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Estimation of the flower loss due to thrips (*Megalurothrips usitatus*) and grain loss due to tur pod bug (*Clavigralla gibbosa*) in pigeonpea crop

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Abstract
The present field experiment was conducted during *Kharif* season- 2016 at Research Farm, Department of Entomology, JNKVV, College of Agriculture, Rewa (M.P.) to study the estimation of flower loss by the thrips and grain loss by tur pod bug under the agro climatic condition of Rewa district. Flowers loss in pigeonpea due to thrips infestation under the changing climatic condition during *kharif* season- 2016 in Rewa district, occurred from 41 to 51standard weeks. Minimum 14.89% of flower shedding was noted in the treatment of Monocrotophos 36% SL followed by Triazophos 40% EC (14.99%) and the maximum (25.32%) flower shedding was measured in the untreated control. As regards the number of thrips in shed flowers it`s presence was from 41 to 51 standard weeks. The average highest number of thrips (3.37 per 10 flowers) was observed in untreated control and minimum (1.73 per 10 flowers) was observed in Monocrotophos 36% SL treated plot followed by Traizophos 40% EC (1.96 per10 flowers). The grain loss by tur pod bug was assessed by randomly selected 100 pods per plot found to the extent of 15.19%. However, treatment wise losses were observed between 5.17 to 8.10% with least in Monocrotophos 36% SL (5.17%) and maximum in Novaluron 10% EC (8.10%) as against 15.19% of the untreated control.

Keywords: Tur, thrips, pod bug, flower shedding, insecticides and grain loss

Introduction
India is the largest producer (25%) and consumer (27%) of pulses in the world and also the biggest importer (14%) of pulses (Mohanty and Satyasai, 2015) [14]. Among pulses, widely cultivated crops are Chickpea (48%), Pigeonpea (15%), Mungbean (7%), Urdbean (7%), Lentil (5%) and Field pea (5%) at the national and global level. In India; Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh, Karnataka and Andhra Pradesh are recognized as major pulse producing states and contribute about 80% of the total production (Ali and Gupta, 2012) [1].

Pigeonpea (*Cajanus cajan* (L.) Millsp.**),** popularly known as Arhar, Tur or Red gram, is an important pulse crop and a foraging crop for honeybees. India is the largest producer (25% of global production), consumer (27% of world consumption) and importer (14%) of pulses in the world and pigeon pea is no exception, with India producing about 75% of the world's total produce. While India is the largest producer and also importer of the crop in the world (FAOSTAT, 2013) [6]. In India, it occupies an area of 5.34 million hectares with production and productivity of 4.87 million tonnes and 913 kg/ha, respectively (Anonymous, 2018) [2]. Madhya Pradesh is the third largest producer of this crop in the country and it contributes approximately 16.04% of the total production with an area, production and productivity of 0.69 million hectares, 0.78 million tonnes and 1133 kg/ha, respectively (Anonymous, 2018) [2]. Pigeonpea is a rich source of protein (21.71%) and also of iron, iodine and essential amino acids like arginine, cysteine and lysine (Singh *et al*., 2003) [17].

The production of pulses is comparison to the ever increasing population has been remained stagnant the ever-increasing growth of population which has resulted in availability less than 40 g./day as against WHO recommendation of 80 g./day for the vegetarian population. To meet the growing demand for pulses by 2020, desired production of pulses has been targeted at 27.8 million tonnes with the productivity of 1282 kg. /ha in India Which indicates the quite less productivity of the crop in the country which needs to be enhanced. Several factors have been recognized as a limiting factor to higher productivity but among them biotic stress

particulars insect pest have been recognized as the major limiting factor and demand key attention towards by eco-friendly management of the pests. Pigeonpea crop is subjected to attack by a large number of insect pests throughout at all the stages and inflict losses to the extent of 27% to 100%. (Singh and Singh, 1991; Kumar and Nath, 2003) [18, 8]. Approximately 300 species of insect pests have been reported on this crop; but, among them, pod borer complex, pod fly, blister beetle, various species of pod bugs, aphids, jassids and flower thrips have been recognized as a serious pest of, which are responsible for low yield and quality loss (Veda, 1993) [21].

