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Effect of Chemicals in Controlling Bacterial Blight of Cotton

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Abstract: A field experiment with 10 treatments was conducted to evaluate the comparative efficacy of five chemicals viz., Streptomycin sulphate, Thiovit 80 WP, Sulfuric acid, Dithane M-45 and Cupravit either alone or in combination in controlling bacterial blight and on yield of cotton. Germination was highest in T_{10} i.e. Seed treatment with Streptomycin sulphate (0.15%) and foliar spray with Cupravit (0.2%) + Streptomycin sulphate (150 ppm) having 86.31 %. The lowest disease index (21.24%) was found in T_{10} subsequently after three foliar sprays at 104 DAS. This treatment reduced the disease intensity and increased the yield of seed cotton with 26.02%. The treatment T_9 (Foliar spray with Cupravit + Streptomycin sulphate) also resulted better performance in reducing disease intensity and increased yield of seed cotton by 22.81%.

Key words: Chemicals, control, bacterial blight, disease severity, disease index, yield, cotton

Introduction

Cotton (*Gossypium* spp.) is one of the most important fibre crop as well as cash crop in many countries of the world. It is the main raw material for the textile industry that enters into the daily life of the world's population more than any other fibre sources. Their utility in manufacture of cloths and yarns waste cottons are often used for the production of rugs, carpets etc. The fibres have also surgical utility. Besides, cotton seeds are important source of edible oil and oil products while the oilcake is an important cattle feed (Anonymous, 1981). Cotton can successfully grown in our country, especially in the greater districts of Jessore, Kushtia, Dhaka, Mymensingh, Bogra, Rangpur and Rajshahi of Bangladesh. At present, an area of 0.40 lakh hectares is being sown with American cotton (*Gossypium hirsutum*) and 0.14 lakh hectares to Comilla cotton (Khaderbad, 2001). Around 75,000-90,000 bales of lint are produced in Bangladesh as against the demand of 6.0-7.0 lakh bales of lint by the textile industry, of which larger part of the lint is imported. The produced lint in our country can meet up about 12-15% of our total national requirement (Anonymous, 2000-2001). The average yield of cotton in Bangladesh is much lower than other cotton producing countries.

There are many constraints responsible for low yield of cotton in Bangladesh. Among them, disease is considered to be the most important one. Of the major diseases, bacterial blight incited by *Xanthomonas campestris* pv. *malvacearum* is an important and potentially destructive disease of cotton affecting yield and fibre quality seriously (Hasan and Tahir, 1993). It is also known as angular leaf spot, vein blight, black arm and boll rot depending on the plant part infected (Hillocks, 1981). Symptoms of this disease were reported by several authors (Hillocks, 1981; Ashrafuzzaman, 1991; Koenning, 2000 and Wrather, 2001). The control of bacterial blight is a challenging problem due to its systemic infection. Breeding resistant varieties has also been proved not to be satisfactory. The adjustment of date of sowing of cotton, regular spraying with antibiotics and fungicides, flooding, sanitation etc. may reduce the incidence of the disease (Singh and Verma, 1973). Bacterial blight of cotton is a prevalent problem to our farmers. No research work has been critically done in Bangladesh on progressive symptoms development, control measures. This type of experiment is needed in Bangladesh. So, the present study was undertaken to evaluate the comparative efficacy of some chemicals in controlling bacterial blight and on yield of seed cotton.

Materials and Methods

The experiment was conducted in the Central Cotton Research Centre, Sreepur, Gazipur, Bangladesh during 2001–2002. The land was prepared by two disc ploughings followed by harrowing to make a good tilth. The experiment was laid out adopting the Randomized Complete Block Design (RCBD) with three replications for each treatment. The treatments were as follows :

T_1 = Control,
T_2 = Seed treatment with Streptomycin sulphate (0.15%),
T_3 = Seed treatment with Thiovit 80 WP (0.2%),
T_4 = Acid delinting with H_2SO_4 (100 ml kg^{-1}),
T_5 = Foliar spray with Dithane M-45 (0.25%),
T_6 = Foliar spray with Cupravit (0.2%),
T_7 = Foliar spray with Streptomycin sulphate (150 ppm),
T_8 = Foliar spray with Dithane M-45 (0.25%) + Streptomycin sulphate (150 ppm),
T_9 = Foliar spray with Cupravit (0.2%) + Streptomycin sulphate (150 ppm) and
T_{10} = Seed treatment with Streptomycin sulphate (0.15%) and foliar spray with Cupravit (0.2%) + Streptomycin sulphate (150 ppm).

