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COMPARATIVE EFFECTIVENESS OF SEED TREATING AND FOLIAR INSECTICIDES AGAINST SUCKING PESTS OF COTTON AND IMPACT ON THEIR NATURAL ENEMIES

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Abstract

The Imidacloprid insecticide, Gaucho 70 WS at 1.5, 2.5, 3.5, 4.5 and 5.5 g/kg seed was used as seed treatment and monocrotophos 40 WSC at 1120 ml/ha was applied as foliar spray on CB9 cotton cultivar to suppress aphid, whitefly and thrips, and impact on their natural enemies during 2008-2011 at the Regional Cotton Research Station, Dinajpur, Bangladesh. The activity of natural enemies, such as ladybird beetle, lacewing, syrphid, and spider population on the sucking pests attacking cotton cultivar CB9 and yield of cotton were recorded. Imidacloprid significantly reduced aphid, whitefly, and thrips population on cotton crops compared to untreated control or foliar spray of monocrotophos 40 WSC at 1120 ml/ha. Ladybird beetles, lacewings, syrphids, and spiders were abundant in the field but their population decreased in the treated plots compared to untreated control. The CB9 cotton cultivar produced significantly higher yield (1.73 t/ha) with a benefit cost ratio 12.47 when seeds were treated with Imidacloprid at 5.5 g/kg fuzzy seed. This study indicated that Imidacloprid (Gaucho 70 WS) used as a seed treatment may be suggested to the cotton growers for controlling sucking pests.

Keywords: Effectiveness, cotton, imidacloprid, seed treatment, sucking pest, natural enemies, monocrotophos.

Introduction

Economy of Bangladesh is based on agriculture and cotton is the most highly valued cash crop, which is a major input for textile, agriculture and food industries. The CB9 is an extensively cultivated cotton variety in Bangladesh, which was been released by the Cotton Development Board (CDB) in the year 2005. This is a tall and hairy variety with bushy stem. Branches of this cultivar are well developed with light green leaves and light bronze stems, and the cultivar possesses leaf trichomes of 193/cm^2 (Amin *et al*., 2011). This cultivar also bore nectar gland, spherical bolls having weight 5.5 - 6.0 g/boll. Seed cotton yield of this cultivar is 1.65 t/ha (Amin *et al*., 2008; Amin *et al*., 2011). Yield and quality of this cultivar is reduced by the attack of various sucking insects, namely aphid (*Aphis gossypii* Clover), whitefly (*Bemisia tabaci* Gennadius) and thrips (*Thrips tabaci* Lindeman) (Amin *et al*., 2008). Natural enemies of the pests in the

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cotton field of Bangladesh are dominated by ladybird beetles, lacewings, syrphids, and spiders (Azad *et al.,* 2010). These predator species population are reducing day by day because of indiscriminate application of foliar insecticides with over doses (Moser and Obrycki, 2009).

Imidacloprid is a neonicotinoid compound belonging to the chloronicotinyl insecticide which has gut and contact activities against insects (Maienfisch *et al.,* 2001). After seed treatment, imidacloprid shows systemic and residual toxicity in several crop plants and interferes with the transmission of stimuli or impulses in the nervous system of insect herbivores, and gives excellent control against a broad range of commercially important sucking insect pests (Zhang *et al*., 2011).

Seed treatment with systemic insecticide is an integral part of pest management tactics, which is comparatively less pollutant to the environment, cost effective, selective and reported to maintain natural equilibrium (Taylor *et al*., 2001; Nault *et al*., 2004). The Imidacloprid (Gaucho 70 WS) is a low cost, selective and less polluting compound which is found promising against sucking pests of cotton (Patil *et al.,* 1999; Dandale *et al.*, 2001; Vadodaria *et al*., 2001; Dhawan and Simwat, 2002; Patil *et al.,* 2004). This compound is safe to natural enemies and keeps cotton seedlings free from sucking pests at least 45 days of their age (Udikeri *et al.,* 2007).