The average yield of the crop has been recorded between 500 - 800 kg /ha in the region as against the potential yield of 1800 - 2000 kg/ha (Lal *et al.*, 1997 and Upadhyay *et al.*, 1998) [10, 20]. According to Minja *et al.* (1999) [13], approximately 11.7% yield loss is caused by the infestation of various pod bugs. Among the infesting pests, their succession on the crop indicates the appearance of different insects at different stages of crop growth (Pawar *et al.*, 2014) [15]. The productivity of pigeonpea crop in the Rewa district is quite low and the insect pests have also been recognized as a major constrain but the systematic study on these aspects in growth lacking for boosting up the crop productivity in the region.

Materials and methods

A field trial was conducted in the field of Department of Entomology, JNKVV, College of Agriculture, Rewa (M.P.) during *kharif* season- 2016 in randomized block design with nine treatments in three replications including untreated control. Pigeonpea variety Asha was sown in plots of 5 × 3m with the spacing of 60 × 30cm. The recommended fertilizer dose (N: P: K- 30: 50: 50 kg/ha) was applied as basal dose at the time of planting. All the cultural practices except plant protection were carried out as per recommendations. The flower loss due to thrips and percentage of grain loss due to tur pod bug were estimated from insecticides treated and untreated control plots. The losses were worked out in the form of flowers loss caused by thrips and grain damage by tur pod bug.

Flower loss due to thrips

Observation on flower thrips incidence was recorded on five randomly selected tagged plants from each plot. Observation on the percent of flower loss due to thrips was recorded at weekly intervals on a tagged branch of each randomly selected plant. The observation was initiated from the first day of flowering and continued until pod formation was completed. The total number of flowers per branch, number of flowers shed down due to thrips infestation and number of thrips in shed flowers were counted on each observation. The observations were taken from 41 standard weeks to 51 standard weeks.

Grain loss due to tur pod bug

The losses to the grain by tur pod bug was assessed by counting the number of healthy and damaged grains on 100 randomly selected pods at the time of maturity, these were collected randomly from the insecticides treated and untreated control plots and the percentage of grain loss due to tur pod bug was estimated. The shriveled grains were considered as the damaged caused by tur pod bug.

The damage grain due to pod bug could be distinguished by the twisting and sickly appearance of the pod which could be easily crushed into powder with the pressure of finger (Das, 1990) [5] similar symptoms of shrivelled grain due to physiological disorder also occur which do not crush into powder easily by finger pressure. The percentage of grain loss due to pod bug was calculated by using the following formula.

$$\text{percentage of grain loss} = \frac{\text{Number of grains damaged by pod bug}}{\text{Total number of grains examined}} \times 100$$

For the observations of thrips and pod bug total 8 insecticidal sprays along with one untreated control used in the investigation which was presented in table 1.

Table 1: Details of the treatments including insecticides with their doses

S. No	Name of Insecticides	Dosage g a.i./ha	Dosage ml or g/ha
1.	Acephate 75% SP (Asataf)	750	1000 g/ha
2.	Chlorantraniliprole 18.5% EC (Coragen)	20	108 ml /ha
3.	Emamectin benzoate 0.9% SG + Novaluron 5.25% EC (Proclaim + Rimon)	48.56 + 8.33	926 ml/ha
4.	Lambda cyhalothrin 5% EC (Matador)	12.5	250 ml/ha
5.	Monocrotophos 36% SL (Suphos)	500	1390 ml/ha
6.	Novaluron 10% EC (Rimon)	33.5	335 ml/ha
7.	Triazophos 40% EC (Trifos-40)	320	800 ml/ha
8.	Indoxacarb 15.8% EC (Avaunt EC)	60	380 ml/ha
9.	Untreated control	-	-