Fertilizers were applied @ 250, 175, 150, 100, 20, 20 and 20 kg of Urea, TSP, MP, Gypsum, Zinc sulphate, Magnesium sulphate and Borax per hectare, respectively as per recommended by Cotton Development Board (2000-2001). An American susceptible variety of upland cotton DL-50 (*Gossypium hirsutum*) known as CB-3 was used in the experiment. 4-6 seeds per hill were placed to a depth of 2.5 cm maintaining line to line distance 90 cm and plant to plant distance 45 cm. After placement of the seeds, the furrows were fully covered with the soil of another side of the furrows. Two times irrigation were given after final weeding with an interval of one month. Both systemic (Azodrin) and contact (Ripcord) insecticides were applied as and when required to control sucking insects (e.g. Jassid, Aphid, White fly, Thrips) and chewing insects (e.g. Bollworm, leaf roller, spodoptera, semi looper), respectively. The pathogens (*Xanthomonas campestris* pv. *malvacearum)* was isolated and purified. The involvement of *Xanthomonas campestris* pv. *malvacearum* was confirmed through pathogenicity test. It was done by inoculation of bacterial suspension (10^6 bacterial cells ml^{-1}) on the leaves of mature plants. The produced symptoms were more or less similar to the naturally developed symptoms. The data were recorded on germination (%), percent of diseased leaf area and diseased index at 59 DAS, 74 DAS, 89 DAS and 104 DAS, healthy bolls/plant, rotted bolls/plant, seed cotton yield (kg ha^{-1}), stalk yield (kg ha^{-1}) and seed cotton yield increase over the control (%). Counted percentages of diseased leaf area were graded to calculate PDI following the slight modification of 1-7 scale of Santhanam (1967). From total grade of 50 leaves in each plot, PDI and percent disease control were calculated following the formulae of Rajpurohit and Lodha (1981) as follows:

$$PDI = \frac{\text{Sum total of grades x 100}}{\text{No. of leaves examined x maximum grade}}$$

Seed cotton (CB_3) from each net plot was picked thrice at 20-25 days intervals starting from first harvest at 128 days after sowing. The recorded data on different parameters were statistically analyzed following MSTAT programme. The effect of the chemicals were compared by Duncan's Multiple Ranges Test (DMRT). The mean values were presented and interpreted for discussion.

Results and Discussion

The effect of some seed treating chemicals on percent germination were recorded under the natural condition and presented in Table 1. There was a significant variation among the treated and the untreated treatments. The highest germination (86.90%) was found in T_2 (seed treatment with Streptomycin sulphate), which was statistically similar to that of T_3, T_4 and T_{10}. The lowest germination (77.05%) was recorded in untreated T_1 (control).

Comparative effect of different treatments on percent diseased leaf area (DLA) recorded at 15 days intervals are presented in Table 2. Percent DLA was minimum in all plots at 59 days after sowing (DAS) while foliar sprays were started. The recorded DLAs were not significantly varied from one to another. During this period, the highest DLA (1.41%) was recorded in untreated treatment (T_1) and the lowest DLA (0.70%) was found in T_2 (seed treatment with Streptomycin sulphate). This was followed by T_{10} (0.79%), T_3 (0.96%) and T_4 (0.96%). DLAs (%) were significantly increased at 74 DAS, 89 DAS and 104 DAS. During this periods, the highest DLA (%) were recorded in control plots (T_1) which were 4.54, 7.57 and 9.66%, respectively. These DLA (%) were not statistically similar to other treatments. On the contrary, during this periods, the lowest DLA (%) were recorded in T_{10} (seed treatment with Streptomycin sulphate) followed by foliar spray with Cupravit + Streptomycin sulphate. The recorded DLAs were 1.88, 3.23 and 4.21%, respectively, which were identical to that of T_9 (foliar spray with Cupravit + Streptomycin sulphate). Among the seed treated treatments, T_2 (Streptomycin sulphate) always showed better performance in reducing DLA (%) than other treated plots T_3 (Thiovit 80 WP) and T_4 (Acid delinting with Sulfuric acid).

