MANAGEMENT OF POD BUGS IN COWPEA *(Vigna unguiculata L.)*
WITH ECO-FRIENDLY AGENTS

ABSTRACT

Field investigation on the management of pod bugs in cowpea (*Vigna unguiculata L.*) with eco-friendly strategies was carried out during autumn 2018 at dry land farm, S.V. Agricultural College, Tirupati. The results revealed that NSKE @ 5% was found to be the most effective in reducing pod bugs population with highest mean per cent reduction over the control ?, lowest per cent pod damge (39.57 %), seed damage (27.33%), highest hundred grain weight (12.0gm) and the highest grain yield (933 kg ha^{-1}). It was followed by spinosad @ 0.2 ml/l and neem oil @ 0.5 per cent. It would be suggest NSKE @ 5% as distinctive and safe agent for the management of pod bugs in cowpea.

Key words: Pod bugs, Management and Cowpea, safe control agents

INTRODUCTION

Cowpea (*Vigna unguiculata* L.) is one of the most important pulse crops, native to central Africa, belongs to family Fabaceae. Cowpea is called as vegetable meat due to high amount of protein in grain with better biological value on dry weight basis. In recent years pod bugs are a real threat to quality grain production in cowpea. Among the Pod bugs, *Riptortus pedestris* (Fabricius) (Heteroptera: Coreidae), and *Clavigralla gibbosa* Spinola (Hemiptera: Coreidae) are the most destructive pests to leguminous crops. There are represent a dangerous pests of desap tender shoots and pods of cowpea leads to the damage of pods and seeds up-to 60 to 70 percent (Krishna *et al*., 2005). Damaged seeds further do not germinate and are not acceptable for human consumption (Shanower *et al*., 1999).

The chemical insecticides have found to be effective in controlling the pod pest complex. But the indiscriminate use of chemicals lead to the problems like pest outbreak, development of insecticide resistance by pests, elimination of natural enemies and risk to human and animal health besides environmental pollution. So, now it is urgent to think of safe strategies which are eco-friendly and environmentally safe to manage the pests efficiently. For this, the present study was undertaken to evaluate the efficacy of eco- friendly agents against pod bugs in cowpea ecosystem.

MATERIAL AND METHODS

Field trial was conducted with popular cowpea variety (TPTC-29) during autumn 2017-2018 at Dryland farm, S.V. Agricultural College, Tirupati to evaluate the efficacy of the eco–friendly compounds against pod bugs (Fig. 1.). The experiment was placed in a randomized block design with eight treatments viz T1: NSKE 5 % , T2 : Neem oil 0.5 % , T3 : *Beauveria bassiana* 1.0 g/l, T4 : *Metarhizium anisopliae* 1.0 g/l, T5 : Novaluron 1.0 ml/l, T6 : Spinosad 45 SC 0.2 ml/l, T7 : Emamectin benzoate and T8 : control (water spray only). The size of the individual plot was 5 m ×

4 m with spacing of 45 cm between the rows and 10 cm between the plants. All the recommended package of practices was adopted in managing the crop to maintain a good crop stand.

Fig.1. Field view of experiment on management of pod bugs in cowpea with eco-friendly methods.

Tested compounds were applied twice, one at flowering (55DAS) and another at poding stage (70DAS) using battery operated knapsack sprayer. Spraying was done during morning hours with care to prevent the drift of the spray fluid reaching the adjacent plots by keeping a screen in between the plots. Pest population was recoreded by observing five randomly selected plants from each treatment at one day prior to insecticide application and one, three, five and seven days after each application. Percent reduction of pod bugs in treatment over control plots was estimated by using the following formula supported by Abbot (1925).