Results

Evaluation of flower loss due to thrips

Thrips cause flower loss in the pigeonpea which ultimately affects pod formation. Flowers loss in pigeonpea due to thrips infestation under the changing climatic condition during *kharif* season- 2016 in Rewa district, occurred from 41 to 51 standard weeks. The extent of flower loss due to thrips under Rewa condition was done and it was made on a specified length (35-45cm) of a branch. Percentage of flower shedding by thrips was observed between 9.33 to 18.56 percent in 41 standard weeks and there was a non-significant difference among all treatments. In the 42 standard weeks; flower shedding percentage varied between 14.09 to 18.54 percent but the difference was also non-significant. It was observed that there was a significant difference among all treatments and ranged from 11.61 to 18.05 and 16.05 to 18.24 percent, respectively in 43 and 44 standard weeks. In the 43 and 44 standard weeks; the lowest flower shedding percent 11.61 and 16.05, were observed in treatments Monocrotophos 36% SL and Indoxacarb 15.8% EC and highest flower shedding percent 18.05 and 18.24 were observed in insecticides Acephate 75% SP and Novaluron 10% EC, respectively. In 48 and 49 standard weeks; a significant flower loss percentage was assessed among different treatments. Minimum percentage of loss i.e. 10.97 and 11.02% was recorded in Indoxacarb 15.8% EC, while the maximum percentage of loss

i.e. 37.77 and 24.01% occurred in untreated control in both standard weeks. Further a significant flower shedding percentage was observed among different treatments in 50 and 51 standard weeks. The highest flower loss percent i.e. 38.90 and 27.79% was occurred in again untreated control, while the lowest flower loss percent i.e. 5.48 and 3.18% was observed in Monocrotophos 36% SL. Based on overall thrips infestation, the mean percentage of flower shedding varied from 14.89 to 25.32%. The lowest infestation was noted in Monocrotophos 36% SL (14.89%.) followed by Triazophos 40% EC (14.99%) and the maximum infestation (25.32%) was measured in the untreated control followed by Novaluron 10% EC (17.68). The detailed data for Per cent flower shedding in different insecticidal treatments has been given in table 2.

Table 2: Percent of flower shedding due to Thrips in different standard weeks

Average percent of shedding flower due to thrips														
Treatments No.	**Name of Insecticides**	**41SW**	**42SW**	**43SW**	**44SW**	**45SW**	**46SW**	**47SW**	**48SW**	**49SW**	**50SW**	**51SW**	**Total**	**Average**
T_1	Acephate 75% SP (Asataf)	9.33 (17.32)*	14.09 (21.90)	18.05 (25.13)	16.22 (23.67)	18.86 (25.73)	23.45 (28.88)	24.45 (29.52)	17.80 (24.55)	11.29 (19.59)	13.64 (21.49)	6.09 (13.97)	173.27	15.75
T_2	Chlorantraniliprole 18.5% EC (Coragen)	15.75 (22.64)	16.56 (23.98)	13.09 (21.16)	17.40 (24.64)	17.48 (24.58)	14.96 (21.42)	21.47 (30.34)	18.01 (25.07)	16.79 (24.16)	12.42 (19.76)	10.96 (19.30)	174.89	15.90
T_3	Emamectin benzoate 0.9% SG + Novaluron 5.25% EC (Proclaim + Rimon)	12.26 (20.31)	15.69 (23.22)	13.15 (21.24)	16.62 (24.01)	18.27 (25.27)	21.15 (26.92)	28.70 (32.33)	15.80 (22.87)	14.48 (22.22)	13.85 (18.79)	8.92 (17.02)	178.89	16.26
T_4	Lambda cyhalothrin 5% EC (Matador)	15.03 (22.63)	16.17 (23.22)	13.94 (21.90)	16.50 (23.93)	20.39 (26.17)	17.76 (24.80)	31.71 (35.10)	18.31 (24.42)	17.76 (24.08)	11.83 (18.79)	9.56 (17.30)	188.96	17.18
T_5	Monocrotophos 36% SL (Suphos)	18.59 (25.24)	14.54 (22.07)	11.61 (19.91)	18.06 (25.10)	19.47 (25.97)	18.95 (22.46)	26.51 (30.77)	15.14 (22.42)	12.28 (20.25)	5.48 (11.06)	3.18 (10.24)	163.81	14.89
T_6	Novaluron 10% EC (Rimon)	16.47 (23.65)	17.63 (24.62)	12.94 (21.91)	18.24 (25.25)	19.20 (25.35)	14.65 (21.78)	32.85 (34.19)	20.78 (27.01)	14.65 (22.46)	14.26 (21.82)	12.81 (18.12)	194.48	17.68
T_7	Triazophos 40% EC (Trifos-40)	15.93 (23.34)	17.56 (24.69)	14.66 (22.49)	17.80 (24.94)	18.36 (25.35)	14.45 (21.99	20.09 (29.79)	10.97 (18.86)	14.45 (21.99)	13.08 (20.56)	7.52 (14.69)	164.87	14.99
T_8	Indoxacarb 15.8% EC (Avaunt EC)	15.04 (21.75)	18.54 (25.62)	14.01 (21.91)	16.05 (23.60)	20.21 (26.69)	11.02 (19.04)	28.03 (31.71)	16.08 (23.32)	11.02 (19.04)	12.87 (19.76)	8.42 (16.13)	171.29	15.57
T_9	Untreated control	13.26 (20.86)	16.43 (23.98)	12.87 (21.07)	18.70 (25.60)	24.52 (29.52)	27.34 (31.36)	36.98 (37.69)	37.77 (43.56)	24.01 (29.27)	38.90 (36.56)	27.79 (31.56)	278.57	25.32
CD		NS	NS	1.54	1.30	NS	NS	NS	10.85	5.41	12.69	7.51	-	-
SE(m)		-	-	0.51	0.43	-	-	-	3.59	1.79	4.19	2.48	-	-

