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Efficacy of Some Insecticides against Root Grubs (*Holotrichia sps*) (Coleoptera: Scarabaeidae) in Groundnut

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ABSTRACT

Background: Root grub is the most destructive soil pests, causing damage in groundnut crop immediately after germination. Younger grubs feed on fine rootlets and the later grub stages feed on both roots and pods. Varying degrees of wilting and death of the plants is the usual symptoms of damage. The damaged plants can be pulled out easily. The infestation occurs as 'patchy appearance' of dead plants in the field.

Methods: A trial was conducted to manage the root grubs in groundnut crop during *kharif* 2018 to 2020 at Regional Agricultural Research Station, Tirupati Andhra Pradesh, India. The experiment was laid out in RCBD with nine treatments including untreated control and replicated thrice to determine the suitable insecticide against root grubs in groundnut. The number of grubs per square meter area, per cent mortality of the plants in each treatment and pod yields were recorded.

Result: The results revealed that the root grub incidence in groundnut crop as well as the plant mortality was nil in the treatments with seed treated with Imidacloprid 600 FS @ 2 ml + 4 ml of water/kg seed and furrow application of Carbofuran 3 G @ 33 kg/ha before sowing. The highest yield was recorded in seed treatment with Imidacloprid 600 FS @ 2 ml + 4 ml of water/kg seed followed by furrow application of Carbofuran 3 G @ 33 kg/ha before sowing. These treatments can be recommended to protect groundnut crop in the initial stages of growth.

Key words: Groundnut, Insecticides, Management, Root grubs.

INTRODUCTION

Around 360 species of insect pests attack groundnut in different parts of the world (Smith and Barfield, 1982). Of which, the most destructive soil pests that harm a variety of crops are root grubs. In general, top levels of root damage to Indian groundnut crop is caused by the root grub *Holotrichia consanguinea* Blanch (Coleoptera: Scarabaeidae). In recent studies, the pestiferous species *viz., Holotrichia reynaudi, H. serrata, Phyllognathus dionysius, Brahmina mysorensis* and *Anomola dorsalis* were abundant in predominant groundnut growing areas of Southern and Scarce rainfall zones in Andhra Pradesh (Kumar and Sagar, 2018). White grub damage typically appears as stunted, wilted, discolored, or dead seedlings and/or as gaps in rows where plants fail to emerge. White grubs prune roots and can feed on the mesocotyl causing plant death (Gautam *et al*., 2023). Under severe infestation, drying and dying of plants resulted in complete yield loss (Selvi *et al.,* 2010). Due to its subterranean dwelling nature, predicting the occurrence of root grubs is difficult as well challenging. Abiotic factors like rainfall aid in escalating root grub damage. The emergence of the adult *Holotrichia* species coincides with the onset of the monsoon and is delayed until late in the season. The emergence, mobility and distribution of root grub adults are influenced by weather variables like temperature, humidity and wind velocity along with rainfall (Mishra and Singh, 1999). In root grub endemic areas, the damage in groundnut ranges from 20-100%. The presence of one grub/m^2 may even cause 80-100% mortality in groundnut (Yadava and Sharma, 1995). Umeh *et al*. (1999) reported that it can cause damage upto 39.40 per cent.

Alternate to insecticides are microbial bio-pesticides which are effective in managing root grubs in groundnut. Tara *et al*. (2024) reported that furrow application of powder formulation of entomopathogens like *Beauveria bassiana, Metarhizium anisopliae* @ 5 kg (1×10^{12} CFU/gm) and *Heterorhabditis indica* @ 5000 galleria per hectare at the time of sowing were significantly superior in reducing the per cent plant mortality of groundnut (28.00%, 29.33%, 31.77%, respectively) while highest mortality was recorded in untreated control (87.28%).

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Insecticide application is the common strategy deployed for root grub management, which is not only in vogue in larger areas but also gives fruitful results in a jiffy. Sorting to such techniques will give better yields. In recent years, new formulations of insecticides were imposed in seed treatment and their application in soil along with sand or soil drenching to manage root grubs. The soil drenching approach involves applying diluted insecticides directly to the base of the plant base or near the root region. Hence, this trial was taken up to observe the efficacy of different insecticidal formulations to manage root grubs in groundnut.