Population reduction over control (%)

$$= \frac{\text{Population in untreated check - Population in treatment}}{\text{Population in untreated check}} \times 100$$

Pod damage

The per cent of pod damage was recorded on five randomly selected plants in each treatment. Pods which are shrunken, deformed and shrivelled were considered as damged pods. The pod damage per cent was calculated by using the following formula.

$$\text{Per cent pod damage} = \frac{\text{Number of damaged pods}}{\text{Total no. of pods}} \text{x}100$$

Seed damage

The pods harvested from five randomly selected plants in each treatment were dehusked and the obtained seeds were segregated into healthy and damaged seeds. Seeds which were shrivelled, shrunken and malformed were considered as damaged seeds. The per cent seed damage was estimated based on number of seeds damaged by pod bugs in a pod by using the formula.

$$\text{Per cent seed damage} = \frac{\text{Number of damaged seeds}}{\text{Total no. of seeds per pod}} \text{x}100$$

Weight of 100 grains which collected randomly from each treatment was recorded. The data on grain yield was recorded from the net plot of each treatment separately and converted to per hectare for statistical analysis.The documented data was transformed into necessary transformation and subjected to ANOVA and DMRT analysis for evaluating the relative efficacy of different treatments over the control.

RESULTS AND DISCUSSION

Riptortus pedestris

First spray:

The pre-treatment count at one day before spraying showed that, the mean number of nymphs and adults per plant of *R. pedestris* on cowpea in all the experimental plots ranged from 5.67 to 8.00 bugs per plant which was more or less uniform.

As shown in Table 1., after one day of spraying, the highest reduction per cent was recorded by NSKE @ 5 per cent (59.72%) followed by spinosad @ 0.2 ml/L (48.52%), neem oil @ 0.5 per cent (40.28%), *Metarhizium anisopliae* @ 1.0 g/l (30.16%), novaluron @ 1.0 ml/l (29.44%), emamectin benzoate @ 0.2g/l (21.56%) and *Beauveria bassiana* @ 1.0 g/l (20.44%). While, after three days of spraying the highest reduction per cent was achieved by NSKE @ 5 per cent (75.20%) followed by spinosad 45SC @ 0.2 ml/l (56.67%), neem oil @ 0.5 per cent (50.00%), *Metarhizium anisopliae* @ 1.0 g/l (45.62%), *novaluron* @1.0ml/l (38.61%), *Beauveria bassiana* @ 1.0 g/l (35.56 %) and *emamectin benzoate* @ 0.2 g/l (25.26%). At the fifth day of application, the highest per cent of reduction was exhibited by NSKE @ 5 per cent (65.4%) followed by spinosad @ 0.2 ml/l (55.17 %), neem oil @ 0.5 per cent (46.75%), *Metarhizium anisopliae* @1.0 g/l (39.03 %), novaluron @ 1.0 ml/l (30.83%), *Beauveria bassiana* @ 1.0 g/l (29.31%) and emamectin benzoate @ 0.2 g/l (21.52 %) . whereas, after seven days of spraying the highest reduction per cent was recorded by NSKE @ 5 per cent (79.50%) followed by spinosad @ 0.2 ml/l (67.78%), neem oil @ 0.5% (54.67%), *Metarhizium anisopliae* @ 1.0 g/l (44.00%), *Beauveria bassiana* @ 1.0 g/l (35.11%), novaluron @1.0 ml/l (30.33%) and emamectin benzoate @ 0.2 g/l (23.52%).

Generally when the overall efficacy of first spray against *R. pedestris* was considered, NSKE @ 5 per cent was found to be the best treatment by recording the highest mean reduction per cent over control (69.97%) followed by spinosad @ 0.2 ml/l (57.03%) and neem oil @ 0.5 per cent (47.92 %). The next treatments in the descending order of efficacy were *Metarhizium anisopliae* @ 1.0 g/l (39.70%), novaluron @ 1.0 ml/l (32.31%) *Beauveria bassiana* @ 1.0 g/l (30.11%) and emamectin benzoate @ 0.2 g/l (22.97%).

Second spray

The pre treatment count at one day before spraying showed that the mean number of nymphs and adults per plant of *R. pedestris* (Fig. 2.) on cowpea in all the experimental plots ranged from to 8.67 to 10.00 bugs per plant which was more or less uniform.

