*Bangladesh J. Sugarcane, **31**: 104-111* *July, 2009*

Screening of Botanical Products against some Major Insect Pests of Sugarcane

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ABSTRACT

An experiment was conducted to study the effect of different botanical products (crude & patent) at two locations viz. Mohan farm, TSM Ltd., Thakurgaon and BSRI farm, Ishurdi, Pabna during 2003-2004 cropping season. Botanical products such as neem leave (powder & extract), tobacoo leaves (powder & extract), bishkatali plants powder and nimbicidine (patent) were used at different doses. Data collected at Mohan farm data (Pooled data) showed that all the treatments had similar response in reducing the Top shoot borer (TSB) infestation indicating the effectiveness ranged from 44.10-60.46% except Biskatali plant powder @ 100 kg ha^{-1} (29.52%). While at BSRI farm the effectiveness ranged from 23.23-51.35% over control. Stem borer (SB) infestation was moderately high at (September) at Mohan farm compared to SB infestation at BSRI farm through effectiveness was almost similar both at Mohan farm and BSRI farm ranged 24.65-44.23% and 27.94-43.62% respectively. May data at Mohan farm showed significant results over untreated plots in reducing Rootstock borer (RSB) infestation while at harvest botanical products showed 12.94-34.94% and 20.98-77.85% effectiveness at Mohan farm and BSRI farm respectively. White grubs and Termite population were non-significant at Mohan farm.

Keywords: Botanical products, major insect pests, sugarcane.

INTRODUCTION

Sugarcane is one of the important commercial crops in the tropics and serves as the main source of sugar in the world. In Bangladesh it is grown in about 0.17 million hectare a productivity of 44.0 tonnes/hectare. About 5.0 million people directly or indirectly depend on sugarcane for their livelihood (Pal *et al.*, 2005). Amongst the several factors of low yield like drought, low rainfall, temperature, humidity and insufficient millable cane the insect pests alone constitute the major problem. About 70 insect pests are reported to attacking sugarcane in Bangladesh (SRTI, 1973-78;1992) of which Top shoot borer, *Scirpophaga excerptalis* Walker, Stem borer, *Chilo tumidicostalis* Hampson and Root stock borer, *Emmalocera depressella* Swinhoe are most destructive. Alam (1967) reported that these pest alone cane cause damage ranging from 20-60% under the field conditions. Considerable yield losses which are estimated to be around 20% in yield and 15% in sugar recovery have also been reported (Avasthy, 1983). Their infestation causes heavy losses in yield sugar recovery every year which are estimated to be 4.0-48.0% and 2.0-62.5% by top shoot borer (*Scirpophaga excerptalis* Walker), 8.2-70.0% & 3.0-48.6% by stem borer (*Chilo tumidicostalis* Hampson) and 1.3-73.0% & 0.3-16.0% by root stock borer (*Emmalocera depressella* Swinhoe) (Alam *et al.*, 2003). Several species of scarab beetle known as white grubs were identified as serious pest of sugarcane in the northern

and north-western districts of Bangladesh (Miah *et al.*, 1986). Infestation by white grubs causes heavy losses in yield every year estimated to be 34.4-100% (Alam *et al.*, 2003).

Increasing demand of chemical pesticides in agriculture create serious problems like environmental pollution, health hazards and elimination of natural enemies. On the other hand, insecticides are costly and not easily available. Moreover, chemical insecticides often fail to kill the internal feeders due to their concealed habit. The newly hatched larvae pass few times before entering into the plants while can not be synchronised with the application of insecticides might cause failure of the chemicals. For the above reasons the scientists are diverting their attention worldwide to the botanical products due to their biodegradability and safety to natural enemies (Mehta, *et al.*, 2002). Further, indiscriminate use of insecticides has resulted in an adverse effect like resistance and resurgence of secondary pests (Saxena *et al.*, 1992). Therefore, the present experiment was designed to work with native botanical products for controlling major pests of sugarcane to avoid dependence on chemical insecticides.

