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Development and validation of IPM modules against major soil insect pests of groundnut

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Abstract
Five different IPM modules were designed and tested for the management of soil insect-pests in groundnut including farmer practices during *kharif*, 2019& 2020 at Durgapura, Jaipur. The data observed for white grub, *Holotrichia consanguinea* and termite, *Odontotermes obesus.* It was noticed that IPM-I consisting soil application of neem cake 250kg/ha, seed treatment with imidacloprid 600 FS-@ 6.5 ml/kg seed, a*pplication of Beauveria bassiana* @ 0.5g/m^2 and application of imidacloprid 17.8 SL@ 300 ml/ha found significantly superior to reduced insect-pest incidence on groundnut and enhanced the yield over farmers' practices. The population of white grub larvae and percent plant mortality were recorded to be lowest in module T1 and recorded 0.0 larvae/m^2 area and 3.37% plant mortality, respectively. The module T1 was significantly superior to rest of the treatment during both the year.

Keywords: IPM, insecticide, *M. anisople*, biopesticide and neem cake

Introduction
Groundnut (*Arachis hypogaea* L.), an important oilseed and supplementary food crop of the world is attacked by more than 100 insect-pests right from planting stage to its storage [12]. The annual yield loss in groundnut due to insect-pests is approximately 15 per cent *i.e.*, 1.6 million tones of produce worth Rs 25,165 million [4, 6]. Among these pest soil inhibiting pest are more important than other pests. White grubs are the soil inhibiting and root feeding immature stages of scarab beetles of which larval stage is destructive in nature [16]. These are generally known as May-June beetles because of their coincidence of their emergence during the month of May/June. This is a polyphagous pest both in the grub and adult stage and inflicts heavy damage on various fruit trees, their nurseries, vegetables, lawns and field crops [3]. White grubs are broad, fleshy, whitish or grayish white and the body is curved in the form of 'C' shape. Grubs are favored by light soil, fibrous rooted plants and high particulate organic matter content and are not abundant in waterlogged, compacted, stony soils or lands lacking vegetation [9]. In endemic areas, the damage to groundnut ranges from 20-100 per cent. The presence of one grub/m^2 in soil may cause 80-100 per cent plant mortality [18]. In our country, *Holotrichia*, *Brahmina*, *Leucopholis* and *Lepidiota* recorded as major genus of white grubs [8]. In Rajasthan, mainly three species *viz.*, *Holotrichia consanguinea*, *Holotrichia serrata* and *Maladera insanabilis* are identified to damage groundnut crop in their larval stages [11]. Termites *O. obesus* (Rambur) are social insects, attack on the tap root, feed out all contents ultimately replacing it with mud [13]. In case of sever attack, termite can cause 5 to 45 percent mortality of plants and 46 percent damages to pod [7, 14]. Different control methods such as cultural practices, biological control and application of plant extracts and insecticides are used to control termites [2].

The increasing problems due to continued usage of pesticides and failure of individual IPM components to check the pest population necessitates the development of IPM modules that involves the integration of IPM components. Application of chemical insecticides is still regarded as the most preferred pest management strategy among the farmers and their indiscriminate use have serious adverse effect on beneficial insects, human health and environment. There is necessity of implementation of alternative options, considering the adverse effect of insecticides, management of the insect pests of groundnut through IPM strategies is gaining importance in the recent years. Research carried out to identify the alternative means of pest management which have environment interaction with specific and novel mode of action, less hazardous eco-friendly and compatible with eco-friendly pest management programmes.

Keeping the above perspective in view, the present study was planned to synthesize five different IPM modules and compare them with the farmers' practice.

Materials and methods

The experiment was conducted in experimental farm of Rajasthan Agricultural Research Institute, Durgapura, Jaipur in Randomized Block Design with four replications. Five different IPM modules were synthesized for the management of white grub in groundnut including farmers' practices after reviewing the literature/technologies. The detailed description of modules is given in Table 1. These modules comprised of cultural, biological and chemical practices for the management of white grub in groundnut. The modules were evaluated for two consecutive *Kharif* seasons of 2019 and 2020.The groundnut variety RG 510 was sown during *Kharif* seasons. The plot size was kept 20x20 m^2. Observations were recorded on per cent plant damage of groundnut and larval population of white grub during both the seasons. A weekly observation schedule was followed for recording of plant mortality in groundnut. Initial plant population was taken from each replications and treatments. The final plant mortality was taken before harvesting of the crop and percent plant mortality were calculated. Larval populations were counted from five spots of 1m^2 area from each replication at 45 DAS of groundnut. After harvesting, pod yields were recorded from each plot. All analyses were performed at the 0.05 significance level Statistical analysis.

Table 1: Details of IPM modules evaluated against white grubs in groundnut

Practice	IPM modules/Treatment				
	T1	**T2**	**T3**	**T4 (Farmers practice)**	**T5 (control)**
Cultural	Soil amendments with Neem cake 250kg/ha	Soil amendments with Neem cake 250kg/ha	Soil amendments with Neem cake 250kg/ha	-	
Seed treatment	Seed treatment with imidacloprid 600 FS @ 6.5 ml/kg seed	Seed treatment with imidacloprid 600 FS @ 6.5 ml/kg seed	Seed treatment with imidacloprid 600 FS @ 6.5 ml/kg seed	Seed treatment with clothianidin 50 WDG @2g/kg seed	
Microbial treatment	*Furrow application of Beauveria bassiana* –0.5g/m^2 mix with water at 15 DAS for effective management of white grub	*Furrow application of Metarhizium anisopliae-0.5*g/m^2 mix with water at 15 DAS for effective management of white grub	*Furrow application of H.indica-0.5*g/m^2 mix with water at 15 DAS for effective management of white grub	-	
Chemical treatment	Application of imidacloprid 17.8 SL@ 300 ml/ha at 22 DAS for effective control of white grub	Application of Fifronil 5 SC-3.0 lit./ha at 22 DAS for effective control of white grub	Application Fifronil40%+Imidacloprid 40%WG@ 300g/ha at 22 DAS for effective control of white grub	Application of Quinolphos 25%EC @ 4.0 liter/ha at 35 DAS	