At the first day of spraying, the highest per cent of reduction over control was recorded by NSKE @ 5 per cent (61.31%), followed by spinosad @ 0.2ml/L (48.15%), neem oil @ 0.5 per cent (40.65%), *Metarhizium anisopliae* @ 1.0 g/l (32.50%), *Beauveria bassiana* @ 1.0 g/l (26.15%), novaluron @ 1.0 ml/l (24.00%) and emamectin benzoate @ 0.2 g/l (18.10%) (Table 1). After three, 5 and 7 days of application almost all same line of trend in mean reduction per cent was observed. The order of effectiveness of these treatments was NSKE @ 5 per cent > spinosad @ 0.2 ml/l > neem oil @ 0.5 per cent > *Metarhizium anisopliae* @ 1.0 g/l > novaluron @ 1.0 ml/l > *Beauveria bassiana* @ 1.0 g/l > emamectin benzoate @ 0.2 g/l.

These results can be summarized that efficacy of the second spray against *R. pedestris* was considered, NSKE @ 5 per cent was found to be the best treatment by recording the highest mean per cent reduction over control (64.17%) followed by spinosad @ 0.2 ml/l (54.54 %) and neem oil @ 0.5 per cent (47.29%). The next treatments in the descending order of efficacy were *Metarhizium anisopliae* @1.0 g/l (36.91%), novaluron @1.0 ml/l (29.17%) *Beauveria bassiana* @ 1.0 g/l (29.63%) and emamectin benzoate @ 0.2 g/l (21.86%).

Nymph **Adult**

Fig.2. ***Riptortus pedestris***

Clavigralla gibbosa

First spray:

The pre-treatment count at one day before spraying showed that the mean number of bugs/plant (*Clavigralla gibbosa*) (Fig. 3.) on cowpea in all the experimental plots were ranged from 7.67 to10.50 bugs per plant which was more or less uniform.

After one day of spraying the highest per cent of reduction was achieved by NSKE @ 5 per cent (53.33%) followed by spinosad @ 0.2 ml/l (43.39%), neem oil @ 0.5 per cent (38.43%), novaluron @ 1.0 ml/l (30.83%), *Metarhizium anisopliae* @ 1.0 g/l (29.44%), emamectin benzoate @ 0.2 g/l (21.56%) and *Beauveria bassiana* 1.0 g/l (20.44%) (Table 2). After three, five and seven days of spraying almost all same line of trend in mean per cent reduction over control was observed. The order of effectiveness of these treatments was NSKE @ 5 per cent > spinosad @ 0.2 ml/l > neem oil @ 0.5 per cent > *Metarhizium anisopliae* @ 1.0 g/l > novaluron @ 1.0 ml/l > *Beauveria bassiana* @ 1.0 g/l > emamectin benzoate @ 0.2 g/l.

When the overall efficacy of first spray against *C. gibbosa* was considered, NSKE @ 5 per cent was found to be the best treatment by recording the highest mean per cent reduction over control (69.79 %) followed by spinosad @ 0.2 ml/l (60.85%) and neem oil @ 0.5 per cent (51.85%). The next treatments in the descending order of efficacy were *Metarhizium anisopliae* @ 1.0 g/l (41.39%), novaluron @1.0 ml/l (40.21%) *Beauveria bassiana* @ 1.0 g/l (34.72%) and emamectin benzoate @ 0.2 g/l (24.19%).

Second spray:

The pre treatment count at one day before application showed that the experimental plots ranged from 8.00 to 10.7 bugs per plant which was more or less uniform.