Note: *= Figures in parentheses are angular transformed values.

Observation of number of thrips in shed flowers

Number of thrips was recorded from 41 to 51 standard weeks per ten shed flowers. In 41 and 42 standard weeks, there was not any number of thrips recorded in shed flowers among all treatments. The first observations of thrips on number basis were recorded from 43 standard weeks (0.4 thrips/10 flowers) and a non-significant difference among the treatments was noted from 43 to 47 standard weeks. A significant higher number of thrips / 10 flowers were observed from 48 to 51 standard weeks. In 48 standard weeks; average population of thrips in different treatments varied from 2.46 to 6.86/10 flowers. The minimum number (2.46/10 flowers) was recorded in Monocrotophos 36% SL followed by Triazophos 40% EC (2.73/10 flowers) and the maximum number of thrips (6.86/10 flowers) was noted in untreated control. In 49 standard weeks, further highest thrips population (7.2/10 flowers) was recorded in control plot and lowest 2.73/10 flowers in Monocrotophos 36% SL treated plot followed by Triazophos 40% EC (3.13/10 flowers). It was observed that thrips population was continuously reduced after 49 standard weeks and again the highest number of thrips i.e. 4.26 and 4.86/10 flowers were recorded from control plot in both (50 and 51) standard weeks. However, minimum number of thrips i.e. 0.2 and 0.24/10 flowers were noted from Acephate 75% SP and Triazophos 40% EC insecticides, respectively in 50 and 51 standard weeks as compared to 48 and 49 standard weeks observations. Based on overall population of thrips, average number varied from 1.73 to 3.37/10 flowers in different treatments. Minimum average population (1.73/10 flowers) was recorded from Monocrotophos 36% SL treated plot followed by Triazophos 40% EC (1.85/10 flowers) and the maximum average population (3.37/10 flowers) was recorded from untreated control followed by Novaluron 10% EC (2.34/10 flowers). The detailed data for number of thrips in shed flowers at various standard weeks in different insecticidal treatments has been given in table 3.

Table 3: Number of Thrips in 10 shaded flowers at various interval

Average population of Thrips per 10 flower/plant in different standard weeks														
Treatments No.	**Name of Insecticides**	**41SW**	**42SW**	**43SW**	**44SW**	**45SW**	**46SW**	**47SW**	**48SW**	**49SW**	**50SW**	**51SW**	**Total**	**Average number of thrips**
T_1	Acephate 75% SP (Asataf)	0 *(0.7)	0 (0.7)	0.46 (1.21)	0.8 (1.34)	2.6 (1.94)	3.33 (2.08)	4.93 (2.43)	3.26 (2.06)	3.53 (2.12)	0.2 (1.15)	0.72 (1.31)	20.63	1.87
T_2	Chlorantraniliprole 18.5% EC (Coragen)	0 (0.7)	0 (0.7)	0.4 (1.18)	0.73 (1.31)	3.8 (2.01)	4.26 (2.29)	5.6 (2.56)	3 (1.99)	5.46 (2.54)	1.03 (1.42)	1.03 (1.42)	24.51	2.22
T_3	Emamectin benzoate 0.9% SG + Novaluron s5.25% EC (Proclaim + Rimon)	0 (0.7)	0 (0.7)	0.66 (1.28)	0.66 (1.28)	2.86 (1.96)	3.8 (2.18)	5.86 (2.61)	3.6 (2.14)	3.8 (2.18)	0.73 (1.31)	1.06 (1.39)	23.03	2.09
T_4	Lambda cyhalothrin 5% EC (Matador)	0 (0.7)	0 (0.7)	0.53 (1.23)	0.6 (1.26)	3 (2.0)	3.8 (2.19)	4.86 (2.42)	3.8 (2.19)	4.13 (2.26)	1 (1.41)	0.8 (1.34)	22.52	2.04
T_5	Monocrotophos 36%	0	0	0.6	1.2	2.86	3.4	5.33	2.46	2.73	0.28	0.33	19.08	1.73