Seed treatment is one of the highly progressive and demandable technologies in integrated pest management (IPM) for controlling various crop pests (Taylor *et al.,* 2001; Magalhaes *et al.*, 2009). Now-a-days, the cotton growers of Bangladesh are showing interest in seed dressing for protecting their crops from pest attack (Amin *et al.*, 2009). The published paper on the effectiveness of Imidacloprid and other foliar insecticides for suppressing sucking pest population, impact on predator abundance and yield of cotton under Bangladesh conditions are scantly. However, Imidacloprid treated seeds can be an alternative for management of sucking pests of cotton. Therefore, the present study was undertaken to know the comparative effect of Imidacloprid (Gaucho 70 WS) as seed treating agent and monocrotophos 40 WSC as foliar insecticide on the abundance of sucking pests, predator population, and yield of cotton under natural field conditions.

Materials and Method

Seed deliting

CB9 cotton seeds were delinted by a delinting machine (Bajaj Steel Industries Ltd., Nagpur, Maharashtra, India). Seeds were put into the stainless steel container of the machine and the agitator of the machine was then rotated and commercial sulphuric acid was poured slowly into the container at 100 ml/kg

seed having the cotton seeds through its periphery. Due to the churning action, the fuzz was uniformly subjected to the acid reaction. After 90 second, the acid treated seeds were washed with tap water. The process of washing with tap water was repeated thrice and then the seeds were collected and dried.

Seed treatment

Fuzzy and delinted seeds were separately soaked in tap water for half an hour and then put on sieves for drying. Thereafter, Gaucho 70 WS powder and seeds were poured into different bowls following 1.5, 2.5, 3.5, 4.5 or 5.5 g/kg seed and stirred for 10-15 minutes for complete adherence of the chemical to the individual seed coat. Then the seeds were put on the white papers and dried in the sun for 30-40 minutes. Then the seeds were stored in brown paper bags until sowing.

Cultivation of cotton

The cotton crops were cultivated during three consecutive seasons of 2008, 2009, and 2010 at the Regional Cotton Research Station (RCRS), Dinajpur (25°13'N, 88°23'E) in Bangladesh. The experiments were conducted with fuzzy and delinted seeds of CB9 cotton cultivar and treatments consisted of untreated controls and seeds treated with Imidacloprid insecticide (Gaucho 70 WS) at 1.5, 2.5, 3.5, 4.5 or 5.5 g/kg seed. An additional treatment was made with repeated (four times) foliar spray of monocrotophos 40 WSC at 1120 ml/ha, which is widely used by the cotton growers of Bangladesh. The experiment was designed following randomized complete block (RCB) with three replications. The plot size was 5.4 m × 5.0 m and the spacing between block to block and plot to plot was 1.5 m and 1.0 m, respectively. Seeds of cotton (CB9) were sown in rows with 45 cm apart and row to row distance was 90 cm. Fertilization and other intercultural operations were done according to the recommendations of the CDB of Bangladesh (CDB, 2006).

Observation of sucking pests and predator population

For observation of sucking pest population, field inspection was started after emergence of seedlings and continued up to 70 days of the seedlings. Five plants were randomly selected from each plot and number of aphids, whiteflies and thrips on the top, middle, and bottom leaf, respectively, were counted in the afternoon at 14 days intervals. Similarly, population of ladybird beetles *Coccinella septempunctata* L. and *Menochilus sexmaculatus* Fabricius, lace wing *Chrysoperla carnea* Stephens, syrphid *Syrphus opinator* Sacken and spiders *Chiracanthium inclusum* Hentz and *Lycosa pseudoannulata* Bosenberg and Strand were recorded.

Measurement of cotton yield and calculation of benefit cost ratio

Open bolls (seed cotton) in each plot were handpicked and obtained seed cotton yield of each treatment was converted into t/ha. The benefit cost ratio was calculated by dividing the net return by total variable cost.

Data analysis

The mean population of sucking pests, predators, and yield of seed cotton were calculated from the pooled data of the years 2008, 2009, and 2010 and the results were analyzed using analysis of variance (ANOVA). The mean comparisons were made by Duncan's multiple range test (DMRT).

Results

Effectiveness of different doses of Imidacloprid for seed treatments and Monocrotophos as foliar spray against sucking pests of CB9 cotton cultivar under field condition is presented in Table 1. The Imidacloprid seed treatments showed significantly lower abundance of aphid on CB9 cotton than those on the Monocrotophos and untreated control ($F_{11, 96} = 19.7$, $p < 0.001$). The effectiveness of the seed treatments showed that aphid abundance on CB9 cotton decreased from 3.3 ± 1.4 to 0.5 ± 0.3 per leaf. This data indicated that aphid population reduction in the treated plots over untreated control ranged from 48.5 to 84.8%, and seed treatment was found most effective against aphid when Gaucho 70 WS was applied at 5.5 g/kg fuzzy seed of cotton.