MATERIALS AND METHODS

The experiment was set up in 2 location viz. Mohan Farm, TSM, Thakurgaon and BSRI farm, Ishurdi, Pabna during 2003-2004 cropping season. Plantation was done with variety Isd 34 and Isd 16 at Mohan farm and BSRI farm respectively. The experiment was laid out in Randomized Complete Block Design and replicated thrice. The experiment comprised 10 treatments including one control. The plot size was 6m×6m. Block to block distance was 2m and plot to plot distance was 1m. Botanical products such as neem leave (Powder & extract), tobacco leaves (Powder & extract), bishkatali plants powder and nimbicidine (patent) were used. The treatments were as follows-

T_1 = Neem leaves powder @ 50 kg ha $^{-1}$ (at Planting + March + May + July)
T_2 = Neem leaves at 2% solution (March + May + July)
T_3 = Nimbicidine @ 1.5 litre ha $^{-1}$ (March + May + July)
T_4= Nimbicidine @ 2.0 litre ha $^{-1}$ (March +May + July)
T_5 = Nimbicidine @ 2.5 litre ha $^{-1}$ (March + May + July)
T_6 = Bishkatali plants powder @ 80 kg ha $^{-1}$ (at Planting + March + May + July)
T_7 = Bishkatali plants powder @ 100 kg ha $^{-1}$ (at Planting + March + May + July)
T_8= Tobacco leaves extract at 12.5 gm/L water (March + May + July)
T_9 = Tobacco plants powder @ 100 kg ha $^{-1}$ (at Planting + March + May + July)
T_0 = Control

Botanical powder such as neem leaves, bishkatali and Tobacco powder were applied in the trenches during plantation and again and top dressed at root zone in furrows prepared on both sides of the cane rows and then covered with soil as per treatments. Nimbicidine, neem leaves extracts and tobacco leaves extracts were applied as per treatments during March + May + July. Data were taken several times on borers (Top shoot borer, Stem borer, Root stock borer and Early shoot borer) infestation by counting healthy and infested canes per plot and computed to percent infestation. For comparing white grubs and Termite population 5 clumps / plot were uprooted for counting white grubs and termite population. The collected data were analysed for comparison by using LSD at 0.05 levels for interpretation.

RESULTS AND DISCUSSION

At Mohan farm data collected for TSB infestation during March-September showed that there was no significant difference among the treatments in March but May, July and September significant difference were observed among the treatments compared to untreated control plot (Table-1). May data showed the effectiveness among the treatments ranged 55.21-89.14%, that of July and September ranged from 20.52-64.91% and 23.89-59.84% respectively over control. While pooled data showed identical reduction of top shoot borer infestation that ranged from 51.32-60.46% except bishkatali and tobacco plant powder @ 100 kg ha^{-1} which showed 29.52 and 44.10% effectiveness respectively over control (Table-1). At BSRI farm data collected from June-October showed that there were no significant difference among the treatments in reducing the TSB infestation although June data showed some better performance in the treatment tobacco leaves extract that gave 68.40% effectiveness followed by neem leaves (67.70%) at 2% solution. The treatments nimbicidine @ 2.5 L ha^{-1} gave 65.27%, neem leaves powder @ 50 kg ha^{-1} gave 62.50% and bishkatali plants powder @ 100 kg ha^{-1} gave 61.45% efficacy over control (Table 2). The pooled data showed that all the treatments were almost at par indicating effectiveness from 23.23-36.41% except the treatments neem leaves extract that showed above 50% efficacy over control