Comparative effect of different treatments on percent disease index (PDI) recorded at 15 days intervals starting

Table 1: Comparative effect of some seed treating chemicals on percent germination

Treatments	Germination (%)
T_1 = Control	77.05b
T_2 = Seed treatment with Streptomycin sulphate (0.15%)	86.90a
T_3 = Seed treatment with Thiovit 80 WP (0.2%)	80.95ab
T_4 = Acid delinting with Sulfuric acid (100 ml kg^{-1})	82.74ab
T_5 = Foliar spray with Dithane M-45 (0.25%	77.98b
T_6 = Foliar spray with Cupravit (0.2%)	77.38b
T_7 = Foliar spray with Streptomycin sulphate (150 ppm)	77.98b
T_8 = Foliar spray with Dithane M-45 (0.25%) + Streptomycin sulphate (150 ppm)	77.38b
T_9 = Foliar spray with Cupravit (0.2%) + Streptomycin sulphate (150 ppm)	78.57b
T_{10} = Seed treatment with Streptomycin sulphate (0.15%) and foliar spray with Cupravit (0.2%) + Streptomycin sulphate (150 ppm).	86.31a

Means in a column, having the same letter (s) do not differ significantly at 5% level by DMRT.

Table 2: Comparative effect of different treatments on percent diseased leaf area (DLA)

Treatments	% Diseased leaf area at			
	59 DAS	74 DAS	89 DAS	104 DAS
T_1	1.41	4.54a	7.57a	9.66a
T_2	0.70	2.90bc	4.71c	5.74d
T_3	0.96	3.52b	6.47b	7.55b
T_4	0.96	3.19bc	5.94b	7.19bc
T_5	1.29	3.00bc	5.76b	7.17bc
T_6	1.20	2.54cde	4.82c	6.41bcd
T_7	1.24	2.73cd	4.80c	6.02cd
T_8	1.34	2.06de	3.88cd	5.35de
T_9	1.00	1.96e	3.50d	4.42e
T_{10}	0.79	1.88e	3.23d	4.21e

Means in a column, having the same letter (s) do not differ significantly at 5% level by DMRT, NS=Not significant, DAS = Days after sowing.

Table 3: Comparative effect of different treatments on percent disease index (PDI)

Treatments	% diseased index at			
	59 DAS	74 DAS	89 DAS	104 DAS
T_1	8.28	22.86a	32.38a	39.38a
T_2	4.86	16.76cd	23.05de	27.52de
T_3	6.76	20.95ab	29.62ab	33.14bc
T_4	6.38	19.33abc	27.62bc	31.33bcd
T_5	9.14	18.57bcd	28.67abc	34.28b
T_6	8.86	15.05def	25.33cd	32.38bcd
T_7	8.19	15.62de	25.24cd	28.57cde
T_8	7.90	12.48ef	20.20ef	25.33ef
T_9	7.05	11.43f	20.67ef	22.28f
T_{10}	5.90	11.52f	18.48f	21.24f

Means in a column, having the same letter (s) do not differ significantly at 5% level by DMRT, NS=Not significant, DAS = Days after sowing.

at 59 DAS are presented in Table 3. At 59 DAS, the highest PDI (9.14) was recorded in untreated plots (T_5) and the next second highest was (8.86) in untreated plots (T_6). During these periods, the lowest PDI (4.86 and 5.90) were obtained in the seed treated plots (T_2 and T_{10}) where Streptomycin sulphate were used as seed treating chemicals. Gradually, the PDIs of different treatments were significantly increased at 74, 89 and 104 DAS, respectively. At 74 DAS, minimum PDI (11.43) was recorded in T_9 (seed treatment with Streptomycin sulphate and Foliar spray with Cupravit + Streptomycin sulphate. This PDI was statistically similar to that of treated plots (T_8 and T_9). On the other hand, maximum PDI (22.86) was found in the control plots (T_1) which was not statistically different to the seed treated plots (T_3 and T_4). At 89 DAS, minimum PDI (18.48) was calculated in T_{10} at 89 DAS which was statistically similar to that of T_8 and T_9 and maximum (32.38) was obtained in the control plots (T_1). Finally, PDI was recorded at 104 DAS. During this period, the lowest PDI (21.24) was also recorded in T_{10} which was statistically similar to that of T_8 and T_9. On the contrary, in the control plots (T_1), PDI was the highest (39.38) and was significantly different to the plots those were treated with different chemical (s).