As illustrated in Table 2., after one day of the experiment the highest per cent of reduction was showed by NSKE @ 5 per cent (54.23 %), followed by spinosad @ 0.2ml/L (44.81 %), neem oil @ 0.5 per cent (35.83%), *Metarhizium anisopliae* @ 1.0 g/l (33.97%), novaluron @ 1.0 ml/l (24.00%) *Beauveria bassiana* @ 1.0 g/l (26.15%), and emamectin benzoate @ 0.2 g/l (18.10%) (Table 2). After 3, 5 and 7 days of spraying almost all same line of trend in mean reduction per cent was determined. The order of effectiveness of these treatments was NSKE @ 5 per cent > spinosad @ 0.2 ml/L > neem oil @ 0.5 per cent > *Metarhizium anisopliae* @ 1.0 g/l > novaluron @ 1.0 ml/l > *Beauveria bassiana* @ 1.0 g/l (26.00%) > emamectin benzoate @ 0.2 g/L (18.67%).

Generally, when the overall efficacy of second spray against *C. gibbosa* was considered, NSKE @ 5 per cent was found to be the best treatment by recording the highest mean per cent reduction over control (67.38%) followed by spinosad @ 0.2 ml/l (57.27%) and neem oil @ 0.5 per cent (47.92%). The next treatments in the descending order of efficacy were *Metarhizium anisopliae* @ 1.0 g/l (41.24%), novaluron @1.0 ml/l (37.68%), *Beauveria bassiana* @ 1.0 g/l (27.20%) and emamectin benzoate @ 0.2 g/l (21.85%). The present findings are conformity with

Srinivas (2010) reported that the highest per cent reduction (66.1 %) in population bugs over control was observed in NSKE 5% this may be due to affect egg laying and egg hatching influencing the production percentage of young one. The ovipositional deterrency might be mainly due to the strong odour of the products and ovicidal activity due to interference with the embryonic development within the egg (Venugopala Rao *et al.*, 2005).

Nymph **Adult**

Fig 3. *Clavigralla gibbosa*

Yield parameters:

Pod damage:

The per cent pod damage inflicted by pod bugs on cowpea in experimental plots during *kharif* 2018 ranged from 39.57 to 83.33 per cent. The least per cent pod damage was recorded due to NSKE @ 5 per cent (39.57%) followed by spinosad @ 0.2 ml/l (47.49%), neem oil @ 0.5 per cent (49.14%), *Metarhizium anisopliae* @ 1.0 g/l (50.45%), novaluron @ 1.0 ml/l (51.00%), *Beauveria bassiana* @ 1.0 g/l (53.45%) and emamectin benzoate @ 0.2 g/l (58.73%). The untreated control recorded the highest per cent pod damage (83.33%) (Table 3).

Seed damage:

The per cent seed damage inflicted by pod bugs on cowpea in experimental plots during *kharif* 2018 ranged from 27.33 to 63.28 per cent. The lowest per cent seed damage was recorded in NSKE @ 5 percent (27.33 %), followed by spinosad @ 0.2ml/l (29.81 %), neem oil @ 0.5 per cent (37.56%), *Metarhizium anisopliae* @ 1.0g/l (37.89 %), novaluron @ 1.0 ml/l (44.65%), *Beauveria bassiana* @ 1.0 g/l (48.77 %) and emamectin benzoate @ 0.2 g/l (48.93 %). The untreated control recorded the highest per cent seed damage (63.28%) (Table 3). The present findings similar with Nara

100 grain weight:

The present study revealed that, all the treatments recorded higher 100 grain weight, compared to untreated control. The treatment NSKE @ 5 per cent recorded the maximum 100 grain weight 12 g, followed by spinosad @ 0.2 ml/l (11.00g), neem oil @ 0.5 per cent (8.60g), *Metarhizium anisopliae* @ 1.0g/l (7.60 g), novaluron @ 1.0 ml/l (7.40 g), *Beauveria bassiana* @ 1.0 g/l (7.10g), emamectin benzoate @ 0.2 g/l (7.06 g) and untreated control (7.00 g) (Table 3).

