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EFFICACY OF INSECTICIDES AGAINST COTTON PINK BOLLWORM *PECTINOPHORA GOSSYPIELLA* (SAUNDERS)

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ABSTRACT

A field study assessed the efficacy of insecticides against pink bollworm of cotton. Spinosad 45SC treated cotton had the lowest infestation at 23.95% in the first spray, while cypermethrin 25EC had a 26.06% infestation in the second spray. Emamectin benzoate 5SG and spinosad 45SC were the most potent insecticides for locule damage reduction. Emamectin benzoate 5SG had 70.54% mortality in the first spray, while spinosad 45SC had 76.2% mortality in the second spray. Emamectin benzoate 5SG, spinosad 45SC, and cypermethrin 25EC were the most effective insecticides overall.

Key words: *Pectinophora gossypiella*, cotton, spinosad, emamectin, benzoate, cypermethrin efficacy, insecticides, management, field, boll infestation, locule damage, mortality, control.

In India, 160 species of insect pests have been reported to attack cotton crop right from the time of germination to final harvesting of cotton, of which sucking pest and bollworm complex consisting of three notorious bollworms: Pink bollworm (*Pectinophora gossypiella*), Spotted bollworm (*Earias vitella*) and American bollworm (Helicoverpa *armigera*) are considered to be of great menace (Kranthi et al., 2005). Cotton growers in India depend heavily on synthetic pesticides to combat sucking pests. However, due to the continuous and indiscriminate use of synthetic insecticides, there is resistance and hence efficacy has become less reliable (Kranthi et al., 2005). Pink bollworm (PBW) was first reported in 1843 by W.W. Saunders in India. Pink bollworm has more extended developmental period during winter and a shorter one during the summer seasons, with an average life cycle of 32 to 35 days (Naik et al., 2020). In recent years, pink bollworm has been a significant menace to the production of cotton in the past decades leading to large losses in cotton industry up to 34% raw cotton in Punjab (Ghure et al., 2008). With the number of infestations increasing yearly and proposal to ban commonly used insecticides, there is a need for cost-effective alternatives that are more tolerable for the environment and human safety standards. Therefore, this study was conducted to provide cost-effective alternatives of "to-be-banned insecticides" by comparing their performance with insecticides that are still available in the market for effective management of PBW in cotton in the upcoming years (Naik et al., 2021).

MATERIALS AND METHODS

The research was conducted in the field of the Central Institute of Cotton Research in Nagpur, at a specific location (Field C-5) with specific coordinates and elevation (21°02'21.7"N, 79°03'40.7"E, 321 masl). The experiment was conducted in 2021-2022 and used a randomized block design with 9 insecticidal treatments and three replications. Suraj variety (Non-Bt) was selected. The sowing date was August 2, 2021, and N:P:K (50:25:25) Half of N, full P2O5 and full K2O applied as basal dose and half of N applied 30days after sowing. Weeding was carried out 4 times, first at 15 days after sowing, then at 40, 60 and 90 days after sowing. A battery-operated sprayer, measuring tape, and insecticidal solutions mixed at the field recommended dose were used. A pre-treatment count was done one day before the treatment, and each treatment was sprayed at the recommended dose. The spraying was done twice, and after a waiting period of three days, observations were made to estimate the ovicidal properties of the treatments. Observations were made by selecting ten plants per replication for each treatment, and ten bolls were picked from each selected plant. The bolls were dissected, and recordings were made on various parameters, such as boll damage, number of larvae, boll infestation, number of locule, number of damaged locules, mines on the epicarp, exit holes, and number of larvae. These observations were done five times after each spray, starting from one day before spraying (pre-treatment count) and three, six, nine, and fifteen days after spraying.

Using preliminary observations, calculations were made to obtain values such as boll infestation %, locule damage %, and corrected % using Henderson and Tilton's equation (1955). Statistical analysis was conducted using the mean values of pink bollworms boll infestation %, locule damage %, and corrected mortality % for each observation day and the overall value of all observation days. Analysis of variance (ANOVA) was used to compare the mean values, and Duncan Multiple Range Test (DMRT) was used to compare the treatment means at P=0.05 using the SPSS program, version 25. The values were compared to estimate the overall ovicidal effectivity of each insecticide formulation in the field.