In case of stem borer infestation, data collected at Mohan farm, during May and September showed that there was no significant difference among the treatments in reducing the SB infestation. Pooled data showed 24.63-44.23% efficacy among the treatments, which is far below the desired level (80%) of efficacy to recommend a chemical for approval by the government (Table 1). SB infestation at BSRI farm from June to October showed that there was no significant difference among the treatments in reducing the SB infestation although June data showed very low infestation including control plots. Data collected in August and October showed also low infestation 0.45-3.36% by stem borer at BSRI farm compared to that of infestation at TSM. The pool data showed 27.94-43.62% efficacy of SB infestation over control (Table 2). Data collected for SB infestation showed higher rate of field intensity at Mohan farm than that of BSRI farm. But ranges of effectiveness of botanical products in different treatments were almost same. At Mohan farm data collection for RSB infestation was done in May and January. May data showed that almost all the treatments gave satisfactory reduction of RSB infestation giving above 80% effectiveness except nimbicidine @ 2.5 L ha^{-1} and neem leaves extract at 2% solution giving 52.64% and 79.05% effectiveness over control (Table 3). Abdullah *et al.* (2006) reported that extract of eight tobacco varieties sprayed in March, May and July gave 22.74 - 36.90% efficacy to control top shoot borer, 1.41-31.03% efficacy to SB and 25.86-57.98% efficacy to RSB over untreated plots.

Data on White grubs population/5 clumps/plot were taken in January showed that there was no significant difference among the treatments in reducing the white grub population. Neem leaves extract though showed non-significant performance yet it produced 85.65% efficacy over control (Table 3) in lowering the grub population. Data on termite population/5 clumps/plot were taken in January at Mohan farm showed that there was no significant difference among the treatments in lowering termite population. Though non significant difference were observed among the treatments yet both neem leaves powder @ 50 kg ha^{-1} and nimbicidine @ 1.5 L ha^{-1} gave 86.12% efficacy in reducing the termite population over control (Table 3).

At BSRI farm, data collected both for RSB & ESB showed that there were no significant differences in reducing the RSB & ESB infestation among the treatments. Data collected for RSB infestation in April showed some negative response of neem leaves powder, bishkatali plants powder and tobacco leaves extract on RSB incidence (Table 4). Though all the treatments showed non significant results in ESB infestation yet neem leaves powder, nimbicidine @ 2.0 and 2.5 L ha^{-1} produced satisfactory performance in terms of effectiveness that showed 85.57 to 100% efficacy over control. Abdullah *et al.* (2006) evaluated the efficacy of eight tobacco varieties as intercrop and later on incorporated into soil at the base of sugarcane. They observed that all test varieties controlled ESB, TSB, SB and RSB showing 0.00-69.39%, 0.80-64.97%, 0.03-61.62% and 0.17-59.61% efficacy respectively over untreated plots. All these results have similarities with efficacy results of botanical products in the present study.

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Table-1. Effectiveness of different Botanical products in controlling TSB and SB of sugarcane, Mohan farm, TSM, Thakurgaon. 2003-2004