Grain yield:

The data revealed that all the treatments had higher grain yield, compared to untreated check.The treatment NSKE @ 5 per cent recorded the maximum yield of 933.33 kg ha^{-1}, followed by spinosad @ 0.2 ml/l (850 kg ha^{-1}), neem oil @ 0.5 per cent (736.66 kg ha^{-1}), *Metarhizium anisopliae* @ 1.0 g/l (680kg ha^{-1}), novaluron @ 1.0 ml/l (670 kg ha^{-1}), *Beauveria bassiana* @ 1.0 g/l (590 kg ha-^{1}) and emamectin benzoate @ 0.2 g/l (546.6 kg ha $^{-1}$) while untreated check recorded yield of 523.3 kg ha $^{-1}$ (Table 3).

Similar results were reported by Singh and Nath (2011) who reported that eco- friendly bio pesticides *viz.,* (NSKE 5%, *Bt* and nimbicidine) had significant influence on the reduction of grain weight loss by pod bugs. The average grain weight loss was minimum in the plots treated with two sprays of NSKE @ 5 per cent as compared with untreated control, which exhibited the maximum grain weight loss during both the years. And also agreement with Kalyan *et al*. (2017) also reported NSKE 5% has higher per cent reduction in population of sucking pests compare to entomopathogenic fungi in cotton. Similarly, Vinodhini and Malaikozhundan (2010) found neem seed kernel extract (5%) was most effective in reducing the population of sucking pests in cotton. Possession of antifeedant property against sucking pests by neem was proved earlier by (Abudulai *et al*. 2003 and Dutta *et al*. 2013)

In present finding after the NSKE next best treatment is spinosad 45 SC @ 0.2ml/L in terms of pest population in 1, 3, 5, 7 days after spraying and also per cent pod damage, per cent seed damage, 100 grain weight and yield. The present findings conformity with Dahal *et al*. (2020) reported that the highest per cent reduction (53.3%) of pod bugs over the control was observed in spinosad treated plot. The present findings similar with (Narasimha murthy and keval 2013) reported that plot treated with spinosad 45% SC showed minimum (8.30%) pod damageand 2.36% grain damage by pod bug and higher grain yield 1625 kg/ha.

CONCLUSION

The results of the current study revealed that, all tested compounds insecticide were effective in the management of pod bugs in comparison with the untreated control. At seven days of the second spray, the highest reduction per cent of pod bugs was recorded by NSKE @ 5 per cent followed by spinosad @ 0.2 ml/l, neem oil @ 0.5 per cent, *Metarhizium anisopliae* @ 1.0 g/l, novaluron @ 1.0 ml/l, *Beauveria bassiana* @ 1.0 g/l and emamectin benzoate @ 0.2g/l. Whereas, the lowest per cent of pod and seed damage inflicted by pod bugs on cowpea was achieved in the treatment NSKE @ 5 per cent followed by spinosad @ 0.2 ml/l, neem oil @ 0.5 per cent, *Metarhizium anisopliae* @ 1.0 g/l, novaluron @ 1.0 ml/l, *Beauveria bassiana* @ 1.0 g/l and emamectin benzoate @ 0.2g/l. The highest grain yield and 100 grain weight were recorded in the treatment NSKE @ 5 per cent followed by spinosad @ 0.2 ml/l, neem oil @ 0.5 per cent, *Metarrhizium anisopliae* @ 1.0 g/l, novaluron @ 1.0 ml/l, *Beauveria bassiana* @ 1.0 g/l and emamectin benzoate @ 0.2 g/l. Moreover, the treatment with NSKE @ 5 per cent was showed significantly low pod and seed damage by pod bugs and significant high grain yield and 100 grain weight than the other treatments, indicating the superiority of NSKE @ 5 per cent in the control of pod bugs in cowpea.