	SL (Suphos)	(0.7)	(0.7)	(1.26)	(1.48)	(1.96)	(2.09)	(2.51)	(1.86)	(1.92)	(1.34)	(1.15)		
T_6	Novaluron 10% EC (Rimon)	0 (0.7)	0 (0.7)	0.4 (1.18)	1 (1.41)	2.66 (2.91)	4.06 (2.25)	5.26 (2.5)	4.06 (2.25)	5.86 (2.62)	1.2 (1.46)	1.33 (1.48)	25.83	2.34
T_7	Triazophos 40% EC (Trifos-40)	0 (0.7)	0 (0.7)	0.53 (1.23)	1.06 (1.43)	2.8 (1.94)	4 (2.23)	4.46 (2.11)	2.73 (1.93)	3.13 (2.03)	0.53 (1.12)	0.24 (1.11)	20.37	1.85
T_8	Indoxacarb 15.8% EC (Avaunt EC)	0 (0.7)	0 (0.7)	0.6 (1.26)	1.06 (1.43)	2.86 (1.96)	3.46 (2.11)	5 (2.44)	3.26 (2.06)	3.53 (2.12)	0.93 (1.37)	0.86 (1.35)	21.56	1.96
T_9	Untreated control	0 (0.7)	0 (0.7)	0.53 (1.23)	1.2 (1.48)	2.8 (1.94)	3.93 (2.21)	5.33 (2.51)	6.86 (2.78)	7.2 (2.86)	4.26 (2.29	4.86 (2.42)	36.97	3.37
CD		NS	NS	NS	NS	NS	NS	NS	0.42	0.21	0.26	0.27	-	-
SE(m)±		-	-	-	-	-	-	-	0.13	0.07	0.086	0.87	-	-

Note: * Figures in parentheses are square root transformed values.

Estimation of grain loss in pigeonpea due to tur pod bug

In the grain loss by tur pod bug was assessed by 100 randomly selected pods from per plots found to the extent of 15.19%. However, treatment wise losses were observed between 5.17 to 8.10% with least in Monocrotophos 36% SL (5.17%) and maximum in Novaluron 10% EC (8.10%) as against 15.19% of the untreated control. Percentage of grain losses by tur pod bug in different insecticides along with the untreated control were presented in table 4.

Table 4: Percentage of grain losses by tur pod bug in different treatments

S. N.	Treatment	Trade name	Doses in g or ml a.i. /ha	Extent of grain loss (%)
1	Acephate 75% SP	Asataf	750	5.70 *(13.80)
2	Chlorantraniliprole18.5% EC	Coragen	30	6.76 (14.96)
3	Emamectin benzoate 0.9% SG + Novaluron 5.25% EC	Proclaim+ Rimon	48.56 + 8.33	8.10 (16.35)
4	Lambda cyhalothrin 5% EC	Matador	25	9.89 (18.22)
5	Monocrotophos 36% SL	Suphos	500	5.17 (13.14)
6	Novaluron 10% EC	Rimon	33.5	10.04 (18.42)
7	Triazophos 40% EC	Trifos-40	320	5.94 (14.04)
8	Indoxacarb 15.8% EC	Avaunt	60	6.63 (14.84)
9	Untreated control	-	-	15.19 (22.89)
	SEm±			(1.08)
	CD at 5%			(3.26)

Note: * Figures in parentheses are angular transformed values.