Treatments	Percent Pest infestation (Mean)							
	TSB					SB		
	30.03.04	27.05.04	27.07.04	25.09.04	Pool data	27.05.04	25.09.04	Pool data
T_1 = Neem leaves powder @ 50 kg ha $^{-1}$ (Planting +March+May + July)	8.46 (14.73)*	2.75b (71.29)	7.35c (60.93)	17.67c (56.30)	9.06 (53.96)	9.08 (39.75)	37.06 (45.23)	23.07 (44.23)
T_2 = Neem leaves at 2% solution (March +May + July)	4.55 (54.08)	1.04b (89.14)	11.10bc (40.99)	21.39bc (47.11)	9.52 (51.62)	8.05 (46.58)	44.99 (35.50)	26.52 (35.89)
T_3 = Nimbicidine @ 1.5 litre ha $^{-1}$ (March +May + July)	4.39 (55.70)	2.59b (72.96)	12.01bc (36.15)	16.44c (59.35)	8.86 (54.97)	6.33 (56.67)	55.83 (17.48)	31.18 (24.63)
T_4= Nimbicidine @ 2.0 litre ha $^{-1}$ (March +May + July)	5.26 (46.92)	1.34b (86.01)	6.60c (64.91)	18.36c (59.37)	7.89 (59.90)	7.77 (48.44)	52.09 (23.01)	29.93 (27.65)
T_5 = Nimbicidine @ 2.5 litre ha $^{-1}$ (March +May + July)	8.72 (12.00)	1.72b (82.04)	8.87c (52.84)	16.43c (59.37)	8.94 (54.57)	3.10 (79.43)	46.35 (31.49)	24.73 (40.22)
T_6 = Bishkatali plants powder @ 80 kg ha $^{-1}$ (Planting + March + May + July)	4.19 (57.71)	1.52b (84.03)	9.20bc (51.09)	16.24c (59.84)	7.79 (60.46)	6.80 (54.88)	48.31 (28.60)	27.56 (33.38)
T_7 = Bishkatali plants powder @ 100 kg ha $^{-1}$ (Planting + March + May + July)	5.44 (45.10)	4.29b (55.21)	14.95ab (20.52)	30.78ab (23.89)	13.87 (29.52)	6.19 (58.93)	45.07 (33.39)	25.63 (38.05)
T_8= Tobacco leaves extract at 12.5 gm/L water (March + May + July)	6.63 (33.09)	2.18b (77.24)	11.77bc (37.43)	17.75c (56.11)	9.58 (51.32)	7.05 (53.22)	46.35 (31.49)	26.70 (35.46)
T_9 = Tobacco plants powder @ 100 kg ha^{-1} (Planting + March + May + July)	6.15 (37.94)	2.83b (70.45)	12.24bc (34.93)	22.78bc (43.67)	11.00 (44.10)	3.87 (74.32)	49.94 (26.19)	26.91 (34.95)
T_0 = Control	9.91 (-)	9.58a	18.81a	40.44	19.68 (-)	15.07	67.66	41.37 (-)
LSD 5%	NS	3.291	5.909	11.38	-	NS	NS	-

*Figures in parentheses are percent effectiveness over control.

Table-2. Effectiveness of different Botanical products in controlling TSB and SB of sugarcane, BSRI farm, Ishurdi, 2003-2004.

Treatments	Percent pest infestation (Mean)							
	TSB				SB			
	26.06.04	22.08.04	21.10.04	Pool data	26.06.04	22.08.04	21.10.04	Pool data
T_1 = Neem leaves powder @ 50 kg ha $^{-1}$ (Planting +March+May + July)	2.16 (62.50)	11.72 (18.44)	11.47 (38.36)	8.45 (34.54)	0.00 (100.00)	1.22 (12.23)	2.24 (3.33)	1.15 (43.62)
T_2 = Neem leaves at 2% solution (March +May + July)	1.86 (67.70)	6.62 (53.93)	10.35 (44.38)	6.28 (51.35)	0.00 (100.00)	1.21 (12.95)	2.77 (17.55)	1.33 (34.80)
T_3 = Nimbicidine @ 1.5 litre ha $^{-1}$ (March +May + July)	2.53 (56.07)	12.26 (14.68)	14.56 (21.76)	9.78 (24.24)	0.00 (100.00)	1.25 (10.07)	2.68 (20.23)	1.31 (35.78)
T_4= Nimbicidine @ 2.0 litre ha $^{-1}$ (March +May + July)	3.20 (44.44)	8.28 (42.37)	13.15 (29.33)	8.21 (36.41)	0.17 (87.68)	1.17 (15.83)	2.30 (31.54)	1.21 (40.68)
T_5 = Nimbicidine @ 2.5 litre ha $^{-1}$ (March +May + July)	2.00 (65.27)	10.45 (23.27)	12.24 (34.22)	8.23 (36.25)	0.16 (88.40)	1.36 (2.16)	2.22 (33.92)	1.25 (38.73)
T_6 = Bishkatali plants powder @ 80 kg ha $^{-1}$ (Planting + March + May + July)	2.45 (57.46)	11.93 (16.97)	15.27 (17.94)	9.88 (23.47)	0.00 (100.00)	0.92 (33.81)	2.77 (17.55)	1.23 (39.70)
T_7 = Bishkatali plants powder @ 100 kg ha $^{-1}$ (Planting + March + May + July)	2.22 (61.45)	12.73 (11.41)	10.73 (42.34)	8.56 (33.69)	0.00 (100.00)	1.33 (4.33)	2.80 (16.66)	1.38 (32.35)
T_8= Tobacco leaves extract at 12.5 gm/L water (March + May + July)	1.82 (68.40)	8.94 (37.78)	14.05 (24.50)	8.27 (35.94)	0.17 (87.68)	0.45 (67.63)	2.97 (11.60)	1.20 (41.18)
T_9 = Tobacco plants powder @ 100 kg ha^{-1} (Planting + March + May + July)	4.50 (21.87)	12.60 (12.31)	12.64 (32.08)	9.91 (23.23)	0.00 (100.00)	1.31 (5.76)	3.10 (7.73)	1.47 (27.94)
T_0 = Control	5.76	14.37	18.61	12.91	1.38 (-)	1.39 (-)	3.36 (-)	2.04 (-)
LSD 5%	NS	NS	NS	-	NS	NS	NS	-

