product as above can be taken advantage for the evaluation for toxic level against spider mite. Azadirachtin (0.03%, 5 ml/liter) have been found effective up-to (76.80%) against Tetranychus urticae Koch after seven days. Sugeetha (1998) investigated the efficacy of acaricides on the control of mites and reported that dicofol at 0.05 percent and wettable sulphur 80 WP at 2 percent was effective against Tetranychus macfarlanei infesting okra. Sivakumar and Hariprasad (1999) assessed the efficacy of different pesticides for the control of mites Tetranychus cinnabarinus in okra and reported that among the treated chemicals, Dicofol (1.5 L/ha.) was highly effective against T.cinnabarinus on okra in Tamil Nadu. Kharboutli et al., (2000) reported that several miticides provided good control of spider mites in this test. The strong initial efficacy of Curacron in this test has not been consistently seen in previous tests in Arkansas. Lorsban reduced the mite population, but the level of control was not adequate. Mite populations tended to rebound following treatments with Curacron or Lorsban. Pirate and Kelthane performed well in this test and have shown strong performance in previous tests. We do not have strong databases on either Zephyr or Capture; therefore, more test work will be needed before definitive conclusions can be drawn about the effectiveness of these products. Singh et al. (2004) reported that maximum mortality of mite population was observed with propagate 57 EC @ 0.17 and 0.11 per cent (49.1 and 53.37 per three leaves, respectively) and dicofol 18.5 EC @0.02% (56.7 per three leaves) at 7 days after first spraying against T. cinnabarinus infesting okra (cv. Super Anamika) evaluated near Ghaziabad, Uttar Pradesh from April to July 2003. Elbert et al. (2005) reported that Oberon (spiromesifen) with excellent activity against spider mites in vegetables and field crops in USA. Oberon is a valuable tool for mite control and for resistance management. Kumar and Singh (2005) reported that Omite @ 2 ml/l alone proved significantly best in control of mites (T. urticae and T. neocacedonicus) on okra but addition of Dhanuvit @ 1 ml/l (a surfactant) enhanced the efficacy of mite culminating in the mortality of mites 94.88, 98.77, 90.99 and 71.20 per cent on okra after 1, 3, 7 and 10 days, respectively. Ethion and Phosalone were found only moderately effective and NSKE, gronim and sulphur have shown very poor control at Varanasi. Nauen and Konanz (2005) reported that spiromesifen was highly active against tetranychid mite, T. urticae by contact. The product was shown to have similar or even superior efficacy compared to many commercial standards. Similarly, Adilakshmi et al. (2008) evaluated the bioefficacy of various botanical insecticides against okra mite (Cv. Go-2) at Anand, during summer season of 2006. NSKE (5%) proved to be more effective against mites, T. telarius [T. urticae] infesting okra and was at par with recommended conventional insecticide (endosulfan). Varadaraju (2010) The higher fruit yield of 17.59 t/ha was recorded in abamectin 1.9 EC with highest cost benefit ratio of 1: 4.80. The next best treatments were diafenthiuron 50 WP (17.15 t/ha) and fenazaquin 10 EC (16.15 t ha-1). The standard check i.e., dicofol recorded 14. 83 tons fruit yield per ha.

Conclusions

- After 1st spray, all the acaricides were found to be effective in reducing the mite population in okra. However, Oberon proved to be highly effective to suppress mite infestation maximally.
- After second spray, effective control of mites was observed by spraying acaricides, but Oberon displayed high performance by minimizing the mite population upto the negligible level, closely followed by Nova Star.
- The Oberon ranked 1st being most effective acaricide to control mites in okra, followed by Nova Star; while Polo, Galit and Mortal showed sort of similarity in the effectiveness with slight variation.
- Oberon acaricide resulted in more positive impact on the crop yield, other monetary parameters and resulted in highest amount of additional income as compared to rest of the acaricides over control.

Suggestions

It is suggested that for achieving good control of mites in okra, the crop may be sprayed with any of the acaricides, would be beneficial if preference is given to Oberon (Bayer) or Nova Star (FMC).

