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Evaluation of efficacy of ecofriendly biopesticides against gram pod borer and legume pod borer of short duration pigeonpea

R Shravan Kumar, Paras Nath, SVS Raju and U Nagabhushanam

Abstract
The field experiment was conducted during rainy season of 2004 and 2005 at the Agricultural Research Farm, Banaras Hindu University, Varanasi, Uttar Pradesh, India to study of evaluation of efficacy of ecofriendly biopesticides (botanical and microbial) against gram pod borer and legume pod borer. Among all, T_{15} (control) was least effective whereas T_6 (two sprays of NSKE) was very effective in reducing pest population of gram pod borer. In case of legume pod borer, the T_6 (two sprays of NSKE) was highly effective and T_{15} (control) was least effective. Among all the treatments tested, T_3, T_1 and T_7; T_1, T_7 and T_2; T_4, T_{10}, T_{12}, T_9 and T_{13}; T_{12}, T_9, T_{13} and T_5 and T_5, T_{11}, T_8, T_{14} and T_6 were found to be at par among themselves within their respective groups against legume pod borer.

Keywords: Pigeonpea, gram pod borer, legume pod borer, biopesticides

Introduction
Pigeonpea is the fourth most important pulse crop in the world with almost all production confining to developing countries. Being a leguminous crop, it is capable of fixing atmospheric nitrogen and thereby restores lot of nitrogen in the soil. Extensive ground cover of pigeonpea prevents soil from wind and water erosion and smothers weeds. There is an immense scope for short duration pigeonpea in the future and there is a dearth of information regarding biopesticidal management of insect pests of flowers and pods of short duration pigeonpea. Therefore this study of evaluation of efficacy of ecofriendly biopesticides (botanical and microbial) against gram pod borer and legume pod borer.

Materials and Methods
The field experiment was conducted during rainy season of 2004 and 2005 at the Agricultural Research Farm, Banaras Hindu University, Varanasi, Uttar Pradesh, India. The study was conducted in Randomized Block Design (RBD) with 15 treatments and 3 replications and the plot size was 20 sqm. A spacing of 60x20 cm was followed. Pigeonpea short duration variety UPAS-120 was grown during the Kharif season in the well prepared field on raised flat bed made by flat bed planter. The fertilizers were applied @20 kg Nitrogen and 60 Kg Phosphorus per hectare. All the required amount of fertilizers were applied as basal dressing before sowing of the crop. Need based agronomic operations i.e., weeding, hoeing etc were carried out as per the requirement. No plant protection measures except the experimental spray schedule was undertaken during the entire period of the experiment.

Table 1: The treatment schedules of biopesticides are as follows

Tr. No.	Treatments	Spray Schedule
T_1	B.t formulation	One spray at pod formation stage
T_2	B.t formulation	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_3	Nimbecidine 0.2%	One spray at pod formation stage
T_4	Nimbecidine 0.2%	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_5	NSKE 5%	One spray at pod formation stage
T_6	NSKE 5%	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_7	Endosulfan 0.07%	One spray at pod formation stage
T_8	Endosulfan 0.07%	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_9	B.t formulation+ Nimbecidine 0.2%	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_{10}	B.t formulation+ NSKE 5%	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_{11}	B.t formulation+ Endosulfan 0.07%	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_{12}	Nimbecidine 0.2%+ NSKE 5%	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_{13}	Nimbecidine 0.2%+ Endosulfan 0.07%	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_{14}	NSKE 5%+ Endosulfan 0.07%	Two sprays at 15 days interval: first at flower initiation and second at pod formation stage
T_{15}	Untreated Control (No application of pesticides was done)	

The application of biopesticides was done at flower initiation and pod formation stage. Single application of B.t (T1), nimbecidine 0.2% (T3), NSKE 5% (T5), Endosulfan (T7) was done at pod formation stage. In T2, B.t was applied once at flower initiation stage and next pod formation stage. In case of T4, Nimbecidine was applied once at flower initiation stage and second time at pod formation stage. In T6 NSKE was applied once at flower initiation stage and second at pod formation stage. In T8, endosulfan was applied twice at 15 days interval, once at flower initiation stage, second at pod formation stage.

In T9, B.t was applied twice at flower initiation stage, nimbecidine at pod formation stage. In T10 B.t was applied at pod formation stage, NSKE 5% was applied at pod formation stage. In T11, B.t was applied at flower initiation stage, endosulfan was applied at pod formation stage. In T12, nimbecidine 0.2% was applied at flower initiation stage, NSKE 5% was applied at pod formation stage. In T13, nimbecidine 0.2% was applied at flower initiation stage, endosulfan 0.07% was applied at pod formation stage. In T14, NSKE 5% was applied at flower initiation stage, endosulfan 0.07% was applied at pod formation stage. The treatments were imposed with the help of knap sac sprayer. The calibration of sprayer was done before each spraying using tap water. No plant protection chemicals were sprayed in T15 plot and it was treated as control.

Observations

The observations were recorded on the pest incidence one day after insecticide application and subsequently at seven days interval till harvest. The data on pod damage and seed damage were also recorded. The population of insect pests i.e., gram pod borer and legume pod borer in pigeonpea crop recorded at weekly intervals was analysed to know the trend of population fluctuation. The data were used to compute the standard deviation, coefficient of variation and standard error.

The extent of seed damage (%) and pod damage by gram pod borer was computed by using the following formula as suggested by Sahoo *et al*., (2000) [10].

$$\text{Seed damage (\%)} = \frac{\text{No. of damaged seeds}}{\text{Total No. of seeds collected}} \times 100$$

$$\text{Pod damage (\%)} = \frac{\text{No. of damaged pods}}{\text{Total No. of pods collected}} \times 100$$

The percent data were used for analysis of variance after transformations by using Arc Sine transformations as suggested by Gomez and Gomez (1976) [3].

Results and Discussion

Gram pod borer (*Helicoverpa armigera* Hb.)

The data pertaining to gram pod borer population recorded after the application of biopesticides at weekly intervals starting from one day immediately after spraying of insecticides are presented in Table 2.