*Figures in parentheses are percent effectiveness over control.

Table-3. Effectiveness of different Botanical products in controlling RSB, WG population and Termites population of sugarcane, Mohan farm, TSM, Thakurgaon. 2003-2004.

Treatments	Percent Infestation (Mean)				
	RSB (Percent infestation)			WG population/5 Clumps/plot	Termite population/5 Clumps/plot
	27.05.04	12.01.05	Pooled data	12.01.05	12.01.05
T_1 = Neem leaves powder @ 50 kg ha $^{-1}$ (Planting +March+May + July)	0.44c (91.98)*	41.91 (32.64)	21.18 (34.87)	2.76 (42.82)	3.33 (86.12)
T_2 = Neem leaves at 2% solution (March +May + July)	1.15c (79.05)	42.37 (31.90)	21.76 (33.09)	0.67 (85.65)	22.33 (6.95)
T_3 = Nimbicidine @ 1.5 litre ha $^{-1}$ (March +May + July)	1.01c (81.60)	48.81 (21.55)	24.91 (23.40)	2.67 (42.82)	3.33 (86.12)
T_4= Nimbicidine @ 2.0 litre ha $^{-1}$ (March +May + July)	0.25c (95.45)	41.62 (33.11)	20.94 (33.61)	3.00 (35.76)	17.66 (26.41)
T_5 = Nimbicidine @ 2.5 litre ha $^{-1}$ (March +May + July)	2.60b (52.64)	45.17 (12.94)	28.39 (12.70)	3.33 (28.69)	23.33 (2.79)
T_6 = Bishkatali plants powder @ 80 kg ha $^{-1}$ (Planting + March + May + July)	0.67c (91.43)	54.13 (13.00)	27.30 (16.05)	3.00 (33.76)	15.33 (35.12)
T_7 = Bishkatali plants powder @ 100 kg ha $^{-1}$ (Planting + March + May + July)	0.84c (84.69)	40.48 (34.94)	20.66 (36.46)	2.00 (57.17)	12.33 (48.62)
T_8= Tobacco leaves extract at 12.5 gm/L water (March + May + July)	0.51c (90.71)	44.31 (28.78)	22.41 (31.08)	3.00 (35.76)	10.00 (58.33)
T_9 = Tobacco plants powder @ 100 kg ha $^{-1}$ (Planting + March + May + July)	0.31c (94.35)	41.23 (33.73)	20.77 (36.13)	3.00 (35.76)	15.00 (37.50)
T_0 = Control	5.49a	55.55 (-)	30.52 (-)	4.67 (-)	24.00 (-)
LSD 5%	1.447	NS	-	NS	NS

*Figures in parentheses are percent effectiveness over control.

properties also. Two cups of cattle urine with 5 ml peppermint oil and 10 litres of water can be used to control fungal diseases on grapes (Gabriele Stoll, 1986). Cattle urine diluted at a rate of 1: 6 with water, poured down termite holes and repeated for a few days can control termites (Gabriele Stoll, 1986). Preparation of cattle-dung and urine extract deters female moths from laying eggs and leaf feeding by larvae (*H. armigera* and *S. litura*), and protects against some diseases (NRI, 2003). Sulyo (2008) has proven the effectiveness of natural pesticide made from the leaves and branches of the paitan (*Tithonia diverfolia*) plant and cattle urine in controlling dragonflies, caterpillars and mites.