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Table-1 Mites population per leaf on okra as affected by various acaricides after 2, 4, 6 and 15 days of first spray

Treatments	Pre-treat	2 days after spray	4 days after spray	6 days after spray	15 days after spray	Efficacy %
Polo	4.57	3.29 b	2.37 b	1.66 b	1.13 c	75.32
Nova Star	4.61	3.18 b	2.19 a	1.34 b	0.42 b	91.00
Galit	4.74	3.46 c	2.53 b	1.79 c	1.18 c	75.03
Oberon	4.33	2.81 a	1.83 a	0.99 a	0.24 a	94.52
Mortal	4.92	3.64 c	2.69 b	1.94 c	1.30 d	73.58
Control	4.85	4.61 d	4.78 c	5.17 d	5.21 e	-7.28
S.E.	0.1440	0.1141	0.1718	0.1616	0.0700	-
LSD 0.05	-	0.2542	0.3828	0.3600	0.1559	-
LSD 0.01	-	0.3616	0.5445	0.5121	0.2217	-
F-Value	2.47	57.56	73.97	176.86	1369.13	-
P-Value	0.0912	0.0001	0.0001	0.0001	0.0001	-
Significance	NS	**	**	**	**	-
CV%	3.78	3.99	7.70	9.21	5.43	-

In the vertical columns means followed by same alphabets are not different statistically (P=0.05) by DMRT

Table-2 Mites population per leaf on okra as affected by various acaricides after 2, 4, 6 and 15 days of second spray

Treatments	Pre-treat	2 days after spray	4 days after spray	6 days after spray	15 days after spray	Efficacy %
Polo	3.65	2.22 b	1.60 b	1.12 c	0.76 c	79.16
Nova Star	3.52	2.10 b	1.45 b	0.89 b	0.27 b	92.20
Galit	3.73	2.32 b	1.69 c	1.20 d	0.79 d	78.74
Oberon	3.14	1.81 a	1.09 a	0.45 a	0.06 a	98.01
Mortal	3.83	2.44 c	1.81 c	1.30 e	0.87 e	77.21
Control	3.87	3.71 d	3.62 d	3.71 f	3.93 f	-1.46
S.E.	0.3370	0.1425	0.1115	0.0379	0.0181	-
LSD 0.05	-	0.3176	0.2485	0.0844	0.0403	-
LSD 0.01	-	0.4517	0.3534	0.1200	0.0573	-
F-Value	1.28	42.95	127.00	1853.03	12279.4	-
P-Value	0.3438	0.0001	0.0001	0.0001	0.0001	-
Significance	NS	**	**	**	**	-
CV%	11.39	7.17	7.28	9.21	11.99	-

In the vertical columns means followed by same alphabets are not different statistically (P=0.05) by DMRT

Table-3 Comparative efficacy (%) of various acaricides against mites on okra after first and second spray

Treatments	1st spray	2nd spray	Average
Polo	75.32	79.16	77.24
Nova Star	91.00	92.20	91.6
Galit	75.03	78.74	76.89
Oberon	94.52	98.01	96.27
Mortal	73.58	77.21	75.4

Table-4 Average pod yield (kg ha^{-1}) of okra as affected by different acaricides against okra mites

Pesticides	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week	10th week	Total
Polo	456	802	983	1020	1102	1180	992	712	187	58	7492
Nova Star	467	721	1004	1052	1130	1210	1017	734	193	60	7588
Galit	439	674	850	972	1059	1133	955	678	179	55	6994
Oberon	499	775	1065	1143	1211	1398	1088	798	210	65	8252
Mortal	435	667	843	960	1049	1122	946	670	176	55	6923
Control	361	571	721	701	916	971	902	618	158	41	5960

Table-5 Income (Rs. ha^{-1}) of okra as affected by different acaricides against okra mites

Pesticides	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week	10th week	Total
Polo	8664	14436	18677	20400	22040	22420	21824	17088	5049	1624	152222
Nova Star	8873	12978	19076	21040	22600	22990	22374	17616	5211	1680	154438
Galit	8341	12132	16150	19440	21180	21527	21010	16272	4833	1540	142425
Oberon	9481	13950	20235	22860	24220	26562	23936	19152	5670	1820	167886
Mortal	8265	12006	16017	19200	20980	21318	20812	16080	4752	1540	140970
Control	6859	10278	13699	14020	18320	18449	19844	14832	4266	1148	121715

Table-6 Additional pod yield (kg ha^{-1}) and income (Rs. ha^{-1}) received from the plots sprayed with different acaricides over control

Acaricides sprayed	Additional pod yield (kg ha^{-1}) received over control	Additional income (Rs ha^{-1}) realized over control
Polo	1532	30507
Nova Star	1628	32723
Galit	1034	20710
Oberon	2292	46171
Mortal	963	19255

Figure 1. The Trend of Economic Development
Description for the above figure.