In the year 2004, the efficacy of different treatments was tested and it was in the ascending order of T_{15} (control) < T_1 (one spray of B.t.) < T_7 (one spray of endosulfan) < T_3 (one spray of Nimbecidine) < T_5 (one spray of NSKE) < T_{13} (one spray of Nimbecidine and one spray of endosulfan) < T_{11} (one spray of B.t. and one spray of endosulfan) < T_8 (two sprays of endosulfan) < T_2 (two sprays of B.t.) < T_{14} (one spray of NSKE and one spray of endosulfan) < T_9 (one spray of B.t. and one spray of Nimbecidine) < T_{10} (one spray of B.t. and one spray of NSKE) < T_4 (two sprays of Nimbecidine) < T_{12} (one spray of Nimbecidine and one spray of NSKE) < T_6 (two sprays of NSKE). Among all the treatments screened, the pest population was more in T_{15} (control) plots and least in T_6 (two sprays of NSKE) plot. The treatments T_1 and T_7, T_3 and T_5, T_5 and T_{13}, T_{13}, T_{11}, T_8 and T_2, T_8, T_2, T_{14}, T_9 and T_{10}, T_2, T_{14}, T_9, T_{10}, T_4 and T_{12} in their respective groups were found to be at par among themselves.

In the year 2005, the efficacy of different treatments was in the ascending order of $T_{15} < T_1 < T_7 < T_3 < T_5 < T_{11} < T_{13} < T_{10} < T_{12} < T_9 < T_2 < T_4 < T_8 < T_{14} < T_6$. In control plot ($T_{15}$) the pest population was more. The treatments T_1 and T_7; T_7, T_3 and T_5; T_{11}, T_{13}, T_{10}, T_{12}, T_9, T_2 and T_4; T_{10}, T_9, T_2, T_4 and T_8; T_9, T_2, T_4, T_8 and T_{14} were found at par among themselves in their respective groups. The treatments T_8, T_{14} and T_6 were superior to all other treatments and at par among themselves.

The pooled population of gram pod borer recorded in the various treatment plots during 2004 and 2005 was in an ascending order of $T_{15} < T_1 < T_7 < T_3 < T_5 < T_{13} < T_{11} < T_8 = T_9 = T_{10} < T_2 < T_{12} < T_4 < T_{14} < T_6$. Among all, T_{15} (control) was least effective whereas T_6 (two sprays of NSKE) was very effective in reducing pest population of gram pod borer. Among treatments, T_1 and T_7; T_3 and T_5; T_{13} and T_{11}; T_8, T_9, T_{10}, T_2, T_{12}, T_4 and T_{14} were found to be at par among themselves in their respective groups.

Table 2: Efficacy of ecofriendly biopesticides against gram caterpillar (*H. armigera*) infesting short duration pigeonpea at Varanasi in 2004 and 2005