MATERIALS AND METHODS

Field experiments were conducted during *kharif*, 2018, 2019 and 2020, at Regional Agricultural Research Station, Tirupati to determine the suitable new insecticide formulation as seed treatment or soil application against root grubs in groundnut. The experiment was laid in randomized block design with a plot size of 5×4 m^2, with a spacing of 30 cm between the rows and 10 cm within the row and replicated thrice. Package of practices as per the recommendations were followed during the period of study. Studies on light trap collections at RARS, Tirupati revealed that the monsoon rains favour the emergence of adult root grubs. Hence, the test variety, Dharani (TCGS 1043) was sown two days after the receipt of rains in the month of July. The treatments under study were:

Treatments		Method of application	Dose
T_1	Chlorpyriphos 20 EC	Seed treatment	12 ml/kg seed
T_2	Imidacloprid 600 FS	Seed treatment	2 ml + 4 ml of water/kg seed
T_3	Clothianidin 50 WDG	Seed treatment	2 g/kg seed
T_4	Carbofuran 3 G	Furrow application	33 kg/ha
T_5	Quinalphos 1.5 D	Furrow application	25 kg/ha
T_6	Imidacloprid 17.8 SL	Soil drenching	3 ml/10 L
T_7	Chlorpyriphos 20 EC	Soil drenching	8 ml/10 L
T_8	Urea (1 kg) + Phorate 10 G (1 kg)	Soil drenching	2 kg/10 L
T_9	Untreated control	Water spray	-

Groundnut seeds were treated with Chlorpyriphos 20 EC @ 12 ml/kg seed, Imidacloprid 600 FS @ 2 ml + 4 ml of water/kg seed and Clothianidin 50 WDG @ 2g/kg seed 12 hours prior to sowing and dried under shade. The shade dried seeds were sown on the next day. Required quantity of granular formulation *i.e*., Carbofuran 3 G @ 33 kg/ha and Quinalphos 1.5 D @ 25 kg/ha (dust formulation) were applied in furrows immediately after sowing the groundnut. Soil drenching with insecticides was followed in the treatments with Imidacloprid 17.8 SL @ 3 ml/10 L, Chlorpyriphos 20 EC @ 8 ml/10 L and Urea (1 kg) + Phorate 10 G (1 kg) @ 2 kg/10 L of water as and when the incidence of root grub crossed Economic Threshold Level (ETL) *viz.,*1 grub/m^2 area. One treatment was kept as untreated control as check without any protection from root grubs.

Data collection

Observations were recorded at 25 to 30 days after sowing (DAS) on plant mortality (%) due to incidence of root grubs in 1 m^2 area at 5 spots per plot and per cent plant mortality was calculated by using the formula:

$$\text{Per cent plant mortality} = \frac{\text{No. of dead plants due to white grubs/m}^2\text{ area}}{\text{Total number of plants/m}^2\text{ area}} \times 100$$

Destructive sampling procedure was followed by uprooting the dead or wilting groundnut plants, further the soil was dug out to know grubs in each plot. Per cent protection over control, pod yield (kg/ha) and increased yield over control was recorded.

Statistical analysis

Observations of per cent plant mortality was subjected to square root transformation *i.e.,* ($\sqrt{(X+0.5)}$, whereas the counts of grubs/m^2 area was log transformed (log (x+1)). Data were recorded during individual years (*kharif* 2018, 2019 and 2020) was subjected to analysis of variance in SPSS 20.0, while the pooled data, was subjected to repeated measures anova in SPSS 20.0.