Table 1 shows that the whitefly population on CB9 cotton cultivar varied from 1.1 ± 1.1 to 7.3 ± 2.7 per leaf in treated and untreated plots and the results revealed that whitefly abundances on the treated plots were significantly lower (1.1 ± 1.1 to 3.6 ± 1.9 per leaf) than those on the untreated control ($F_{11, 96} = 9.7$, $p < 0.001$). Whitefly population reduction in the treatments over untreated control ranged from 50.7 to 84.9%, and showed significantly lowest abundance of whitefly when seed treatment was done with Gaucho 70 WS at 5.5 g/kg fuzzy seed.

The population of thrips on CB9 cotton cultivar was significantly lower in the treated plots than those on the untreated control plots ($F_{11, 96} = 42.5$, $p < 0.001$) and the observed results varied from 2.0 ± 0.3 to 9.5 ± 2.3 per leaf. All the treatments reduced thrips population over untreated control and pest reduction varied from 43.2 to 78.9%. The lowest abundance of thrips was found in the plots treated with Gaucho 70 WS at 5.5 g/kg fuzzy seed.

Table 1. Incidence of sucking pests attacking CB9 cotton cultivar following seed treatment with imidacloprid (Gaucho 70 WS) and foliar spray with monocrotophos (40 WSC) during 2008-2010 at RCRS Dinajpur (pooled data of 3 years).

Treatments	Number of pest (mean ±SD)/plant			Reduction of pest population over control (%)		
	Aphid	Whitefly	Thrips	Aphid	Whitefly	Thrips
Gaucho 1.5 g/kg fuzzy seed	1.5 ± 0.2 bc	2.5±1.7 be	4.5±0.7 bc	54.5	65.8	52.6
Gaucho 2.5 g/kg fuzzy seed	1.2 ± 0.3 bd	2.1±1.7 be	3.7±0.3 cd	63.6	71.2	61.1
Gaucho 3.5 g/kg fuzzy seed	0.9 ± 0.3 df	1.8±1.4 ce	3.0±0.2 de	72.7	75.3	69.9
Gaucho 4.5 g/kg fuzzy seed	0.7 ± 0.3 ef	1.5±1.5 de	2.5±0.2 ef	78.8	79.5	73.7
Gaucho 5.5 g/kg fuzzy seed	0.5 ± 0.3 f	1.1±1.1 e	2.0±0.3 f	84.8	84.9	78.9
Gaucho 1.5 g/kg delinted seed	1.7 ± 0.2 b	3.4±1.4 bc	5.4±0.9 b	48.5	53.4	43.2
Gaucho 2.5 g/kg delinted seed	1.4 ± 0.2 bc	2.9±1.3 bd	4.5±0.5 bc	57.6	60.3	52.6
Gaucho 3.5 g/kg delinted seed	1.2 ± 0.3 bd	2.5±1.1be	3.7±0.5 cd	63.6	54.5	61.1
Gaucho 4.5 g/kg delinted seed	1.1 ± 0.2 ce	2.2±1.0 be	2.9±0.7 df	67.7	69.9	69.5
Gaucho 5.5 g/kg delinted seed	0.9 ± 0.3 df	1.8±1.0 ce	2.4±0.3 ef	72.7	75.3	74.7
Monocrotophos 1120 ml/ha	1.3 ± 0.2 bd	3.6±1.9 b	4.2±0.9 c	60.6	50.7	55.8
Control (fuzzy seed)	3.3 ± 1.4 a	7.3±2.7 a	9.5±2.3 a	….	…..	….