Trt.	2004							2005							Pooled Data						
	D1	D2	D3	D4	D5	D6	Avg	D1	D2	D3	D4	D5	D6	Avg	D1	D2	D3	D4	D5	D6	Avg
T_1	4.00 (2.12)	3.33 (1.96)	3.00 (1.87)	2.67 (1.78)	0.89 (1.18)	2.00 (1.58)	2.65 (1.75)	6.33 (2.61)	6.67 (2.68)	7.00 (2.74)	3.00 (1.87)	2.00 (1.58)	2.00 (1.58)	4.50 (2.18)	5.17 (2.38)	5.00 (2.35)	5.00 (2.35)	2.83 (1.83)	2.00 (1.58)	2.00 (1.58)	3.67 (2.01)
T_2	1.67 (1.47)	1.67 (1.47)	2.67 (1.78)	2.00 (1.58)	0.67 (1.08)	1.00 (1.22)	1.61 (1.43)	1.67 (1.47)	1.33 (1.35)	2.67 (1.78)	2.33 (1.68)	1.33 (1.35)	1.00 (1.22)	1.72 (1.48)	1.67 (1.47)	1.50 (1.41)	2.67 (1.78)	2.17 (1.63)	1.00 (1.22)	1.00 (1.22)	1.67 (1.46)
T_3	4.00 (2.12)	3.67 (2.04)	3.33 (1.96)	1.00 (1.22)	0.33 (0.91)	1.67 (1.47)	2.33 (1.62)	6.33 (2.61)	6.67 (2.68)	7.00 (2.74)	2.00 (1.58)	1.33 (1.35)	1.33 (1.35)	4.11 (2.05)	5.17 (2.38)	5.17 (2.38)	5.17 (2.38)	1.50 (1.41)	1.17 (1.29)	1.50 (1.41)	3.28 (1.88)
T_4	2.00 (1.58)	2.00 (1.58)	2.00 (1.58)	1.00 (1.22)	0.33 (0.91)	1.00 (1.22)	1.39 (1.35)	2.00 (1.58)	1.67 (1.47)	2.33 (1.68)	1.67 (1.47)	1.33 (1.35)	1.00 (1.22)	1.67 (1.46)	2.00 (1.58)	1.83 (1.53)	2.17 (1.63)	1.33 (1.35)	1.17 (1.29)	1.00 (1.22)	1.58 (1.44)
T_5	4.00 (2.12)	3.67 (2.04)	3.67 (2.04)	1.00 (1.22)	0.33 (0.91)	1.00 (1.22)	2.28 (1.59)	5.67 (2.48)	6.33 (2.61)	6.67 (2.68)	1.67 (1.47)	1.33 (1.35)	1.00 (1.22)	3.78 (1.97)	4.83 (2.31)	5.00 (2.35)	5.17 (2.38)	1.33 (1.35)	1.17 (1.29)	1.00 (1.22)	3.08 (1.82)
T_6	1.33 (1.35)	1.33 (1.35)	2.00 (1.58)	0.67 (1.08)	0.22 (0.85)	0.33 (0.91)	0.98 (1.19)	1.33 (1.35)	1.33 (1.35)	1.67 (1.47)	1.33 (1.35)	1.00 (1.22)	0.67 (1.08)	1.22 (1.31)	1.33 (1.35)	1.33 (1.35)	1.83 (1.53)	1.00 (1.22)	0.67 (1.08)	0.50 (1.00)	1.11 (1.26)
T_7	4.00 (2.12)	3.67 (2.04)	3.33 (1.96)	1.67 (1.47)	0.56 (1.03)	2.33 (1.68)	2.59 (1.72)	6.33 (2.61)	7.33 (2.80)	7.67 (2.86)	1.67 (1.47)	1.67 (1.47)	1.00 (1.22)	4.28 (2.07)	5.17 (2.38)	5.50 (2.45)	5.50 (2.45)	1.67 (1.47)	1.83 (1.53)	1.67 (1.47)	3.56 (1.96)
T_8	2.00 (1.58)	2.00 (1.58)	2.67 (1.78)	1.33 (1.35)	0.44 (0.97)	2.00 (1.58)	1.74 (1.47)	1.67 (1.47)	1.33 (1.35)	2.67 (1.78)	1.33 (1.35)	1.33 (1.35)	0.67 (1.08)	1.50 (1.40)	1.83 (1.53)	1.67 (1.47)	2.67 (1.78)	1.33 (1.35)	1.33 (1.35)	1.33 (1.35)	1.69 (1.47)
T_9	2.00 (1.58)	2.00 (1.58)	2.00 (1.58)	1.33 (1.35)	0.44 (0.97)	1.00 (1.22)	1.46 (1.38)	2.00 (1.58)	1.67 (1.47)	2.33 (1.68)	2.00 (1.58)	1.33 (1.35)	1.00 (1.22)	1.72 (1.48)	2.00 (1.58)	1.83 (1.53)	2.17 (1.63)	1.67 (1.47)	1.33 (1.35)	1.00 (1.22)	1.67 (1.47)
T_{10}	2.00 (1.58)	2.00 (1.58)	2.67 (1.78)	1.00 (1.22)	0.33 (0.91)	1.00 (1.22)	1.50 (1.38)	2.00 (1.58)	2.00 (1.58)	2.67 (1.78)	1.67 (1.47)	1.33 (1.35)	1.00 (1.22)	1.78 (1.50)	2.00 (1.58)	2.00 (1.58)	2.67 (1.78)	1.33 (1.35)	1.17 (1.29)	1.00 (1.22)	1.69 (1.47)
T_{11}	2.00 (1.58)	2.00 (1.58)	2.67 (1.78)	1.67 (1.47)	0.56 (1.03)	1.67 (1.47)	1.76 (1.49)	2.33 (1.68)	2.00 (1.58)	2.33 (1.68)	2.00 (1.58)	1.67 (1.47)	1.67 (1.47)	2.00 (1.58)	2.17 (1.63)	2.00 (1.58)	2.50 (1.73)	1.83 (1.53)	1.67 (1.47)	1.67 (1.47)	1.97 (1.57)
T_{12}	2.00 (1.58)	2.00 (1.58)	2.00 (1.58)	1.00 (1.22)	0.33 (0.91)	1.00 (1.22)	1.39 (1.35)	2.00 (1.58)	1.67 (1.47)	2.33 (1.68)	1.67 (1.47)	1.33 (1.35)	1.33 (1.35)	1.72 (1.49)	2.00 (1.58)	1.83 (1.53)	2.17 (1.63)	1.33 (1.35)	1.17 (1.29)	1.17 (1.29)	1.61 (1.45)
T_{13}	2.67 (1.78)	2.00 (1.58)	2.33 (1.68)	1.67 (1.47)	0.56 (1.03)	2.00 (1.58)	1.87 (1.52)	2.33 (1.68)	2.00 (1.58)	2.67 (1.78)	1.33 (1.35)	1.67 (1.47)	1.67 (1.47)	1.94 (1.56)	2.50 (1.73)	2.00 (1.58)	2.50 (1.73)	1.50 (1.41)	1.83 (1.53)	1.83 (1.53)	2.03 (1.59)
T_{14}	1.67 (1.47)	1.33 (1.35)	1.67 (1.47)	2.00 (1.58)	0.67 (1.08)	1.33 (1.35)	1.44 (1.39)	1.67 (1.47)	1.33 (1.35)	2.00 (1.58)	1.33 (1.35)	1.00 (1.22)	1.00 (1.22)	1.39 (1.37)	1.67 (1.47)	1.33 (1.35)	1.83 (1.53)	1.67 (1.47)	1.33 (1.35)	1.17 (1.29)	1.50 (1.41)
T_{15}	4.33 (2.20)	3.67 (2.04)	3.67 (2.04)	4.33 (2.20)	1.44 (1.39)	4.00 (2.12)	3.57 (2.00)	6.00 (2.55)	7.67 (2.86)	7.67 (1.86)	8.33 (2.97)	7.67 (2.86)	5.00 (2.35)	7.06 (2.74)	5.17 (2.38)	5.67 (2.48)	5.67 (2.48)	6.33 (2.61)	6.17 (2.58)	4.50 (2.24)	5.58 (2.46)

Figures in parentheses are transformed as square root (x+0.5).

	2004	2005	Pooled
Difference between treatments CD (p=0.05)	0.093	0.121	0.076
Difference between Dates of observation CD (p=0.05)	0.059	0.077	0.48
Interaction between treatments and dates of observations CD (p=0.05)	0.228	0.297	0.187

Pod damage (%) by gram pod borer

The data recorded on the extent of per cent pod damage by gram caterpillar (*H. armigera*) in short duration pigeonpea during 2004 and 2005 are represented in Table 3. It was found that all the eco-friendly bio-pesticidal treatments significantly reduced the pod damage (%) by gram caterpillar in both the years of study. The relative performance of the biopesticides in reducing the per cent pod damage was found to be in order of T_6 (two sprays of NSKE) > T_{14} (one spray of NSKE and one spray of endosulfan) > T_8 (two sprays of endosulfan) > T_5 (one spray of NSKE) > T_{10} (one spray of B.t. and one spray of NSKE) > T_{12} (one spray of Nimbecidine and one spray of NSKE) > T_2 (two sprays of B.t.) > T_7 (one spray of endosulfan) > T_{11} (one spray of B.t. and one spray of endosulfan) > T_{13} (one spray of Nimbecidine and one spray of endosulfan) > T_1 (one spray of B.t.) > T_4 (two sprays of Nimbecidine) > T_9 (one spray of B.t. and one spray of Nimbecidine) > T_3 (one spray of Nimbecidine) > T_{15} (control). The per cent pod damage recorded was relatively less in T_6 (two sprays of NSKE) treatment plot and relatively more in T_{15} (control) treatment. The treatments T_6 (two sprays of NSKE) and T_{14} (one spray of NSKE and one spray of endosulfan); T_9 (one spray of B.t. and one spray of Nimbecidine) and T_3 (one spray of Nimbecidine); T_{14} (one spray of NSKE and one spray of endosulfan), T_8 (two sprays of endosulfan) and T_5 (one spray of NSKE); T_{11} (one spray of B.t. and one spray of endosulfan), T_{13} (one spray of Nimbecidine and one spray of endosulfan), T_1 (one spray of B.t.) and T_4 (two sprays of Nimbecidine) were found to be at par with each other with in their respective groups in their performance in reducing percent pod damage in short duration pigeonpea.