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Table 1.Efficacy of botanical, microbial and synthetic compounds against *Riptortus pedestris* on cowpea during autumn 2018- first and second spray

S.No.	Treatment	Pre spray count (Mean*)	Per cent reduction over control - 1 st spray				Mean % Reduction	Pre spray count (Mean*)	Percent reduction over control -2nd spray				Mean % Reduction
			1 DAS	3DAS	5DAS	7DAS			1 DAS	3DAS	5DAS	7DAS	
1	NSKE 5%	7.00	59.72 ^{a} (50.66)	75.00^{a} (60.00)	65.4^{a} (54.23)	79.50 ^{a} (63.22)	69.97	8.67	61.31 ^{a} (51.64)	55.71^{a} (48.29)	64.64 ^{a} (53.57)	75.00 ^{a} (60.07)	64.17
2	Neem oil 0.5%	7.33	40.28^{cd} (39.34)	50.00^{ab} (45.00)	46.75^{ac} (43.10)	54.67 ^{c} (47.69)	47.92	8.33	40.65^{bc} (39.60)	40.65^{c} (39.60)	52.67b (46.53)	55.19 ^{bc} (47.99)	47.29
3	*Beauveria bassiana* 1.0 g/l	5.67	20.44 ^{a} (26.71)	35.56^{bc} (36.59)	29.31^{cd} (32.62)	35.11^{cd} (36.30)	30.11	10.00	26.51^{de} (30.81)	26.00^{d} (30.65)	30.67^{cd} (33.62)	35.33^{d} (36.43)	29.63
4	*Metarhizium anisopliae* 1.0 g/l	6.67	30.16^{cd} (33.30)	45.62^{ab} (42.47)	39.03^{bd} (38.58)	44.00^{de} (41.54)	39.70	7.67	32.50^{bc} (34.68)	33.67 ^{c} (35.46)	36.67 ^{c} (37.26)	44.81 ^{bc} (42.01)	36.91
5	Novaluron 1.0 ml/l	8.00	29.44^{cd} (32.83)	38.61^{bc} (38.39)	30.83^{bd} (33.44)	30.33^{ef} (33.34)	32.31	9.33	24.00^{cd} (28.90)	26.00 ^{d} (30.57)	25.00^{cd} (29.94)	41.67 ^{bc} (40.19)	29.17
6	Spinosad 0.2 ml/l	6.67	48.52^{ab} (44.14)	56.67 ^{b} (48.85)	55.17^{ab} (48.00)	67.78^{b} (55.42)	57.03	8.67	48.15 ^{b} (43.94)	47.00 ^{b} (43.28)	58.00^{ab} (49.63)	65.00 ^{ab} (53.79)	54.54
7	Emamectin benzoate 0.2 g/l	8.00	21.56 ^{d} (27.26)	25.26 ^{d} (30.15)	21.52 ^{d} (27.30	23.52^{f} (28.92)	22.97	9.67	18.10 ^{e} (25.11)	18.67 ^{f} (25.57)	21.33^{d} (27.47)	29.33 ^{d} (32.74)	21.86
8	Untreated check	8.00	-					10.00		-	-	-	
	SE(m)		2.51	2.30	0.83	0.82			2.30	1.35	0.94	0.82	
	CD at 5%		7.76	7.08	2.57	2.54			7.08	4.23	2.90	2.54	

* Mean no. of nymphs and adults on five randomly selected plant. DAS- Days after spraying.

Figures in parentheses are angular transformed values. The values followed by same letter did not differ significantly as per DMRT

Table2. Efficacy of botanical, microbial and synthetic compounds against *Clavigralla gibbosa* on cowpea during autumn 2018-first and Second spray