Means within a column followed by same letter(s) are not significantly different (DMRT, $p \leq 0.05$)

The ladybird beetle, lacewing, syrphid, and spider populations associated with sucking insect pests attacking CB9 cotton cultivar are presented in Table 2. Plots having seed treatment with Imidacloprid and Monocrotophos spray significantly reduced ladybird beetle abundance compared to control ($F_{11, 96}$ = 46.0, $p < 0.001$). The ladybird beetle (*C. septempunctata and M. sexmaculatus*) abundance was found lowest (2.5 ± 0.4 per leaf) in the plots where seed treatment was done by Gaucho 70 WS at 5.5 g/kg fuzzy seed. The lacewing abundance in the treated plots was varied from 2.0 ± 0.5 to 5.2 ± 0.6 per leaf and it differed significantly ($F_{11, 96}$ = 44.4, $p < 0.001$) among the treatments. The treatment with Gaucho 70 WS at 5.5 g/kg fuzzy seed revealed the lowest abundance of lacewing (2.0 ± 0.5 per leaf). The abundance of Syrphid in the treated plots ranged from 1.7 ± 0.4 to 3.7 ± 0.4 per leaf and there were significant differences among the treatments ($F_{11, 96}$ = 62.6, $p < 0.001$). Imidacloprid seed treatments significantly ($F_{11, 96}$ = 62.7, $p < 0.001$) suppressed spider abundance (1.9 ± 0.3 to 5.1 ± 1.0 per leaf) compared to that of control (Table 2).

Table 2. Abundance of major predators of sucking insect pests attacking CB9 cotton cultivars following seed treatment with Imidacloprid (Gaucho 70WS) and foliar spray with Monocrotophos (40 WSC) during 2008-2010 at RCRS Dinajpur (pooled data of 3 years).

Treatments	Number of predators (mean ±SD)/leaf			
	Lady bird beetles	Lacewing	Syrphid	Spider
Gaucho 1.5 g/kg fuzzy seed	3.8±0.3 cd	3.1±0.1 d	3.0±0.2 de	2.9±0.2 cd
Gaucho 2.5 g/kg fuzzy seed	3.4±0.4 de	2.9±0.3 d	2.5±0.3 f	2.7±0.3 de
Gaucho 3.5 g/kg fuzzy seed	3.1±0.4 e	2.6±0.3 e	2.5±0.3 f	2.4±0.3 ef
Gaucho 4.5 g/kg fuzzy seed	2.6±0.4 f	2.3±0.3 ef	2.1±0.3 g	2.2±0.4 fg
Gaucho 5.5 g/kg fuzzy seed	2.5±0.4 f	2.0±0.5 f	1.7±0.4 h	1.9±0.3 g
Gaucho 1.5 g/kg delinted seed	4.7±0.3 b	4.1±0.3 b	3.7±0.4 b	3.5±0.6 b
Gaucho 2.5 g/kg delinted seed	4.2±0.4 c	3.7±0.5 c	3.3±0.4 c	3.3±0.2 bc
Gaucho 3.5 g/kg delinted seed	3.9±0.5 c	3.2±0.2 d	3.2±0.3 d	3.1±0.3 bd
Gaucho 4.5 g/kg delinted seed	3.5±0.4 de	3.0±0.4 d	3.0±0.2 de	2.9±0.3 cd
Gaucho 5.5 g/kg delinted seed	3.1±0.4 e	3.0±0.4 d	2.9±0.2 ef	2.6±0.4 de
Monocrotophos 1120 ml/ha	3.3±0.5 e	2.9±0.5 d	2.7±0.2 ef	2.7±0.3 de
Control (fuzzy seed)	6.1±0.8 a	5.2±0.6 a	5.0±0.5 a	5.1±1.0 a

Means within a column followed by same letter(s) are not significantly different (DMRT, $p \leq 0.05$)

The seed yield of CB9 cotton in different treated plots were significantly different ($F_{11, 96} = 253.8$, $p < 0.001$), and the yield ranged from 0.92 ± 0.05 to 1.73 ± 0.93 t/ha (Table 3). All the treatments increased yield over untreated control and increasing yield in the treatments ranged from 58.7 to 78.0%. The treatment Gaucho 70 WS at 5.5 g/kg fuzzy seed produced the highest seed yield (1.73 ± 0.93 t/ha) of cotton. The treatment Monocrotophos showed benefit cost ratio 6.25, whereas the seed treating chemical showed 8.51 to 12.47 and 7.58 to11.32 in the fuzzy and delinted seeds, respectively. All the fuzzy seed treatments showed higher benefit cost ratio than that on delinted seeds.

