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

ABSTRACT

Field investigation on the management of pod bugs in cowpea *(Vigna unguiculata L.)* using eco-friendly insecticides was carried out during the *kharif* season in 2018 at dry land farm, S.V. Agricultural College, Tirupati. The results revealed that neem seed kernel extract, NSKE @ 5 percent was found to be the most effective in reducing pod bugs population with highest mean percent reduction over the control (65.0%), lowest percent pod damage (39.57%), seed damage (27.33%), highest hundred-grain weight (12.0gm) and the highest grain yield (933 kgha^{-1}) followed by spinosad @ 0.2 ml/l and neem oil @ 0.5 percent. Therefore, it might be suggested that NSKE @ 5 percent can be applied for the better management of pod bugs in cowpea.

Keywords: *Pod bugs, Population, Eco-friendly, Management, and Cowpea*

INTRODUCTION

Cowpea (*Vigna unguiculata* L.) is one of the most important pulse crops which native to central Africa, and belongs to the family Fabaceae.[24-25] Cowpea is called as vegetable meat due to the high amount of protein in grain with better biological value on a dry weight basis. In recent years pod bugs have been a real threat to quality grain production in cowpeas. Among the Pod bugs, *Riptortus pedestris* (Fabricius) (Heteroptera: Coreidae), and *Clavigralla gibbosa* Spinola (Hemiptera: Coreidae) are the most destructive pests to leguminous crops, desap tender shoots and pods of cowpea leads to damage to pods and seeds up to 60 to 70 percent (Krishna *et al*., 2005). Damaged seeds usually do not germinate and are not acceptable for human consumption (Shanower *et al*., 1999).

Chemical insecticides have been found to be effective in controlling the pod and pest complex. However, indiscriminate use of chemicals leads to problems like pest outbreak, development of insecticide resistance by pests, elimination of natural enemies including predator (Mollah *et al*., 2012) and parasitoids (Mollah and Khatun, 2023) and risk to human and animal health besides environmental pollution. So, now it is high time to think of strategies that are eco-friendly and environmentally safe to manage the pests efficiently. Some eco-friendly insecticides have already been found effective against brinjal shoot and fruit borer, *Leucinodes orbonalis* G.(Mollah *et al*., 2023; Mollah *et al*., 2022a). Some non-toxic entomopathogenic bacterial metabolites were also found effective against the diamondback moth, *Plutella xylostella* L in. (Mollah, 2024) and fall armyworm, *Spodoptera exigua* Hub. (Mollah *et al*., 2020). In the country bean field Neem Oil found effective against bean pod borer, *Maruca testulalis* G. (Mollah *et al*., 2012), bean aphid, *Aphis craccivora* Koch (Mollah *et al*., 2013), bean bug, *Riptortus pedestris* Fab.), hairy caterpillar, *Spilosomaobliqua* Walk., and stink bug complex (Mollah et al., 2022b; Mollah *et al*., 2017).These above finding reveals that eco-friendly and bio insecticides can effectively control the insect pests of crops. Keeping this in view, the present study was undertaken to evaluate the efficacy of some eco-friendly insecticides against pod bugs in the cowpea ecosystem.

MATERIAL AND METHODS

The field trial was conducted with popular cowpea variety (TPTC-29) during the *kharif* 2017-18 at Dryland farm, S.V. Agricultural College, Tirupati to evaluate the efficacy of eco–friendly insecticides against pod bugs. The experiment was laid out in a randomized complete block design with eight treatments including untreated control and replicated thrice. Treatments viz T1: NSKE 5%, T2: Neem oil 0.5% , T3 :*Beauveria bassiana* 1.0 g/l or $1x10^{10}$ cfu/gm, T4: *Metarhizium anisopliae* 1.0 g/l or $1x10^{11}$cfu/gm, T5: Novaluron 1.0 ml/l, T6: Spinosad 45 SC 0.2 ml/l, T7: Emamectin benzoate and T8:control (water spray only) were applied. The size of the individual plot was 5 m x 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 the experiment for the management of pod bugs in cowpeas through eco- friendly techniques

Insecticides were applied twice, one at flowering (55DAS) and another at the podding stage (70DAS) using battery operated knapsack sprayer. Spraying was done during morning hours with care to prevent the drift of the spray fluid from 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).

$$\text{Population reduction over control (\%)} = \frac{\text{Population in control} - \text{Population in treatment}}{\text{Population in the control}} \times 100$$

Pod damage

The observations on pod damage were recorded on five randomly selected plants in each treatment. Pods that are shrunken, deformed, and shriveled were considered as damaged pods. The pe rcent pod damage was worked out by using the following formula.

$$\text{Pod damage (\%)} = \frac{\text{Number of damaged pods}}{\text{Total no of pods}} \times 100$$

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.

$$\text{Seed damage (\%)} = \frac{\text{Number of damaged seeds}}{\text{Total no. of seeds per pod}} \times 100$$

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 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.

At one day after spraying (DAS), the highest percent reduction over control was recorded in NSKE @ 5 percent (59.72%) followed by spinosad @ 0.2 ml/L (48.52%), neem oil @ 0.5 percent (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%) (**Table 1**). At 3th DAS the highest percent reduction over control was recorded in NSKE @ 5 percent (75.20%) followed by spinosad 45SC @ 0.2 ml/l (56.67%), neem oil @ 0.5 percent (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%) (**Table 1**).At fifth DAS, The highest percent reduction over control was recorded in NSKE @ 5 percent (65.4%) followed by spinosad @ 0.2 ml/l (55.17 %), neem oil @ 0.5 percent (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 %) (**Table 1**). At seventh DAS, the highest percent reduction over control was recorded in NSKE @ 5 percent (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%) (**Table 1**).