RESULTS AND DISCUSSION

Per cent mortality of groundnut

Treatments had significant effects on the mortality of plants against the groundnut root grub (Table 1). Among the treatments, the highest mortality (16.00%) of plants was observed in untreated control. Conversely, no mortality was observed in plants when the seeds were treated with Imidacloprid 600 FS @ 2 ml + 4 ml of water per kg seed in 2018. Similar trend was observed during 2019 and 2020. The efficacy of insecticides against root grub were in the order of ($T_2 = T_4 > T_6 > T_1 > T_5 > T_8 > T_3 > T_7 > T_9$). Maximum protection (100%) was recorded in the treatments, T_2: seed treatment with Imidacloprid 600 FS @ 2 ml + 4 ml of water per kg seed compared with control and Imidacloprid was effective against a wide spectrum of pests because of its very good root-systemic action and with contact and stomach action. Similar results were also found in the treatments T_4: soil application of Carbofuran 3G @ 33 kg/hectare (ha) at the time of sowing.

The pooled mean data revealed that seed treatment with Imidacloprid 600 FS @ 2 ml + 4 ml of water per kg seed and soil application of Carbofuran 3G @ 33 kg/hectare (ha) at the time of sowing were efficient in protecting the crop from groundnut root grubs during *kharif* season as no damage was noticed (Table 1). Gangwar *et al*. (2015) reported that seed treatment with imidacloprid 17.8 SL @ 4 ml/kg seed recorded the lowest plant mortality of 3.87 per cent and provided the highest pod yield of 26.45 q/ha. Anitha *et al*. (2005) reported that chlorpyrifos and imidacloprid as seed-dressing chemicals were effective against *Holotrichia serrata* at rates as 0.6 and 3.5 g a.i./kg, respectively. While in microplot and on-farm trials, the results revealed that 1.2 and 3.5 g a.i./ kg of chlorpyrifos and imidacloprid, respectively, were required for management of *H. reynaudi.*

Root grubs population/m^2 area

No incidence of root grubs was observed in the treatments with seed treatment with imidacloprid 600 FS @ 2 ml + 4 ml of water /kg seed (T_2) and furrow application of carbofuran 3 G @ 33 kg/ha (T_4). Highest number of root grubs of 5.67, 3.67 and 4.00 was recorded during 2018, 2019 and 2020 respectively in the treatment with untreated control.

The pooled mean data revealed that maximum number of root grubs/m^2 area was recorded in untreated control (4.44) which was on par with seed treatment with Clothianidin 50 WDG @ 2 g/kg seed (2.22) and soil drenched with Chlorpyriphos 20 EC @ 8 ml/10 L of water (2.22) respectively, while no incidence of root grubs was recorded in imidacloprid 600 FS @ 2 ml + 4 ml of water/kg seed (T_2) and furrow application of carbofuran 3 G @ 33 kg/ha (T_4). The mean population of root grubs recorded over three years of study were in the order of $T_2 = T_4 < T_6 < T_1 < T_5 < T_8 < T_3 < T_7 < T_9$ (Table 2). Radha *et al.* (2020) studied the comparative bio-efficacy of six insecticides *viz*., chlorantraniliprole, bifenthrin, clothianidin, thiamethoxam, imidacloprid and chlorpyriphos against grubs of *Brahmina coriacea* (Hope) through dip treatment and reported that chlorantraniliprole and bifenthrin showed desirable efficacy against grubs of *B. coriacea* in soil. While, chlorpyriphos was found to be least toxic among the tested chemicals. Devina *et al.* (2023) reported that the seed treatment with imidacloprid 17.8 SL @ 3 ml/kg seeds proved to be the most effective by exhibiting the lowest grub incidence (0.17 grubs/12 sq m plot) and minimum plant infestation (1.82%).

Pod yield

Maximum pod yield in this trial during *kharif* 2018, 2019 and 2020 recorded was 1095 kg/ha, 2265 kg/ha and 1965 kg/ha respectively and maximum pooled mean yield of 1775 kg ha^{-1} was recorded in the treatment with Imidacloprid 600 FS @ 2 ml + 4 ml of water per kg seed. The alternate treatment that can be recommended to Imidacloprid is furrow application of Carbofuran @ 33 kg ha^{-1} which recorded the mean yield of 1698 kg ha^{-1}. Significant differences among the treatments with respect to pod yield and pooled mean yield calculated for three years were

Table 1: Efficacy of different insecticides against Root grubs in groundnut during *kharif* 2018, 2019 and 2020.