Table 3. Yield (seed cotton) of CB9 cotton cultivar following seed treatment with Imidacloprid (Gaucho 70WS) and foliar spray with monocrotophos (40 WSC) during 2008-2010 at RCRS Dinajpur (pooled data of 3 years).

Treatments	Yield (t/ha)	Yield increased over control (%)	Benefit cost ratio
Gaucho 1.5 g/kg fuzzy seed	0.98±0.04 hi	61.2	8.51
Gaucho 2.5 g/kg fuzzy seed	1.12±0.05 f	66.0	8.88
Gaucho 3.5 g/kg fuzzy seed	1.13±0.06 e	66.4	9.19
Gaucho 4.5 g/kg fuzzy seed	1.46±0.07 c	73.9	10.44
Gaucho 5.5 g/kg fuzzy seed	1.73±0.93 a	78.0	12.47
Gaucho 1.5 g/kg delinted seed	0.92±0.05 i	58.7	7.58
Gaucho 2.5 g/kg delinted seed	1.05±0.07 g	63.8	8.22
Gaucho 3.5 g/kg delinted seed	1.18±0.05 f	67.8	8.54
Gaucho 4.5 g/kg delinted seed	1.37±0.08 d	72.3	9.72
Gaucho 5.5 g/kg delinted seed	1.60±0.12 b	76.3	11.32
Monocrotophos 1120 ml/ha	1.03±0.04 gh	63.1	6.25
Control (fuzzy seed)	0.38±0.03 j	-	-

Means followed by same letter(s) are not significantly different (DMRT, $p \leq 0.05$)

Discussion

From the study, the results revealed that Imidacloprid (Gaucho 70 WS) effectively reduced population of aphid, whitefly, and thrips in the cotton field. Both fuzzy and delinted seeds exhibited higher efficiency as well as showed cost effective measures against the sucking pests in the field conditions. This result was almost similar to the findings of Zhang *et al*. (2011), who reported that Imidaclorpid seed treatments were effective in suppressing the whitefly population in cotton fields. The findings also agreed with the results of Mote *et al*. (1995) and Patil *et al*. (2003) who observed that Imidacloprid as seed treating chemical reduced sucking pest population below the economic threshold level up to 40 days after sowing and 61 days after germination (Dandale *et al.*, 2001; Murugan *et al*., 2003).

This study showed that Imidacloprid seed treatments had proved better performances compared to control as well as traditional pest control method using foliar application of Monocrotophos at 1120 ml/ha. This study also showed that sucking pest population attacking CB9 cotton cultivar differed depending on different doses of Imidacloprid. The cotton plant encountered lower pest incidence when the fuzzy and delinted seeds were treated with Gaucho 70 WS at 5.5 g/kg seed.

Imidachloprid is a broad-spectrum insecticide that kills the most insect species (Lind *et al.,* 1998a; 1998b). This study showed that Imidacloprid seed treatments were safer for cotton cultivation but reduced predator population in the field. It is revealed that ladybird beetle, lacewing, syrphid, and spider population were abundant on cotton plants, but their population decreased with increasing doses of Imidacloprid. This finding showed harmony with Rogers *et al.* (2007), who observed the reduction of pink ladybird beetle, *Coleomegilla maculate* DeGeer and green lacewing, *C. carnea* population in the treatment groups compared to the untreated control. They also reported that translocation of Imidacloprid from seeds to flowers occurred when the chemical was applied to the seeds at higher concentration.

This study indicated that Imidacloprid kept the cotton plants free from severe infestation of sucking insects and produced the higher cotton yield compared to the untreated control. This finding shows similarity with that of Udikeri *et al*. (2007), who obtained higher seed yield of cotton (11.2 q/ha) by protecting the crop from early sucking pest infestation by treating the seeds with Chlothianidin 600 FS (Poncho) at 9.0 ml/kg seed. Dobbs *et al.* (2006) reported that seed treatments with Gaucho 4FS at 0.25 lb ai/100 lb seed produced significantly higher lint yield of cotton (1.32 t/ha) than the untreated control (0.48 t/ha).

Conclusion

From the present study, it can be suggested that Imidacloprid (Gaucho 70 WS at 5.5 g/kg seed) can be used as seed treating chemical for protection of cotton safely. This information might be helpful to the cotton growers in Bangladesh.

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