RESULTS AND DISCUSSION

The data analysis showed that the group of insecticides including spinosad 45SC, emamectin benzoate 5SG, cypermethrin 25EC, profenofos 50EC, thiodicarb 75EC, and fenvalerate 20EC had the lowest % boll infestation after the first spray, with an overall mean reduction value ranging from 23.95% to 25.98%. These treatments were found to be highly significant in comparison with the control group at 49.71%. The insecticides quinalphos 25EC and chlorpyriphos 20EC also showed significant reduction in % boll infestation at 27.39% and 33.57%, respectively. Neem oil 0.3% had the least effectiveness among the treatments with an overall % boll infestation of 37.30%.The results of the second spray also showed that the group of insecticides including cypermethrin 25EC, emamectin benzoate 5SG, spinosad 45SC, profenofos 50EC, fenvalerate 20 EC, thiodicarb 75 WP, and quinalphos 25EC had the lowest % boll infestation, with an overall mean reduction value ranging from 26.06% to 29.40%. Chlorpyriphos and neem oil were found to be less effective with an overall % boll infestation of 37.97% and 37.49%, respectively. All the treatments were found to be significant in comparison with the control group at 53.48%. The studies by Ghure et al. (2008) and Gopala et al. (2000) also reported spinosad 45SC and profenofos 20 EC to be effective against pink bollworm infestation. However, the lower overall numbers reported in the previous studies may be attributed to the studies being conducted in a different location and at a different time when the infestation was not as severe. The findings in the present study are consistent with those of Ghanim et al. (2017), who reported that spinosad was effective in reducing bollworm infestation in cotton. Their study found that spinosad 45SC had a per cent boll infestation of 30.20%, which is higher than the result observed in the present study after the first spray. However, their study was conducted under different environmental conditions and may have used a different concentration or formulation of spinosad. In another study by Sarfraz et al. (2019) they found that thiodicarb and cypermethrin were effective in controlling bollworm infestation in cotton. Their study found that thiodicarb had a per cent boll infestation of 19.78%, which is lower than the result observed in the present study after the first spray. However, their study only evaluated the efficacy of thiodicarb and cypermethrin on American bollworm not pink bollworm.

The values for the data on locule damage after the first are emamectin benzoate 5SG, spinosad 45SC, cypermethrin 25EC, profenofos 50EC, fenvalerate 20 EC, thiodicarb 75 WP, and quinalphos 25EC were the most effective insecticides in controlling bollworm infestation, with an overall mean value of 18.97%, 19.36%, 19.96%, 20.72%, 21.39%, and 22.07%, respectively, after the first spray. These insecticides were significantly more effective than chlorpyriphos 20EC and neem oil 0.3%, which had a locule damage of 27.93% and 29.66%, respectively. All treatments were significantly more effective than the control, which had a boll infestation of 40.88%.The results of the present study were supported by previous research conducted by Gopala et al. (2000), which found that spinosad 45SC and profenofos 20EC were more effective than neem oil 0.3% in controlling bollworm infestation. However, the results of the present study were slightly different from those of Mahalakshmi et al. (2021), which found that spinosad 45SC and emamectin benzoate 5SG were less effective than quinalphos 20EC, thiodicarb 75WP, profenofos 20EC, and cypermethrin 25EC in controlling locule damage. The results of the second spray showed that spinosad 45SC, cypermethrin 25EC, emamectin benzoate 5SG, profenofos 50EC, thiodicarb 75WP, fenvalerate 20EC, and quinalphos 25EC were the most

Table 1. Effect of insecticides against boll infestation, locule damage and mortality caused by *P. gossypiella*