	Treatments	Per cent mortality of groundnut/m^2				PROC (%)
		2018	2019	2020	Pooled mean	
T_1	Seed treatment with chlorpyriphos 20 EC @ 12 ml/kg seed	7.00^{bc} (2.73)	2.00^{a} (1.47)	2.33^{ab} (1.66)	3.78^{bc} (1.95)	59.00
T_2	Seed treatment with imidacloprid 600 FS @ 2 ml + 4 ml of water /kg seed	0.00^{a} (0.71)	0.00 ^{a}(0.71)	0.00^{a} (0.71)	0.00^{a} (0.71)	100.00
T_3	Seed treatment with clothianidin 50 WDG @ 2 g/kg seed	12.67^{cd} (3.62)	3.67^{ab} (1.87)	3.33^{b} (1.93)	6.57^{cde} (2.47)	28.74
T_4	Furrow application of carbofuran 3 G @ 33 kg/ha	0.00^{a} (0.71)	0.00^{a} (0.71)	0.00^{a} (0.71)	0.00^{a} (0.71)	100.00
T_5	Furrow application of quinalphos 1.5 D @ 25 kg/ha	8.67^{bc} (3.02)	2.33^{ab} (1.68)	2.67^{bc} (1.77)	4.56^{bcd} (2.16)	50.54
T_6	Soil drenching of imidacloprid 17.8 SL @ 3 ml/10 L	5.67^{bc} (2.46)	2.00^{ab} (1.48)	2.33^{ab} (1.56)	3.33^{b} (1.84)	63.88
T_7	Soil drenching of chlorpyriphos 20 EC @ 8 ml/10 L	13.33^{cd} (3.69)	3.00^{ab} (1.86)	3.67^{b} (2.04)	6.67^{de} (2.53)	27.66
T_8	Soil drenching of Urea (1 kg) + Phorate 10 G (1 kg) @ 2 kg/10 L	10.00^{bcd} (3.22)	2.67^{bc} (1.76)	2.67^{ab} (1.76)	5.11^{bcd} (2.25)	44.58
T_9	Untreated control	16.00^{d} (4.04)	5.33^{b} (2.40)	6.33^{b} (2.60)	9.22^{e} (3.02)	0.00
	F value	36.46	3.36	8.27	48.06	
	P value (0.05)	0.00	0.02	0.00	0.00	

Note: Values in the parenthesis are square root transformed √(X+0.5); PROC: Per cent reduction over control.

observed at 5 per cent level of significance. Reduced yields were recorded in the treatment with no insecticide (T_9) with pooled mean yield of 1143 kg ha^{-1} (Table 3).

The overall results of this trial were in conformity with Kumar *et al*. (2019) where the authors reported that Imidacloprid 600 FS @ 2 ml + 4 ml water per kg seed was

Table 2: Efficacy of different insecticides against number of groundnut root grubs per m^2 area during 2018, 2019 and 2020.

	Treatments	No. of root grubs per m^2 area			
		2018	2019	2020	Pooled mean
T_1	Seed treatment with chlorpyriphos 20 EC @ 12 ml/kg seed	1.33^{ab} (0.36)	1.33^{ab} (0.32)	1.00^{ab} (0.25)	1.22^{ab} (0.31)
T_2	Seed treatment with imidacloprid 600 FS @ 2 ml + 4 ml of water /kg seed	0.00^{a} (0.00)	0.00^{a} (0.00)	0.00^{a} (0.00)	0.00^{a} (0.00)
T_3	Seed treatment with clothianidin 50 WDG @ 2 g/kg seed	2.67^{bc} (0.56)	2.00^{ab} (0.46)	2.00^{b} (0.39)	2.22^{bc} (0.47)
T_4	Furrow application of carbofuran 3 G @ 33 kg/ha	0.00^{a} (0.00)	0.00^{a} (0.00)	0.00^{a} (0.00)	0.00^{a} (0.00)
T_5	Furrow application of quinalphos 1.5 D @ 25 kg/ha	1.67^{ab} (0.33)	1.67^{ab} (0.36)	1.33^{ab} (0.32)	1.56^{b} (0.34)
T_6	Soil drenching of imidacloprid 17.8 SL @ 3 ml/10 L	0.67^{ab} (0.20)	1.00^{ab} (0.26)	1.33^{ab} (0.36)	1.00^{ab} (0.27)
T_7	Soil drenching of chlorpyriphos 20 EC @ 8 ml/10 L	2.67^{bc} (0.56)	1.67^{ab} (0.42)	2.33^{b} (0.52)	2.22^{bc} (0.49)
T_8	Soil drenching of Urea (1 kg) + Phorate 10 G (1 kg) @ 2 kg/10 L	1.67^{b} (0.42)	1.67^{ab} (0.36)	2.67^{ab} (1.76)	1.56^{b} (0.38)
T_9	Untreated control	5.67^{c} (0.83)	3.67^{b} (0.64)	4.00^{b} (0.69)	4.44^{c} (0.72)
	F value	12.32	2.76	4.96	11.49
	P value (0.05)	0.00	0.04	0.03	0.00