S.No.	Treatment	Pre spray count (Mean*)	Per cent reduction over control -1st spray				Mean % Reduction	Pre spray count (Mean*)	Percent reduction over control - 2nd spray				Mean % Reduction
			1 DAS	3DAS	5DAS	7DAS			1 DAS	3DAS	5DAS	7DAS	
1	NSKE 5%	8.67	53.33^{a} (46.92)	73.33^{a} (58.93)	75.83^{a} (61.27)	76.67^{a} (61.14)	69.79	8.00	54.23^{a} (47.43)	66.87^{a} (54.89)	69.97^{a} (56.99)	78.44^{a} (62.74)	67.38
2	Neem oil 0.5%	8.67	38.43^{bc} (38.28)	50.00^{c} (45.00)	57.41^{ab} (49.31)	61.57^{ab} (51.72)	51.85	9.33	35.83^{c} (36.73)	50.00^{b} (45.00)	49.17^{ab} (44.51)	56.67^{ab} (48.85)	47.92
3	*Beauveria bassiana* 1.0 g/l	9.67	27.41^{c} (31.31)	31.11e (33.90)	44.81^{cd} (42.01)	35.56^{cd} (36.59)	34.72	9.00	19.17^{de} (25.76)	29.07d (32.45)	33.61^{d} (35.41)	26.93^{e} (31.22)	27.20
4	*Metarhizium anisopliae* 1.0 g/l	10.33	29.44^{b} (32.83)	39.33^{d} (38.23)	51.67^{cd} (45.91)	46.11^{bc} (42.75)	41.39	8.67	33.97^{d} (35.60)	39.10^{c} (38.64)	42.43^{ad} (40.65)	49.47^{b} (44.69)	41.24
5	Novaluron 1.0 ml/l	8.67	30.83b (33.66)	38.33^{d} (38.25)	50.00^{cd} (45.00)	41.67^{bc} (40.17)	40.21	9.67	31.11^{de} (33.90)	37.01^{c} (37.42)	37.78^{bc} (37.91)	44.81^{bc} (42.01)	37.68
6	Spinosad 0.2 ml/l	7.67	43.39$_{ab}$ (41.20)	65.08^{b} (53.84)	65.08^{ab} (53.84)	69.84^{b} (56.70)	60.85	9.00	44.81 b (42.01)	59.35^{ab} (50.40)	58.52^{ab} (49.99)	66.39^{a} (54.59)	57.27
7	Emamectin benzoate 0.2 g/l	8.33	16.20^{d} (23.39)	24.07^{e} (29.38)	32.41^{a} (34.55)	24.07^{e} (29.38)	24.19	10.67	12.78^{e} (20.59)	21.83^{d} (27.82)	27.78^{d} (31.68)	25.00^{e} (29.93)	21.85
8	Untreated check	10.50		-	-	-		10.70	-	-	-	-	
	SE(m)		1.49	1.12	2.25	1.95			1.65	2.06	1.54	2.33	
	CD at 5%		4.61	3.46	6.85	6.03			5.11	6.36	4.75	7.18	

*Mean no. of nymphs and adults on five randomly selected plant. DAS- Days after spraying.

Figures in parentheses are angular transformed values. The values followed by same letter did not differ significantly as per DMR

Table 3. Influence of tested compounds on pod damage, seed damage, 100 grain weight and yield of cowpea during autumn 2018

S.No.	Treatment	Dosage	Per cent pod damage	Per cent seed damage	100 grain weight (g)	Yield (kg/ha^{-1})
1	NSKE	5%	39.57^{a} (38.97)	27.33^{a} (31.36)	12.0	933 .3^{d}
2	Neem oil	0.5%	49.14^{ab} (44.51)	37.56^{abc} (37.67)	8.60	736.6^{abc}
3	*Beauveria bassiana*	1.0 g/l	53.45^{ab} (47.05)	48.77^{bc} (44.15)	7.10	590.0^{a}
4	*Metarhizium anisopliae*	1.0 g/l	50.45^{ab} (45.29)	37.89^{abc} (37.94)	7.60	680.5^{ab}
5	Novaluron	1.0 ml/l	51.00^{ab} (45.58)	44.65^{abc} (41.87)	7.40	673.3^{ab}
6	Spinosad	0.2 ml/l	47.49^{ab} (43.55)	29.81^{ab} (33.06)	11.00	850.0^{cd}
7	Emamectin benzoate	0.2 g/l	58.73^{b} (50.24)	48.93^{bc} (44.38)	7.06	546.6^{a}
8	Untreated check	-	83.33^{c} (65.98)	63.28^{c} (52.80)	7.00	523.3^{a}
	SE(m)		3.47	0.98	0.59	188.7
	CD at 5%		10.52	2.82	1.81	61.6

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