Comparative effect of different treatments on healthy bolls $plant^{-1}$, rotted bolls $plant^{-1}$, seed cotton yield (kg ha^{-1}), stalk yield (kg ha^{-1}), seed cotton yield increase over the control (%) are presented in Table 4. It was observed that the treatments showed significant effect on those yield contributing characters. The data revealed that the highest number of healthy bolls/plant (17.67) was obtained in T_{10} followed by T_9, T_8 and T_2. The lowest number of healthy bolls $plant^{-1}$ was found in T_1 which was not statistically different from T_2 to T_7. The number of rotted bolls/plant among the treatments ranged from 1.10 to 2.83, where the lowest number of rotted bolls/plant was recorded in T_{10}. This was followed by T_9 and T_8 and the highest number of rotted bolls/plant was obtained in T_1 followed by T_4. Yield of seed cotton varied from one treatment to another ranging 1205.17 to 1518.81 kg ha^{-1}. Highest seed cotton yield was recorded in T_{10} which was statistically similar to that of T_9, T_8, T_7, T_6 and T_2. The treatment T_{10} increased 26.02% seed cotton yield over the control (T_1). The second highest yield (1480.01 kg ha^{-1}) was found in T_9 which was 22.81% higher over the control (T_1). No significant variation was found among the treatments T_1 to T_7 where the lowest seed cotton 1205.17 kg ha^{-1} was recorded in T_1. Stalk yield of cotton profoundly varied among the treatments ranging 1782.17 to 2219.13 kg ha^{-1}. The highest stalk yield was obtained in T_{10} followed by T_9, T_8, T_7 and T_2. Statistically no significant difference was found in the above treatments. The lowest stalk yield was found in T_1 which was statistically similar to that of T_3 and T_4.

All treatments significantly reduced percentage disease index (PDI) over the control. But complete control of disease could not be achieved even after three sprays at 104 DAS due to systemic nature of the disease. This finding is supported by Rao and Rao (1979) and Khan (1995). Among the different treatments, the lowest disease index (21.24%) was recorded at 104 DAS in T_{10} where

Table 4: Comparative effect of different treatments on healthy bolls/plant, rotted bolls/plant, seed cotton yield (kg ha^{-1}), stalk yield (kg ha^{-1}), seed cotton yield increase over the control (%)

Treatments	Healthy bolls/plant	Rotted bolls/plant	Seed cotton yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Seed cotton yield increase over the control (%)
T_1	12.77c	2.83a	1205.17c	1782.62f	–
T_2	15.53abc	1.60de	1406.52abc	2079.80abcd	16.71
T_3	14.00bc	2.27bc	1277.19bc	1943.12def	5.98
T_4	13.97bc	2.50ab	1287.48bc	1859.34ef	6.83
T_5	14.43bc	2.10c	1314.67bc	1965.16cde	9.09
T_6	14.97abc	1.73d	1338.92abc	2040.12bcd	11.10
T_7	15.33abc	1.63d	1350.67abc	2082.45abcd	12.07
T_8	16.17ab	1.43def	1406.21ab	2145.94abc	20.00
T_9	16.73ab	1.23ef	1480.01ab	2167.98ab	22.81
T_{10}	17.67a	1.10f	1518.81a	2219.13a	26.02

Means in a column, having the same letter (s) do not differ significantly at 5% level by DMRT.

seeds were treated with Streptomycin sulphate and three foliar sprays of Cupravit + Streptomycin sulphate. This was followed by T_9 (foliar spray with Cupravit + Streptomycin sulphate) where disease index was recorded 22.28 %. The highest disease index (39.38%) was observed in T_1 (control) and it was statistically different from the other treatments.