Results and discussion

(i) Evaluation of modules: The evaluation of five modules (T1 to T5) was carried out in two seasons; *Kharif* 2019 and 2020

Larval population: The larval population of white grub varied significantly in the tested modules. During *Kharif*-2019, the lowest larval population of white grub was recorded in T1 (0.00 larvae/m^2) module followed by T2 (0.17 larvae/m^2) and highest in T5 (7.00 larvae/m^2) module. Similar trends were observed in larval population recorded during *Kharif*-2020 (Table 2). The mean larval population of white grub from 0.0 to7.07 larvae/m^2. The mean larval population of white grub was maximum in T 5 module (7.07 larvae/m^2) and minimum larval population in T 1 module (0.0 larvae/m^2).

Percent plant mortality: The highest plant mortality was recorded in T 5 module (control) followed by T4,T3 and T2 *i.e*. 37.67, 14.91 and 3.37 percent during *Kharif*-2019, respectively. Similar trends were also observed during *kharif*, 2020. The mean plant mortality were recorded lowest in T1 followed by T2,T3, T4 and T5 (3.90,7.00,15.56, 38.39 and 100.0 percent, respectively)**.**The present finding corroborates with the finding of ([1]) who conducted the study on chemical control of groundnut white grub, *Holotrichia serrata* and *H. reynaudi* in south-central India. They observed that chlorpyriphos and imidacloprid seed dressing were effective against *H. serrata* at rates as low as 0.6 and 3.5 gm a.i/kg seed, respectively. This result also corroborate with ([5]) they observed that the seed treatment with imidaclopride 600 FS record lowest plant mortality.

Yield: The highest pod yield was recorded during *Kharif, 2019* season was obtained in module T1 (31.0qha-1) and lowest in T 5 (0.0qha-1). The groundnut mean yield was recorded in T1 (30.20q/ha) followed by T2 (28.25q/ha) and minimum pod yield was recorded in T5 (0.0q/ha. The present finding were corroborate with ([17]&[10]) they found *Beauveria bassiana and M. Anisopliae* effective against *H.* serrata in sugarcane. In a study on the control of white grub, seed treatment of groundnut with imidacloprid 200 SL @ 3 ml /kg seed resulted in 80.36 percent control ([15]). ([5]) observed that the seed treatment with imidaclopride 600 FS record highest groundnut yield.

Net incremental cost benefit ratio

Further, it could be seen from the results that the highest ICBR was recorded in the treatment TI consisting of soil amendments with Neem cake 250kg/ha, seed treatment with imidacloprid 600 FS @ 6.5 ml/kg seed, *furrow application of Beauveria bassiana* –0.5g/m^2 mix with water at 15 DAS for effective management of white grub and application of imidacloprid 17.8 SL@ 300 ml/ha at 22 DAS for effective control of white grub (1:23.16).The lowest NICBR (1:12.83) was obtained in the treatment T3.

Conclusion

The present finding revealed that IPM module consisting of soil amendments with neem cake 250kg/ha, seed treatment with imidacloprid 600 FS @ 6.5 ml/kg seed, furrow application of *Beauveria bassiana* 0.5g/m^2 and application of imidacloprid 17.8 SL@ 300 ml/ha at 22 DAS was found most effective against soil pests in groundnut. The use of Integrated

Pest Management modules is believed to be a promising strategy in managing white grub and other soil arthropods in groundnut. The adoption of IPM modules, farmers can reduce the pesticide pressure on crops and effectively manage the insect pests of crops.

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Table 2: Effect of IPM modules (treatments) on population of whitegrub on groundnut

Module/Treatment	Larval population of white grub per square meter		
	Kharif-2019	*Kharif*-2020	Mean
T1	0.00	0.00	0.00
T2	0.17	0.20	0.18
T3	0.50	0.55	0.52
T4	2.0	2.10	2.05
T5	7.00	7.15	7.07
SE(m)	0.149	0.272	0.030
C.D. at 5%	0.45	0.84	0.12
C.V. %	12.05	14.18	10.13

Table 3: Plant mortality in different IPM modules (treatments) on groundnut.

Module / Treatment	Per cent plant mortality of groundnut		
	Kharif-2019	*Kharif*-2020	Mean
T1	3.37 (10.32)	4.43 (12.13)	3.90 (11.23)
T2	6.68 (14.78)	7.33 (15.63)	7.00 (15.20)
T3	14.91 (22.55)	16.21 (23.72)	15.56 (23.13)
T4	37.67 (37.48)	39.11 (38.68)	38.39 (38.08)
T5	100.00 (90.00)	100.00 (90.00)	100.00
SE(m)	1.095	0.545	0.674
C.D. at 5%	3.32	1.699	2..022
C.V. %	7.79	8.02	9.13

Table 4: Effect of IPM modules (treatments) on yield of groundnut

Module/Treatment	Yield of groundnut			ICBR ratio
	Kharif-2019	*Kharif*-2020	Mean	
T1	31.0	29.41	30.20	1:23.16
T2	29.05	27.45	28.25	1:14.27
T3	26.33	25.00	25.66	1:12.83
T4	16.05	14.83	15.44	1:18.30
T5	0.00	0.00	0.00	-
SE(m)	1.128	0.779	0.331	-
C.D. at 5%	3.43	2.42	1.33	-
C.V. %	12.78	11.05	12.35	-

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