In 2005, the relative performance of biopesticidal treatments was found to be in order of T_6 (two sprays of NSKE) > T_{14} (one spray of NSKE and one spray of endosulfan) > T_8 (two sprays of endosulfan) > T_5 (one spray of NSKE) > T_{12} (one spray of Nimbecidine and one spray of NSKE) > T_7 (one spray of endosulfan) > T_{11} (one spray of B.t. and one spray of endosulfan) > T_2 (two sprays of B.t.) > T_{10} (one spray of B.t. and one spray of NSKE) > T_{13} (one spray of Nimbecidine and one spray of endosulfan) > T_4 (two sprays of Nimbecidine) > T_1 (one spray of B.t.) > T_9 (one spray of B.t. and one spray of Nimbecidine) > T_3 (one spray of Nimbecidine) > T_{15} (control). The treatment T_6 (two sprays of NSKE) was the best in reducing the per cent pod damage than other treatments. The highest pod damage was recorded in T_{15} (control) treatment. The treatments T_6 (two sprays of NSKE) and T_{14} (one spray of NSKE and one spray of endosulfan); T_{14} (one spray of NSKE and one spray of endosulfan), T_8 (two sprays of endosulfan) and T_5 (one spray of NSKE); T_1 (one spray of B.t.), T_4 (two sprays of Nimbecidine) and T_9 (one spray of B.t. and one spray of Nimbecidine) were found to be at par with each other with in their groups in reducing the pod damage by gram caterpillar in short duration pigeonpea. Similarly, T_{11} (one spray of B.t. and one spray of endosulfan), T_2 (two sprays of B.t.), T_{10} (one spray of B.t. and one spray of

NSKE), T_{13} (one spray of Nimbecidine and one spray of endosulfan) and T_4 (two sprays of Nimbecidine) and T_{12} (one spray of Nimbecidine and one spray of NSKE), T_7 (one spray of endosulfan), T_{11} (one spray of B.t. and one spray of endosulfan), T_2 (two sprays of B.t.), T_{10} (one spray of B.t. and one spray of NSKE), T_{13} (one spray of Nimbecidine and one spray of endosulfan) and T_4 (two sprays of Nimbecidine) were also statistically similar with each other with in their groups in their performance in reducing the pod damage by gram caterpillar.

The pooled analysis of per cent pod damage by gram caterpillar revealed that the treatment T_6 (two sprays of NSKE) was good performer in reducing the pod damage while T_{15} (control) treatment was least performer. The performance of different biopesticidal treatments was found to be in order of T_6 (two sprays of NSKE) > T_{14} (one spray of NSKE and one spray of endosulfan) > T_8 (two sprays of endosulfan) > T_5 (one spray of NSKE) > T_{12} (one spray of Nimbecidine and one spray of NSKE) > T_7 (one spray of endosulfan) > T_{10} (one spray of B.t. and one spray of NSKE) > T_2 (two sprays of B.t.) > T_{11} (one spray of B.t. and one spray of endosulfan) > T_{13} (one spray of Nimbecidine and one spray of endosulfan) > T_4 (two sprays of Nimbecidine) > T_1 (one spray of B.t.) > T_9 (one spray of B.t. and one spray of Nimbecidine) > T_3 (one spray of Nimbecidine) > T_{15} (control). The treatments T_{14} (one spray of NSKE and one spray of endosulfan), T_8 (two sprays of endosulfan) and T_5 (one spray of NSKE); T_5 (one spray of NSKE), T_{12} (one spray of Nimbecidine and one spray of NSKE), T_7 (one spray of endosulfan), T_{10} (one spray of B.t. and one spray of NSKE) and T_2 (two sprays of B.t.); T_{11} (one spray of B.t. and one spray of endosulfan), T_{13} (one spray of Nimbecidine and one spray of endosulfan) and T_4 (two sprays of Nimbecidine); T_1 (one spray of B.t.) and T_9 (one spray of B.t. and one spray of Nimbecidine) were found to be statically at par with other with in their respective groups in reducing pod damage.

Table 3: Efficacy of ecofriendly biopesticides against legume pod borer (*M. testulalis*) infesting short duration pigeonpea at Varanasi in 2004 and 2005