Mansinghka (2007) revealed that mixing some plant extracts with cow's urine enhances the repellant activity of cow's urine. Neem (*Azadirachta indica*), Sitaphal (Annonaceae) etc. are some common plants which enhance the insect repellant capability of cow's urine. Cattle urine is composed of 3.1% OM, 1.1% N, 0.1% P_2O_5, 1.5% K_2O and 75-90% urea. Studies of urine in organic cattle farms in Sweden in 1999 and 2002 reported the following concentration of heavy metals copper-67, zinc-30, chromium-5, lead-1 and cadmium-0 (all in µg/kg wet weight). Cattle urine is environmentally safe and non-hazardous. Therefore the present study was undertaken to evaluate the efficacy of cattle urine as pesticide against major sugarcane pests and to find out suitable dose and time of application in controlling the target pests.

MATERIALS AND MEHODS

The experiment was conducted during 2007-08 cropping season at Regional Sugarcane Research Station (RSRS and Mohan farm, Thakurgaon Sugar Mills) under Tista Mendar Flood plain (AEZ-1) soils of Bangladesh. The experiment was laid out in randomized complete block (RCB) design with four replications. The plot size was 6 m X 6 m. Blocks were 2m apart from each other while the plot border was 1m. Planting was done through conventional sett placement in the trenches with sugarcane variety Isd 37. At planting, setts were treated with fermented cattle urine according to treatments. Forty setts (two eye budded) were placed per line. So, 240 setts were placed per plot.

Preparation of cattle urine solution: Cattle urine was collected from different cattle. After collection, it was kept underground in earthen pots for 14 days for fermentation. Then it was mixed with neem seed extracts and 95%, 90% 80% and 70% normal clean water. Another way of the preparation of cattle urine as a pesticide was diluting 5 kg of cattle dung into 5 litre water and adding 5 litre cattle urine. The resulting solution was fermented for 4 days in an enclosed container and then 100 g lime was added to neutralize the released toxic phenols and acids. Finally diluting the resulting solution in 80 litre water.

Application of cattle urine solution: The cattle urine solution thus prepared was sprayed with a knap-sack sprayer from February to July. Among the treatments, treatment T_5 was applied during March to July. After germination to vegetative stage fermented cattle urine was applied as foliar spray. Later, fermented cattle urine was applied in soil. Fertilizer application, irrigation, weeding, mulching and earthing-up were done as per normal cultural practices (Anon., 1998).

The following treatments were included in the experiment:

T_0- Control

T_1- 5% fermented cattle urine spray at 30 days interval after planting

T_2- 10% fermented cattle urine spray at 30 days interval after planting

T_3- 20% fermented cattle urine spray at 30 days interval after planting
T_4- 30% fermented cattle urine spray at 30 days interval after planting
T_5- Recommended Pesticides (Regent 3 GR, Furadan 5G, Razex 4G, Nokoban 15G) as and when advised for application by BSRI.

Data collection and Analysis: Germination (%), number of tiller and millable cane were recorded. Both the tiller population and millable cane stalks were recorded and expressed as 1000 ha^{-1}. The yield of sugarcane was also recorded at harvest. Data on the incidence of early shoot borer (ESB) was recorded in the month of March and April. Top shoot borer (TSB) and stem borer (SB) infested data were recorded in the month of April to July by counting the total and infested canes from each plot. For white grubs (WG) and rootstock borer (RSB), data were taken by uprooting five randomly selected clumps per plot in April to July. Larval population was counted in roots and in soils of those pits. In case of rootstock borer, uprooted stocks were dissected to observe their infestation. The collected data were converted to percent infestation to measure the level of incidence and analyzed for comparison by using LSD at 0.05 levels for interpretation.