Discussion

Flower loss due to thrips infestation

Thrips were found to be one of the major pests of pigeonpea. Similar findings have been reported by Sirohi (1990) [19]. Both nymphs and adults are feed on buds and flowers, during the period of heavy infestation it may lead to shedding of buds and flowers which ultimately affect the pod formation. Seetharamu *et al.* (2020) [16] also reported that among sucking insect pests flower thrips, *Megalurothrips usitatus* (Bagnall) are known to significant damage to pulse crops and also indirectly acting as a vector of deadly diseases. The loss to the flowers in pigeonpea due to thrips was estimated at weekly intervals which indicates the initiation of flower damage by thrips in the 41 standard weeks which continued throughout crop maturity. Landge (2009) [11] and Kumar *et al*. (2010) [9] also found that thrips appeared on the crop at reproductive stage and remained available up to maturity of the crop. It was studied that variation among different insecticide treatments and standard weeks i.e. 43, 44, 48, 49, 50 and 51 standard weeks. There was a significant difference among the treatments. However, non-significant losses were observed during 41, 42, 45, 46 and 47 standard weeks. An average loss that occurred from 41 to 51 standard weeks was minimum of 14.89% in treatment Monocrotophos 36% SL (Suphos) followed by Triazophos 40% EC (14.99%) and maximum loss (25.32%) in untreated control. The present findings get support from the reporting of Balikai and Yelshetty (2008) [3] who observed damage to the extent of 36.5% due to *Megalurothrips usitatus* in Bijapur and Gulbarga. Premature flower loss due to thrips in Karnataka has also been reported by Chen (1980) [4].

Observation of number of thrips in shed flowers

Number of thrips per ten shed flowers was recorded from 41st standard week to 51 standard weeks. Rising number of thrips in shed flowers were recorded from 43 to 47 standard week. But the differences among the treatments were non-significant. A significant change in the number of thrips per 10 flowers was observed from 48 to 51 standard weeks. An average of 3.37 thrips per 10 flowers were counted in untreated control whereas, 1.73 thrips per 10 flowers were observed in Monocrotophos 36% SL treated plot followed by Triazophos 40% EC (1.85/10 flowers) and Acephate 75% SP (1.87/10 flowers). Similar findings were also reported by Mallahe (2008) who found peak population of thrips during 51 standard weeks (79 thrips / 25 flowers).

Estimation of grain loss in pigeonpea due to tur pod bug

Grain damage due to tur pod bug was assessed in *kharif* 2016. It was found in the range of 5.17 to15.19 percent. Maximum grain damage (15.19%) was recorded in untreated control plot and minimum (5.17%) was obtained from Monocrotophos 36% SL treated plot followed by Acephate 75% SP (5.70%) and Triazophos 40% EC (5.94%). The present findings get support from the findings of Khamoriya *et al.* (2017) [7] who also observed among all the treatment modules, Module 5 with sequential application of Chlorantraniliprole 18.5 SC @ 30g a.i/ha - Indoxacarb 15.8 EC @ 73g a.i./ha - Acetamiprid 20 SP @ 20g a.i/ha and Module 3 with sequential application of Chlorantraniliprole 18.5 SC @ 30g a.i/ha - Acephate 75 SP @ 750g a.i/ha - Acephate 75 SP @ 750g a.i/ha provided better control of *Melanagromyza obtusa*, *Clavigralla gibbosa* and *Helicoverpa armigera* on pigeonpea in terms of the lower

pod and grain damage and higher grain yield. Hence, these two treatment modules can be suggested to the farmers for effective management of pod borers and pod bug on long duration pigeonpea.

Conclusion

Megalurothrips usitatus and *Clavigralla gibbosa* are important sucking insect pests of pigeonpea which cause flower loss and grain damage, respectively. Heavy infestation of these pests causes a significant loss in yield. The use of various chemical insecticides belonging to different classes is in vogue for suppression of this pest but only partial control of this pest could be achieved. This study had indicated that all insecticides were superior over the untreated control for the management of flower thrips and pod bug. However, among different tested insecticides Monocrotophos 36%SL showed the best results in controlling *Megalurothrips usitatus* and *Clavigralla gibbosa*. Hence, it may be concluded that Monocrotophos 36% SL (500 g. a.i./ha) could be a better option for sustainable management of flower thrips and pod bug in pigeonpea. Farmers may be advised to use this insecticide for the effective control of these pests and higher yield.

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