Trt.	2004							2005							Pooled Data						
	D1	D2	D3	D4	D5	D6	Avg	D1	D2	D3	D4	D5	D6	Avg	D1	D2	D3	D4	D5	D6	Avg
T_1	6.00 (2.55)	5.67 (2.48)	5.67 (2.48)	3.00 (1.87)	2.67 (1.78)	2.00 (1.58)	4.17 (2.12)	6.33 (2.61)	6.00 (2.55)	6.00 (2.55)	3.33 (1.96)	3.00 (1.87)	2.33 (1.68)	4.50 (2.20)	6.17 (2.58)	5.83 (2.52)	5.83 (2.52)	3.17 (1.91)	2.83 (1.83)	2.17 (1.63)	4.33 (2.16)
T_2	5.33 (2.42)	5.67 (2.48)	5.67 (2.48)	2.33 (1.68)	2.00 (1.58)	2.00 (1.58)	3.83 (2.04)	5.67 (2.48)	6.00 (2.55)	6.33 (2.61)	2.67 (1.78)	2.33 (1.68)	2.33 (1.68)	4.22 (2.13)	5.50 (2.45)	5.83 (2.52)	6.00 (2.55)	2.50 (1.73)	2.17 (1.63)	2.17 (1.63)	4.03 (2.09)
T_3	5.67 (2.48)	6.33 (2.61)	5.33 (2.42)	3.33 (1.96)	3.00 (1.87)	2.33 (1.68)	4.33 (2.17)	6.00 (2.55)	6.67 (2.68)	5.67 (2.48)	3.67 (2.04)	3.33 (1.96)	2.67 (1.78)	4.67 (2.25)	5.83 (2.52)	6.50 (2.65)	5.50 (2.45)	3.50 (2.00)	3.17 (1.91)	2.50 (1.73)	4.50 (2.21)
T_4	3.33 (1.96)	3.00 (1.87)	3.67 (2.04)	2.67 (1.78)	2.33 (1.68)	1.67 (1.47)	2.78 (1.80)	3.67 (2.04)	3.33 (1.96)	4.00 (2.12)	3.00 (1.87)	2.67 (1.78)	2.33 (1.68)	3.17 (1.91)	3.50 (2.00)	3.17 (1.91)	3.83 (2.08)	2.83 (1.83)	2.50 (1.73)	2.00 (1.58)	2.97 (1.86)
T_5	3.33 (1.96)	2.67 (1.78)	3.00 (1.87)	2.00 (1.58)	1.67 (1.47)	1.67 (1.47)	2.39 (1.69)	3.67 (2.04)	3.00 (1.87)	3.33 (1.96)	2.33 (1.68)	2.00 (1.58)	2.00 (1.58)	2.72 (1.79)	3.50 (2.00)	2.83 (1.83)	3.17 (1.91)	2.17 (1.63)	1.83 (1.53)	1.83 (1.53)	2.56 (1.74)
T_6	3.00 (1.87)	2.67 (1.78)	3.00 (1.87)	1.67 (1.47)	1.33 (1.35)	1.33 (1.35)	2.17 (1.62)	3.33 (1.96)	3.00 (1.87)	3.33 (1.96)	2.00 (1.58)	1.67 (1.47)	1.67 (1.47)	2.50 (1.72)	3.17 (1.91)	2.83 (1.83)	3.17 (1.91)	1.83 (1.53)	1.50 (1.41)	1.50 (1.41)	2.33 (1.67)
T_7	5.33 (2.42)	5.67 (2.48)	6.00 (2.55)	2.00 (1.58)	2.67 (1.78)	2.67 (1.78)	4.06 (2.10)	5.67 (2.48)	6.00 (2.55)	6.33 (2.61)	2.33 (1.68)	3.00 (1.87)	3.00 (1.87)	4.39 (2.18)	5.50 (2.45)	5.83 (2.52)	6.17 (2.58)	2.17 (1.63)	2.83 (1.83)	2.83 (1.83)	4.22 (2.14)
T_8	2.33 (1.68)	2.33 (1.68)	3.33 (1.96)	2.00 (1.58)	1.67 (1.47)	1.67 (1.47)	2.22 (1.64)	2.67 (1.78)	2.67 (1.78)	3.67 (2.04)	2.33 (1.68)	2.00 (1.58)	2.00 (1.58)	2.56 (1.74)	2.50 (1.73)	2.50 (1.73)	3.50 (2.00)	2.17 (1.63)	1.83 (1.53)	1.83 (1.53)	2.39 (1.69)
T_9	2.67 (1.78)	2.67 (1.78)	3.00 (1.87)	2.67 (1.78)	2.33 (1.68)	2.00 (1.58)	2.56 (1.75)	3.00 (1.87)	3.00 (1.87)	3.33 (1.96)	3.67 (2.04)	2.67 (1.78)	2.33 (1.68)	3.00 (1.87)	2.83 (1.83)	2.83 (1.83)	3.17 (1.91)	3.17 (1.91)	2.50 (1.73)	2.17 (1.63)	2.78 (1.81)
T_{10}	3.00 (1.87)	2.67 (1.78)	3.33 (1.96)	3.00 (1.87)	2.67 (1.78)	2.33 (1.68)	2.83 (1.78)	3.33 (1.96)	3.00 (1.87)	3.67 (2.04)	2.67 (1.78)	3.00 (1.87)	2.67 (1.78)	3.06 (1.88)	3.17 (1.91)	2.83 (1.83)	3.50 (2.00)	2.83 (1.83)	2.83 (1.83)	2.50 (1.73)	2.94 (1.85)
T_{11}	2.67 (1.78)	2.33 (1.68)	2.67 (1.78)	2.33 (1.68)	2.00 (1.58)	1.67 (1.47)	2.28 (1.66)	3.00 (1.87)	2.67 (1.78)	2.67 (1.78)	2.67 (1.78)	2.33 (1.68)	2.00 (1.58)	2.56 (1.75)	2.83 (1.83)	2.50 (1.73)	2.67 (1.78)	2.50 (1.73)	2.17 (1.63)	1.83 (1.53)	2.42 (1.70)
T_{12}	3.33 (1.96)	3.00 (1.87)	3.33 (1.96)	2.33 (1.68)	2.33 (1.68)	2.00 (1.58)	2.72 (1.79)	3.67 (2.04)	3.33 (1.96)	3.33 (1.96)	2.67 (1.78)	2.67 (1.78)	2.33 (1.68)	3.00 (1.87)	3.50 (2.00)	3.17 (1.91)	3.33 (1.96)	2.50 (1.73)	2.50 (1.73)	2.17 (1.63)	2.86 (1.83)
T_{13}	3.67 (2.04)	2.67 (1.78)	3.00 (1.87)	2.67 (1.78)	2.00 (1.58)	2.00 (1.58)	2.67 (1.77)	4.00 (2.12)	3.00 (1.87)	3.33 (1.96)	2.67 (1.78)	2.33 (1.68)	2.33 (1.68)	2.94 (1.85)	3.83 (2.08)	2.83 (1.83)	3.17 (1.91)	2.67 (1.78)	2.17 (1.63)	2.17 (1.63)	2.81 (1.81)
T_{14}	3.00 (1.87)	2.33 (1.68)	2.67 (1.78)	2.00 (1.58)	1.67 (1.47)	1.33 (1.35)	2.17 (1.62)	3.33 (1.96)	2.67 (1.78)	3.00 (1.87)	2.33 (1.68)	2.00 (1.58)	1.67 (1.47)	2.50 (1.72)	3.17 (1.91)	2.50 (1.73)	2.83 (1.83)	2.17 (1.63)	1.83 (1.53)	1.50 (1.41)	2.33 (1.67)
T_{15}	5.67 (2.48)	5.00 (2.35)	6.33 (2.61)	6.67 (2.68)	5.67 (2.48)	2.67 (1.78)	5.33 (2.40)	6.00 (2.55)	5.67 (2.48)	7.00 (2.74)	7.00 (2.74)	6.00 (2.55)	3.00 (1.87)	5.78 (2.49)	5.83 (2.52)	5.33 (2.42)	6.67 (2.68)	6.83 (2.71)	5.83 (2.52)	2.83 (1.83)	5.56 (2.44)

Figures in parentheses are transformed as square root (x+0.5).