Fig. 1. Cattle Urine Collection from Cattle Farm.

Fig. 2. Cattle Urine Fermentation in earthen pots.

Fig. 3. Experimental Plot of T_4 treatment.

RESULTS AND DISCUSSION

No significant difference was observed in germination at both locations (Table 1). The highest germination (42.81 and 43.85%) was observed in T_4 treatment followed by T_5 (41.66 and 43.48%) over untreated control at both locations. No significant difference was observed in tiller production at RSRS farm but significant difference was observed at Mohan farm. The highest tiller population of 159.58 X 10^3 ha^{-1} and 170.20 X 10^3 ha^{-1} was produced from T_4 followed by T_5. Lowest tiller of 122.84 X 10^3 ha^{-1} and 114.01 X 10^3 ha^{-1} was recorded from the T_0 plot, which differed with other treatments (Table 1). Significant difference was observed in millable cane production at Mohan farm but RSRS farm data was not significant (Table 1). The maximum millable cane 91.67 X 10^3 ha^{-1} and 91.94 X 10^3 ha^{-1} was recorded from the T_4 plot and the minimum (77.50 X 10^3 ha^{-1} and 70.70 X 10^3 ha^{-1}) was observed from the T_0 plot at both locations (Table 1).

Significant difference was observed in cane yield among the treatments at Mohan farm but RSRS farm data was not significant (Table 1). The highest yield 105.42 and

Table-4. Effectiveness of different Botanical products in controlling RSB and ESB of sugarcane at BSRI farm, 2003-2004

Treatments	Pest Infestation			
	RSB			ESB
	25.04.04	25.01.05	Pooled data	25.04.04
T_1 = Neem leaves powder @ 50 kg ha $^{-1}$ (Planting +March+May + July)	2.09 (-20.11)*	8.02 (55.59)*	5.06 (43.43)	0.15 (85.57)*
T_2 = Neem leaves at 2% solution (March +May + July)	0.48 (72.41)	14.27 (20.98)	7.38 (25.45)	0.71 (31.76)
T_3 = Nimbicidine @ 1.5 litre ha $^{-1}$ (March +May + July)	0.23 (86.78)	7.64 (57.70)	3.94 (60.20)	0.74 (28.84)
T_4= Nimbicidine @ 2.0 litre ha $^{-1}$ (March +May + July)	1.55 (10.91)	7.80 (56.81)	4.68 (52.72)	0.15 (85.57)
T_5 = Nimbicidine @ 2.5 litre ha $^{-1}$ (March +May + July)	1.63 (6.32)	10.23 (43.36)	5.93 (40.10)	0.00 (100.00)
T_6 = Bishkatali plants powder @ 80 kg ha $^{-1}$ (Planting + March + May + July)	1.86 (-6.89)	11.25 (36.71)	6.56 (33.73)	0.61 (41.34)
T_7 = Bishkatali plants powder @ 100 kg ha $^{-1}$ (Planting + March + May + July)	0.51 (70.68)	13.04 (27.80)	6.78 (31.51)	0.46 (55.76)
T_8= Tobacco leaves extract at 12.5 gm/L water (March + May + July)	1.79 (-2.87)	4.00 (77.85)	2.90 (70.70)	0.34 (67.30)
T_9 = Tobacco plants powder @ 100 kg ha $^{-1}$ (Planting + March + May + July)	0.27 (48.48)	10.25 (43.24)	5.26 (46.86)	0.30 (71.15)
T_0 = Control	1.74 (-)	18.06 (-)	9.90 (-)	1.04 (-)
LSD 5%	NS	NS		NS

*Figures in parentheses are percent effectiveness over control.