Among the seed treating treatments, seeds treated with Streptomycin sulphate (T_2) showed the best performance in respect of germination (%) and minimizing disease index (%). Antibiotics are used in bacterial blight control in the former USSR (Kravchenko and Ponmarev, 1964). Arnold (1965) reported that in Tanzania, the disease could reduce seed cotton yields by up to 350 kg ha^{-1} in a susceptible variety and that a gain of 340 kg ha^{-1} could be obtained from controlling the disease with a chemical seed dressing. In India much larger gains can apparently be achieved when the disease is controlled by a combination of seed treatment and foliar sprays. Mathur *et al.* (1973) reported an increase from 1009 kg ha^{-1} of seed cotton in the untreated control plots to 2238 kg ha^{-1} from plots treated with Streptomycin sulphate. Rao and Rao (1979) also reported that seed treated with Agrimycin-100 reduced bacterial blight incidence in cotton and seed germination was also not inhibited. Beura (1998) found minimum disease incidence and maximum seed cotton yield when seeds were treated with Streptomycin (1.5 g kg^{-1} seed) + Thiram (2 g kg^{-1} seed).

The present findings indicated that although Cupravit (50% Copper oxychloride) alone did not give particularly good control, it was much more effective in combination with the antibiotic (Streptomycin sulphate). Singh and Verma (1973) obtained effective control with foliar sprays of 0.2% Copper oxychloride and 1% Oxycarboxyne. Ekbote (1985) recommended Agrimycin at 50 ppm with 0.25% Copper oxychloride. In Haryana State (India), disease severity was much reduced and yield increased by mixture of Agrimycin (0.01%) and copper oxychloride (0.2%) applied to the foliage at three growth stages; 40-50, 70-80 and 85-95 days after planting (Chauhan *et al.*, 1983). Similarly, Padaganur and Basavaraj (1983) reported that Copper oxychloride + Streptomycin sulphate significantly reduced bacterial blight. Chauhan and Karawasra (1984) also reported that three sprays of 100 g Agrimycin (Streptomycin) + 2 kg Copper oxychloride per hectare gave the lowest disease index.

The effect of different treatments showed significant effect on healthy bolls/plant and rotted bolls/plant. The number of healthy bolls/plant (13.97-17.67) were comparatively higher in different treatments than the control (12.77). On the contrary rotted bolls/plant was comparatively lower (1.10-2.50) in different treatments than the control (2.83). Seed cotton and stalk yield performance differed significantly from one treatment to another. Yields of seed cotton and stalk were the highest in T_{10} (seed treatment with Streptomycin sulphate and foliar spray with Cupravit + Streptomycin sulphate) that received maximum combination of the chemicals. The next highest yield was found in T_9 where the plots were sprayed with Cupravit + Streptomycin sulphate. The results of the present investigation clearly indicated that treated plots of Cupravit (50% Copper oxychloride) and Streptomycin sulphate increased both seed cotton and stalk yield. Yield of seed cotton was also considerably increased in T_2 where seeds were treated with only Streptomycin sulphate. Rajpurohit and Lodha (1981) reported that three sprays of Agrimycin-100 (Streptomycin + Oxytetracycline) + Blitox-50 (Copper oxychloride) reduced disease intensity 46.49% and increased yield of seed cotton by 26.57%. Chauhan *et al.* (1983) also reported that bacterial blight of cotton (*Xanthomonas campestris* pv. *malvacearum*) was effectively controlled by spraying mixture of Agrimycin-100 (0.01%) + Blitox-50 (Copper oxychloride) @ 0.2% and yield of seed cotton was increased. Sharma and Chauhan (1985) showed that Copper oxychloride in combination w with Streptomycin sulphate gave satisfactory control against *Xanthomonas campestris* pv. *Malvacearum* and the highest yield (904 kg ha^{-1}).

It is concluded that T_{10} (seed treatment with Streptomycin sulphate @ 0.15% and foliar spray with Cupravit @ 0.2% + Streptomycin sulphate @150 ppm and T_9 (Foliar spray with Cupravit + Streptomycin sulphate) resulted better performance in reducing disease intensity and increasing yield of seed cotton. So, T_{10} and T_9 may be used in controlling bacterial blight and in increasing seed yield of cotton.

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