	2004	2005	Pooled
Difference between treatments CD (p=0.05)	0.122	0.135	0.109
Difference between Dates of observation CD (p=0.05)	0.077	0.085	0.069
Interaction between treatments and dates of observations CD (p=0.05)	0.300	0.330	0.266

Seed damage (%) by gram pod borer

The data recorded on the per cent seed damage by gram caterpillar (*H. armigera*) in short duration pigeonpea during 2004 and 2005 are shown in Table 4. The performance of different biopesticides in reducing seed damage was found to be in order of T_6 (two sprays of NSKE) > T_{14} (one spray of NSKE and one spray of endosulfan) > T_8 (two sprays of endosulfan) > T_5 (one spray of NSKE) > T_2 (two sprays of B.t.) > T_{11} (one spray of B.t. and one spray of endosulfan) > T_7 (one spray of endosulfan) > T_{10} (one spray of B.t. and one spray of NSKE) = T_{12} (one spray of Nimbecidine and one spray of NSKE) > T_{13} (one spray of Nimbecidine and one spray of endosulfan) > T_4 (two sprays of Nimbecidine) > T_1 (one spray of B.t.) > T_9 (one spray of B.t. and one spray of Nimbecidine) > T_3 (one spray of Nimbecidine) >T_{15} (control) in 2004. The treatment T_6 (two sprays of NSKE) was best in performance while T_{15} (control) was least. The treatments T_6 (two sprays of NSKE) and T_{14} (one spray of NSKE and one spray of endosulfan); T_1 (one spray of B.t.), T_9 (one spray of B.t. and one spray of Nimbecidine) and T_3 (one spray of Nimbecidine); and T_{14} (one spray of NSKE and one spray of endosulfan), T_8 (two sprays of endosulfan), T_5 (one spray of NSKE), T_2 (two sprays of B.t.) and T_{11} (one spray of B.t. and one spray of endosulfan) were statistically at par with each other with in their groups in reducing the seed damage by gram caterpillar. In 2005, the treatment T_6 (two sprays of NSKE) performed very well in reducing seed damage (%) while treatment T_{15} (control) did not perform well. The treatments T_6 (two sprays of NSKE), T_8 (two sprays of endosulfan) and T_{14} (one spray of NSKE and one spray of endosulfan); T_8 (two sprays of endosulfan), T_{14} (one spray of NSKE and one spray of endosulfan), T_{11} (one spray of B.t. and one spray of endosulfan), T_5 (one spray of NSKE), T_2 (two sprays of B.t.) and T_7 (one spray of endosulfan); T_{11} (one spray of B.t. and one spray of endosulfan), T_5 (one spray of NSKE), T_2 (two sprays of B.t.), T_7 (one spray of endosulfan), T_{12} (one spray of Nimbecidine and one spray of NSKE), T_{13} (one spray of Nimbecidine and one spray of endosulfan) and T_{10} (one spray of B.t. and one spray of NSKE) and T_{10} (one spray of B.t. and one spray of NSKE), T_4 (two sprays of Nimbecidine), T_1 (one spray of B.t.), T_3 (one spray of Nimbecidine) and T_9 (one spray of B.t. and one spray of Nimbecidine) were found to be statistically similar with each other with in their group in their performance in reducing seed damage by gram caterpillar.

In pooled analysis it was found that as in two years of study, the treatment T_6 (two sprays of NSKE) performed best in reducing seed damage while T_{15} (control) was least in performance. The treatments T_6 (two sprays of NSKE) and T_{14} (one spray of NSKE and one spray of endosulfan); T_4 (two sprays of Nimbecidine), T_1 (one spray of B.t.) and T_9 (one spray of B.t. and one spray of Nimbecidine); T_1 (one spray of B.t.), T_9 (one spray of B.t. and one spray of Nimbecidine) and T_3 (one spray of Nimbecidine) and T_{14} (one spray of NSKE and one spray of endosulfan), T_8 (two sprays of endosulfan), T_5 (one spray of NSKE) and T_{11} (one spray of B.t. and one spray of endosulfan) were found to be at par with each other with in their groups in reducing seed damage by gram caterpillar.

Neem seed extract alone or in combination with endosulfan and NPV has been found to be very effective insecticide insecticide against podfly and pod borers on pigeonpea by Sachan and Lal (1993) [8] and Sarode *et al*., (1997) [12]. Superiority of endosulfan in controlling the podfly and pod borer complex with significant reduction in extent of pod and seed damage has been reported by Sahoo and Senapathi (2000b) [11]. The present finding are in agreement with those of Reddy *et al*., (2001) who found that three sprays at flower initiation, 50% flowering and 50% pod filling stages were effective against pod borer complex. Similarly in the same study two spray treatment (at 50% flowering + 50% pod filling stage) was sound equally effective.

The results of study conducted by Bhushan and Nath (2005) [1] revealed that grain damage inflicted by pod borer and plume moth was recorded minimum with the application of NSKE followed by Bt and endosulfan. Sinha (1993) [14] repoted that NSKE 5% gave % reduction in infestation of *H. armigera* and was comparable with endosulfan (0.07%) on chickpea. Wanjari *et al*., (1998) [16] reported neem seed extract was effective in reducing larval population of *H. armigera* while Sadawarte and Sorode (1997) [9] observed NSKE alone or in combination of insecticides is most effective for the control of *H. armigera* on pigeonpea. Several scientists also reported effectiveness of Bt against *H. armigera* on pigeonpea (Wanjari *et al* 1998; Mahapatra and Gupta, 1999 and Manjula and Padmavathamma, 1999) [16, 5, 6].

2. Legume pod borer (*Maruca testulalis* Geyer)

The population data pertaining to legume pod borer (*M. Testulalis*) recorded after the application of biopesticides during 2004 and 2005 at weekly interval are presented in Table 3.

In 2004 cropping season, the efficacy of 15 different treatments were in an increasing order of T_{15} (control) < T_3 (one spray of Nimbecidine) < T_1 (one spray of B.t.) < T_7 (one spray of endosulfan) < T_2 (two sprays of B.t.) < T_4 (two sprays of Nimbecidine) < T_{12} (one spray of Nimbecidine and one spray of NSKE) < T_{10} (one spray of B.t. and one spray of NSKE) < T_{13} (one spray of Nimbecidine and one spray of endosulfan) < T_9 (one spray of B.t. and one spray of Nimbecidine) < T_5 (one spray of NSKE) < T_{11} (one spray of B.t. and one spray of endosulfan) < T_8 (two sprays of endosulfan) < T_{14} (one spray of NSKE and one spray of endosulfan) < T_6 (two sprays of NSKE). Among all the treatments, T_6 (two sprays of NSKE) was found to be most effective than all other treatments, while T_{15} (control) was least effective. The treatments T_3, T_1 and T_7; T_1, T_7 and T_2; T_9, T_5, T_{11} and T_8; T_5, T_{11}, T_8, T_{14} and T_6; T_4, T_{12}, T_{10}, T_{13}, T_9 and T_5 were found to be at par among themselves within their respective groups in reducing the population of legume pod borer.