Note: Values in the parenthesis are log transformed [log (X+1)].

Table 3: Efficacy of different insecticides on pod yield (kg/ha) of groundnut during *kharif* 2018, 2019 and 2020.

	Treatments	Pod yield (kg/ha)				Increased yield over control (kg ha^{-1})
		2018	2019	2020	Pooled mean	
T_1	Seed treatment with chlorpyriphos 20 EC @ 12 ml/kg seed	962^{ab}	2069^{ab}	1225^{bc}	1419^{bc}	276
T_2	Seed treatment with imidacloprid 600 FS @ 2 ml + 4 ml of water/kg seed	1095^{a}	2265^{a}	1965^{a}	1775^{a}	632
T_3	Seed treatment with clothianidin 50 WDG @ 2 g/kg seed	893^{ab}	1979^{ab}	1102^{c}	1325^{c}	182
T_4	Furrow application of carbofuran 3 G @ 33 kg/ha	996^{ab}	2228^{a}	1871^{ab}	1698^{ab}	555
T_5	Furrow application of quinalphos 1.5 D @ 25 kg/ha	916^{ab}	1934^{ab}	1288^{bc}	1379^{bc}	236
T_6	Soil drenching of imidacloprid 17.8 SL @ 3 ml/10 L	936^{ab}	1955^{ab}	1197^{b}	1363^{c}	220
T_7	Soil drenching of chlorpyriphos 20 EC @ 8 ml/10 L	903^{ab}	2071^{ab}	1358^{abc}	1444^{abc}	301
T_8	Soil drenching of Urea (1 kg) + Phorate 10 G (1 kg) @ 2 kg/10 L	970^{ab}	2128^{a}	1256^{bc}	1452^{abc}	309
T_9	Untreated control	728^{b}	1736^{b}	963^{c}	1143^{c}	-
	F value	2.82	5.46	6.73	8.12	
	P value (0.05)	0.04	0.002	0.001	0.00	

highly effective against *H. reynaudi* with lowest cumulative per cent plant mortality per plot of 3.26%, highest per cent protection over control (91.03%), with highest pod yield of 1613 kg ha^{-1} and cost-benefit ratio of 1:1.61. The present findings are in agreement with the results reported by Arjun *et al.* (2021) where the maximum pod yield (21.13 q/ha) was found in imidacloprid treated plots (Imidacloprid @ 17.8 SL @ 360 ml per hectare). Early applications of Imidacloprid against Childers canegrubs, *Antitrogus parvulus* Britton appears to be more effective than later applications which lead to larger yield responses (McGill *et al.,* 2003).

CONCLUSION

Among the eight insecticides evaluated, seed treatment with Imidacloprid 600 FS @ 2 ml + 4 ml water per kg seed and soil application of carbofuran 3G @ 33 kg/ha in the furrows at the time of sowing were highly effective with lowest per cent plant mortality (0.00%) due to root grub and highest per cent protection over control (100%). From this study it is evident that these two insecticides can be recommended to farmers to manage root grubs at early stages of plant growth.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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