When the overall efficacy of the first spray against *R. pedestris* was considered, NSKE @ 5 percent was found to be the best treatment by recording the highest mean percent reduction over control (69.97%) followed by spinosad @ 0.2 ml/l (57.03%) and neem oil @ 0.5 percent (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%) (**Table 1**).

Second spray

The pretreatment 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 to 8.67 to 10.00 bugs per plant which was more or less uniform.

At one DAS the highest percent reduction over control was recorded in NSKE @ 5 percent (61.31%), followed by spinosad @ 0.2ml/L (48.15%), neem oil @ 0.5 percent (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**). At the 3DAS, 5DAS and 7 DAS almost all same line of trend in mean percent 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 (Table 1).

When the overall efficacy of 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%) (Table 1)

Nymph **Adult**

Figure2. ***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*) on cowpea in all the experimental plots ranged from 7.67 to10.50 bugs per plant which was almost uniform.

At one DAS,the highest percent reduction over control was recorded in NSKE @ 5 percent (53.33%) followed by spinosad @ 0.2 ml/l (43.39%), neem oil @ 0.5 percent (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%) (**Table2**). At 3 DAS, 5 DAS, and 7 DAS almost the same line of trend in mean percent 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 (**Table 2**).

When the overall efficacy of first spray against *C. gibbosa* was considered, NSKE @ 5 percent was found to be the best treatment by recording the highest mean percent reduction over control (69.79%) followed by spinosad @ 0.2 ml/l (60.85%) and neem oil @ 0.5 percent (51.85%). The next treatments in the descending order of efficacy were *Metarhizium anisopli*ae @ 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%) (**Table 2**).

Second spray:

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

At one DAS the highest per cent reduction over control was recorded in NSKE @ 5 percent (54.23 %), followed by spinosad @ 0.2ml/L (44.81 %), neem oil @ 0.5 percent (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**). At 3DAS, 5DAS, and 7 DAS almost the same line of trend in mean percent reduction over control was observed. The order of effectiveness of these treatments was NSKE @ 5 percent> spinosad @ 0.2 ml/L > neem oil @ 0.5 percent>*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%) (**Table 2**).

When the overall efficacy of second spray against *C. gibbosa* was considered, NSKE @ 5 percent 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 percent (47.92%). The next treatments in the descending order of efficacy were *Metarhizium anisoplia*e @ 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%) (**Table2**). 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 deterrence 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**

Figure 3. ***Clavigralla gibbosa***

Yield parameters:

Pod damage:

The percentage of pod damage inflicted by pod bugs on cowpeas in experimental plots during *Kharif* 2018 ranged from 39.57 to 83.33 percent. The least percent pod damage was recorded due to NSKE @ 5 percent (39.57%) followed by spinosad @ 0.2 ml/l (47.49%), neem oil @ 0.5 percent (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 percent 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 anisoplia e*@ 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 Narasimha *et al*., (2013).

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 (7.60g), novaluron @ 1.0 ml/l (7.40g), *Beauveria bassiana*@ 1.0 g/l (7.10g), Emamectin benzoate @ 0.2 g/l (7.06g) and untreated control (7.00g) (**Table 3**).

Grain yield:

The data revealed that all the treatments had higher grain yield, compared to untreated check.The treatment NSKE @ 5 percent recorded the maximum yield of 933.33 kg ha^{-1}, followed by spinosad @ 0.2 ml/l (850 kgha^{-1}), neem oil @ 0.5 percent (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 kgha^{-1}) while untreated check recorded yield of 523.3 kgha^{-1}(**Table 3**).

Similar results were reported by Singh and Nath (2011) who reported that eco-friendly biopesticides *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 percent pod damage, percent 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 damage and 2.36% grain damage by pod bug and higher grain yield 1625 kg/ha.

CONCLUSION

The results of the current study revealed that, all the insecticide treatments tested were effective in the management of pod bugs than the untreated control. At seven days after the second spray, the highest percent reduction of pod bugs over the control was recorded with NSKE @ 5 percent followed by spinosad @ 0.2 ml/l, neem oil @ 0.5 percent, *Metarhizium anisopliae* @ 1.0 g/l, novaluron @ 1.0 ml/l, *Beauveria bassiana* @ 1.0 g/l and Emamectin benzoate @ 0.2g/l. The lowest percent pod and seed damage inflicted by pod bugs on cowpea was archieved recorded in the treatment NSKE @ 5 percent followed by spinosad @ 0.2 ml/l, neem oil @ 0.5 percent, *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.

The treatment NSKE @ 5 per cent recorded significantly low pod and seed damage by pod bugs and significantly higher grain yield and 100 grain weight than the other treatments, indicating the superiority of NSKE @ 5 per cent in managing the pod bugs in cowpea.

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1.

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3.

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

Sl. No.	Treatments	Pre spray count (Mean*)	Percent reduction over control (1st spray)				Mean % Reduction	Pre spray count (Mean*)	Percent reduction over control (2nd spray)				% Mean reduction
			1st DAS	3rd DAS	5th DAS	7th DAS			1st DAS	3rd DAS	5th DAS	7th DAS	
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 (1x10^{11}cfu/gm)	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(1x10^{11} cfu/gm)	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	

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

Table2. Efficacy of botanical, microbial and synthetic insecticides against *Clavigralla gibbosa* on cowpea during *kharif* 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
			1st DAS	3rd DAS	5th DAS	7th DAS			1st DAS	3rd DAS	5th DAS	7th DAS	
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 (1x10^{11}cfu/gm)	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 (1x10^{11} CFU/gm)	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 DMRT

Table 3.Pod damage, seed damage, 100 grain weight, yield of cowpea as influenced by insecticides during *Kharif*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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