In the year 2005, the bioefficacy of different treatments against legume pod borer was in an increasing order of $T_{15} < T_3 < T_1 < T_7 < T_2 < T_4 < T_{10} < T_9 < T_{12} < T_{13} < T_5 < T_{11} < T_8 < T_{14} < T_6$. Among all the treatments as in 2004, in 2005 also T_6 (two sprays of NSKE) was best in reducing the pest population. The control (T_{15}) treatment had maximum population. The treatments T_3, T_1, T_7 and T_2; T_4, T_{10}, T_9, T_{12}, T_{13} and T_5; T_{10}, T_9, T_{12}, T_{13}, T_5 and T_{11}; T_9, T_{12}, T_{13}, T_5, T_{11} and T_8 and T_{13}, T_5, T_{11}, T_8, T_{14} and T_6 were found to be at par among themselves within their respective groups in reducing the population.

The population data of legume pod borer recorded in 2004 and 2005 were pooled and The bioefficacy of different treatments was in an ascending order of $T_{15} < T_3 < T_1 < T_7 < T_2 < T_4 < T_{10} < T_{12} < T_9 < T_{13} < T_5 < T_{11} < T_8 < T_{14} < T_6$. As in 2004 and 2005, the T_6 (two sprays of NSKE) was highly effective and T_{15} (control) was least effective against legume pod borer. Among all the treatments tested, T_3, T_1 and T_7; T_1, T_7 and T_2; T_4, T_{10}, T_{12}, T_9 and T_{13}; T_{12}, T_9, T_{13} and T_5 and T_5, T_{11}, T_8, T_{14} and T_6 were found to be at par among themselves within their respective groups.

Chaudhary and Sachan (1995) [2] reported that endosulfan spray applied at the reproductive stage of crop effectively reduced pod damage by pod borers giving a significant increase in yield. Sontakke and Mishra (1992) [15] reported that endosulfan was effective aginst pod borer complex and had highest cost benefit ratio in pigeonpea. Kumar *et al*., (2004) [4] found that Dipel (Bt sub sp kurstaki) @ 0.1% lit/ha + monocrotophos 40EC @ 0.04% and monocrotophos 40EC @0.01% showed the highest efficacy in controlling pod borer complex in pigeonpea. Neem has wide range of biological activity (Schmcitter, 1987) [13] that includes delay in development of immature stages, reduced feeding, disturbance in post embryonic development, high mortality between moults, moults failure and sterility.

Table 4: Effect of biopesticides on the pod damage by gram caterpillar, *Helicoverpa armigera* in short duration pigeonpea during 2004 and 2005

Treatment	Pod damage (%)		
	2004	2005	Pooled
T_1 (Bt)	7.67(16.07)	8.67(17.12)	8.17(16.60)
T_2 (Bt+Bt)	6.33(14.53)	7.00(15.32)	6.67(14.93)
T_3 (Nimbicidine)	10.67(19.06)	11.00(19.36)	10.83(19.22)
T_4 imbicidine + Nimbicidine)	7.67(16.07)	7.67(16.07)	7.67(16.07)
T_5 (NSKE)	5.6713.76)	5.67(13.76)	5.67(13.77)
T_6 (NSKE+NSKE)	3.67(11.02)	4.33(12.00)	4.00(11.52)
T_7 (Endosulfan)	6.33(14.57)	6.67(14.95)	6.50(14.76)
T_8 (Endosulfan+Endosulfan)	5.67(13.73)	5.67(13.73)	5.67(13.73)
T_9 (Bt + nimbicidine)	9.33(17.78)	9.00(17.44)	9.17(17.61)
T_{10} (Bt+NSKE)	6.00(14.15)	7.00(15.34)	6.50(14.76)
T_{11} (Bt+endosulfan)	6.67(14.95)	7.00(15.32)	6.83(15.14)
T_{12}(Nimbicidine+NSKE)	6.33(14.53)	6.67(14.93)	6.50(14.74)
T_{13} (Nimbicidine+endosulfan)	7.00(15.32)	7.67(16.07)	7.33(15.70)
T_{14}(NSKE+endosulfan)	4.67(12.46)	5.33(13.34)	5.00(12.91)
T_{15} (Control)	18.33(25.34)	20.00(26.56)	19.17(25.96)
Mean	7.47(15.56)	7.96(16.09)	7.71(15.83)
Difference between biopesticides CD (P=0.05)	1.50	1.53	1.35

Figures in parentheses are arc sin transformed values

The effect of eco-friendly bio-pesticides (botanical and microbial) on the grain yield of short duration pigeonpea during 2004 and 2005

The data recorded on the effect of biopesticides on grain yield of short duration pigeonpea in 2004 and 2005 was presented in Table 6. It is evident from the table that the yields obtained from different biopesticides treated plots were found to be superior over the yield of control plot during both years.

The relative performance of these biopesticidal treatments on the basis of yield obtained during 2004 was in order of control (T_{15}) < T_1 (B.t. one spray) < T_2 (B.t. two sprays) < T_3 (Nimbecidine one spray) < T_4 (Nimbecidine two sprays) < T_7 (endosulfan one spray) < T_9 (B.t. as first spray and Nimbecidine as second spray) < T_5 (NSKE one spray) < T_{10} (B.t. first spray and NSKE as second spray) < T_{11} (B.t. as first spray and endosulfan as second spray) < T_{13} (Nimbecidine as first spray and endosulfan as second spray) < T_8 (endosulfan two sprays) < T_{12} (Nimbecidine as one spray and NSKE as second spray) < T_6 (NSKE two sprays) < T_{14} (NSKE as first spray and endosulfan as second spray). The treatments T_3 (Nimbecidine one spray), T_4 (Nimbecidine two sprays) and T_7 (endosulfan one spray); T_4 (Nimbecidine two sprays), T_7 (endosulfan one spray) and T_9 (B.t. as first spray and Nimbecidine as second spray); T_{10} (B.t. first spray and NSKE as second spray), T_{11} (B.t. as first spray and endosulfan as second spray) and T_{13} (Nimbecidine as first spray and endosulfan as second spray); T_8 (endosulfan two sprays), T_{12} (Nimbecidine as one spray and NSKE as second spray), T_6 (NSKE two sprays) and T_{14} (NSKE as first spray and endosulfan as second spray) were significantly at par with each other with in their groups in influencing the grain yield of pigeonpea. In 2005 also almost the same trend as in 2004 was observed regarding the effect of biopesticides on grain yield of pigeonpea. The grain yield was more in T_6 (NSKE two sprays) and least in control (T_{15}) treatment plots. The treatments T_3 (Nimbecidine one spray), T_7 (endosulfan one spray) and T_4 (Nimbecidine two sprays); T_7 (endosulfan one spray), T_4 (Nimbecidine two sprays), T_9 (B.t. as first spray and Nimbecidine as second spray), T_5 (NSKE one spray) and T_{10} (B.t. first spray and NSKE as second spray) and T_{13} (Nimbecidine as first spray and endosulfan as second spray), T_8 (endosulfan two sprays), T_{14} (NSKE as first spray and endosulfan as second spray), T_{12} (Nimbecidine as one spray and NSKE as second spray) and T_6 (NSKE two sprays) were found to be significantly similar with each other with in their groups in affecting the grain yield of pigeonpea.