Treatments	Boll infestation		Locule damage		Mortality	
Concentrations (gm. or ml/ l)	1st spray (mean ± SE)*	2st spray (mean ± SE)	1st spray (mean ± SE)	2st spray (mean ± SE)	1st spray (mean ± SE)	2st spray (mean ± SE)
Profenophos 50EC	25.06± 1.67^{a}	27.91± 2.07^{a}	20.72± 1.68^{a}	21.17± 0.98^{ab}	66.43± 3.00^{a}	69.21± 4.02^{ab}
(2.0)	(30.01± 1.10)**	(31.12± 0.79)	(27.04± 1.18	(27.38± 0.69)	(54.63± 1.84)	(56.39± 2.53)
Chlorpyriphos 20EC	33.57± 2.60^{bc}	37.97± 0.87^{ab}	27.93± 2.70^{b}	30.61± 0.80^{c}	57.47± 6.86^{ab}	60.28± 7.33^{b}
(2.5)	(35.37± 1.58)	(38.39± 0.49)	(31.85± 1.72)	(33.59± 0.50)	(49.36± .97)	(51.03± 4.28)
Thiodicarb	25.73± 0.88^{a}	28.60± 0.90^{a}	21.39± 0.72^{a}	21.98± 1.26^{ab}	61.67± 8.40^{ab}	64.11± 3.48^{b}
75 WP (2.0)	(30.47± 0.57)	(31.83± 0.98)	(27.54± 0.51)	(27.94± 0.87)	(51.97± 5.03)	(53.24± 2.09)
Spinosad 45SC	23.95± 1.68^{a}	26.84± 0.55^{a}	19.36± 1.15^{a}	19.63± 1.80^{c}	67.66± 3.24^{a}	76.25± 1.32^{a}
(0.3)	(29.27± 1.12)	(29.88± 1.49)	(26.08± 0.83)	(26.25± 1.32)	(55.40± .00)	(60.85± 0.90)
Neem oil 0.3%	37.30± 1.70^{c}	37.49± 0.90^{b}	29.66± 1.18^{b}	30.45± 1.10^{ab}	47.47± 12.83^{b}	44.32± 8.65^{c}
(5.0)	(37.63± 1.01)	(38.24± 0.80)	(32.99± 0.74)	(33.49± 0.69)	(43.24± 7.70)	(41.58± 5.13)
Emamectin benzoate	24.07± 2.16^{a}	26.07± 1.93^{a}	18.97± 2.17^{a}	20.80± 1.03^{ab}	68.17± 6.29^{a}	71.30± 5.27^{ab}
5SG (0.4)	(29.35± 1.43)	(30.82± 0.83)	(25.75± 1.58)	(27.12± 0.73)	(55.85± 3.87)	(57.83± 3.48)
Cypermethrin 25EC	24.43± 0.84^{a}	26.06± 1.36^{a}	19.96± 0.63^{a}	20.65± 0.92^{ab}	66.92± 6.18^{a}	69.97± 7.24^{ab}
(1.0)	(29.61± 0.56)	(30.92± 0.73)	(26.53± 0.45)	(27.02± 0.65)	(55.11± 3.90)	(57.14± 4.69)
Quinalphos 25EC	27.39± 0.59^{ab}	29.40± 1.36^{a}	22.07± 0.89^{a}	23.34± 1.07^{ab}	57.92± 7.72^{ab}	59.29± 8.73^{b}
(2.0)	(31.55± 0.37)	(33.05± 0.84)	(28.01± 0.62)	(28.88± 0.72)	(49.66± 4.52)	(50.58± 5.24)
Fenvalerate 20 EC	25.98± 1.00^{a}	28.43± 1.68^{a}	21.30± 0.87^{a}	22.21± 1.06^{ab}	61.57± 3.56^{ab}	62.27± 4.94^{b}
(1.0)	(31.63± 0.65)	(31.91± 0.83)	(27.48± 0.62)	(28.10± 0.73)	(51.73± 2.12)	(52.18± 2.93)
Control	49.71± 1.40^{d}	53.48± 2.29^{c}	40.88± 1.14^{c}	43.53± 1.38^{d}	0.00± 0.00^{c}	0.00± 0.00^{d}
(water spray)	(44.83± 0.80)	(48.06± 0.66)	(39.14± 0.67)	(41.28± 0.80)	(0.00± 0.00)	(0.00± 0.00)
F stat	Sig	Sig	Sig	Sig	Sig	Sig
SEm±	1.00	0.86	0.53	0.76	2.73	3.00
CD (p= 0.05)	2.95	2.56	1.5	2.26	8.12	8.89

*Values represent means of 3rd day, 6th day, 9th day and 15th day observations; **Figures in parenthesis arc sin transformed values.

effective insecticides in controlling locule damage, with an overall mean value of 19.63%, 20.65%, 20.80%, 21.17%, 21.98%, 22.21%, and 23.34%, respectively. Chlorpyriphos 20EC and neem oil 0.3% were significantly less effective, with a boll infestation % of 30.45% and 30.61%, respectively. All treatments were significantly more effective than the control, which had a boll infestation of 43.53%.The results of the present study were supported by previous research conducted by Gopala et al. (2000), which found that spinosad 45SC and profenofos 20 EC were more effective than neem oil 0.3% in controlling bollworm infestation.

The mortality rates of pink bollworm after the first spray were highest for emamectin benzoate 5SG, spinosad 45SC, cypermethrin 25EC, profenofos 50EC, thiodicarb 75WP, and fenvalerate 20 EC, at 68.17%, 67.66%, 66.92%, 66.43%, 61.67%, and 61.57%, respectively. The next batch of insecticides that showed good mortality rates were quinalphos 25EC and chlorpyriphos 20EC, at 57.92% and 57.47%, respectively, followed by neem oil 0.3% at 47.76%. In comparison, the mortality rates after the second spray were even higher for some insecticides, with spinosad 45SC showing the highest mortality rate at 76.25%, followed closely by emamectin benzoate 5SG, cypermethrin 25EC, and profenofos 50EC, at 71.30%, 69.97%, and 69.21%, respectively.

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AUTHOR CONTRIBUTION STATEMENT

Malsawmtluanga Hnialum, V Chinna Babu Naik and N V Lavhe conceived and designed research, Malsawmtluanga Hnialum conducted experiments, V Chinna Babu Naik and N V Lavhe analysed the data. Malsawmtluanga Hnialum wrote the manuscript and Banka Kanda Kishore Reddy reviewed and corrected it.

CONFLICT OF INTEREST

No conflict of interest.

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