The pooled yield data of both the years showed that relative performance of these biopesticides in increasing the yield of short duration pigeonpea were found to be in order of control (T_{15}) < T_1 (B.t. one spray) < T_2 (B.t. two sprays) < T_3 (Nimbecidine one spray) < T_4 (Nimbecidine two sprays) < T_7 (endosulfan one spray) < T_9 (B.t. as first spray and Nimbecidine as second spray) < T_5 (NSKE one spray) < T_{10} (B.t. first spray and NSKE as second spray) < T_{11} (B.t. as first spray and endosulfan as second spray) < T_{13} (Nimbecidine as first spray and endosulfan as second spray) < T_8 (endosulfan two sprays) < T_{12} (Nimbecidine as one spray and NSKE as second spray) < T_6 (NSKE two sprays) < T_{14} (NSKE as first spray and endosulfan as second spray). The treatments T_3 (Nimbecidine one spray), T_4 (Nimbecidine two sprays) and T_7 (endosulfan one spray); T_4 (Nimbecidine two sprays), T_7 (endosulfan one spray) T_9 (B.t. as first spray and Nimbecidine as second spray) and T_5 (NSKE one spray); T_9 (B.t. as first spray and Nimbecidine as second spray), T_5 (NSKE one spray), T_{11} (B.t. as first spray and endosulfan as second spray) and T_{10} (B.t. first spray and NSKE as second spray); T_{13} (Nimbecidine as first spray and endosulfan as second spray), T_8 (endosulfan two sprays), T_{12} (Nimbecidine as one spray and NSKE as second spray), T_6 (NSKE two sprays) and T_{14} (NSKE as first spray and endosulfan as second spray) were found to be at par with each other with in their groups in affecting grain yield of short duration pigeonpea.

Table 5: Effect of biopesticides on the seed damage by gram caterpillar, *Helicoverpa armigera* in short duration pigeonpea during 2004 and 2005

Treatment	Seed damage (%)		
	2004	2005	Pooled
T_1 (Bt)	5.33(13.30)	5.67(13.76)	5.50(13.55)
T_2 (Bt+Bt)	4.00(11.48)	4.33(12.00)	4.17(11.75)
T_3 (Nimbicidine)	6.33(14.57)	6.33(14.57)	6.33(14.57)
T_4 (Nimbicidine+Nimbicidine)	5.00(12.88)	5.33(13.27)	5.17(13.08)
T_5 (NSKE)	3.67(11.02)	4.00(11.54)	3.83(11.29)
T_6 (NSKE+NSKE)	2.33(8.74)	2.67(9.36)	2.50(9.07)
T_7 (Endosulfan)	4.33(12.00)	4.33(12.00)	4.33(12.01)
T_8 (Endosulfan+Endosulfan)	3.33(10.50)	3.33(10.50)	3.33(10.50)
T_9 (Bt + nimbicidine)	5.67(13.76)	6.33(14.57)	6.00(14.18)
T_{10} (Bt+NSKE)	4.33(12.00)	5.00(12.88)	4.67(12.45)
T_{11} (Bt+endosulfan)	4.00(11.54)	4.00(11.48)	4.00(11.52)
T_{12}(Nimbicidine+NSKE)	4.33(12.00)	4.67(12.46)	4.50(12.24)
T_{13} (Nimbicidine+endosulfan)	4.67(12.42)	4.67(12.46)	4.67(12.45)
T_{14}(NSKE+endosulfan)	3.00(9.97)	3.33(10.50)	3.17(10.24)
T_{15} (Control)	10.33(18.75)	11.67(19.95)	11.00(19.37)
Mean	4.71(12.33)	5.04(12.75)	4.88(12.55)
Difference between biopesticides CD(P=0.05)	1.70	1.76	1.41

Figures in parentheses are arc sin transformed values

Table 6: Effect of bio-pesticides the grain yield of short duration pigeonpea grown during 2004 and 2005

Treatment	Grain yield (q ha^{-1})		
	2004	2005	Average
T_1 (one spray of B. t.)	14.85	14.82	14.84
T_2 (two sprays of B. t.)	15.38	15.38	15.38
T_3 (one spray of nimbicidine)	15.77	15.69	15.73
T_4 (two sprays of nimbicidine)	15.90	15.92	15.91
T_5 (one spray of NSKE)	16.20	16.14	16.17
T_6 (two sprays of NSKE)	16.71	16.66	16.69
T_7 (one sprays of endosulfan)	15.96	15.91	15.94
T_8 (two sprays of endosulfan)	16.56	16.49	16.53
T_9 (one spray of B. t. + one spray of nimbicidine)	16.13	16.12	16.13
T_{10} (one spray of B. t. and one spray of NSKE)	16.25	16.15	16.20
T_{11} (one spray of B. t. + one one spray of endosulfan)	16.29	16.31	16.30
T_{12} (one spray of B. t. and one spray of NSKE)	16.66	16.61	16.64
T_{13} (one spray of nimbicidine and one spray of endosulfan)	16.50	16.45	16.47
T_{14} (one spray of NSKE and one spray of endosulfan)	16.83	16.58	16.70
T_{15} (no control)	8.69	8.72	8.71
Difference between treatments CD (p=0.05)	0.30	0.30	0.29

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