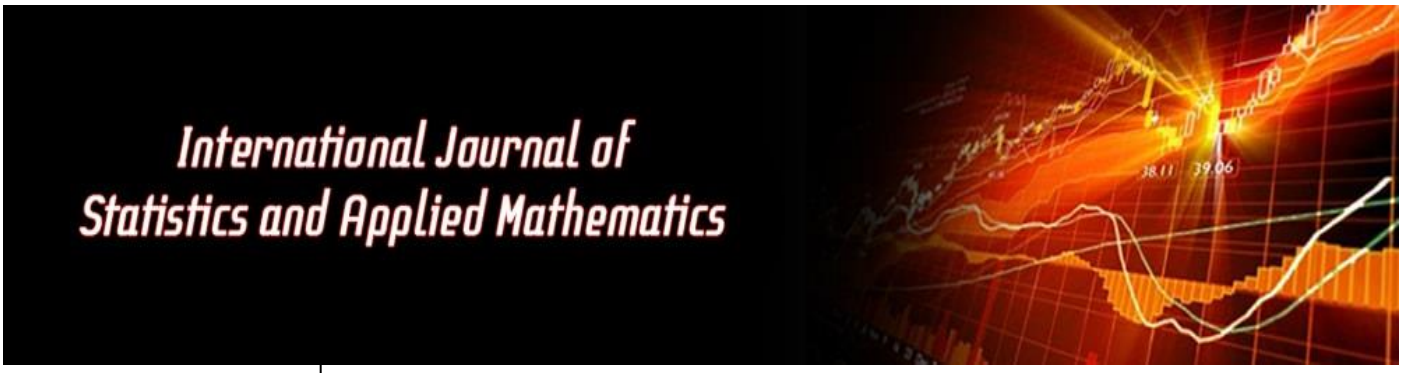

ISSN: 2456-1452
Maths 2023; SP-8(6): 1132-1136

https://www.mathsjournal.com
Received: 26-09-2023
Accepted: 27-10-2023

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Efficacy of pesticides against white grub infesting groundnut (*Arachis hypogaea* L.)

VD Chavan, AS Bagde, SB Kharbade, UB Hole and NA Deore

Abstract
An experiment was undertaken to investigate efficacy of pesticides against white grub infesting groundnut. An investigation was conducted in Tardal village, located in the Hatkangale tehsil of Kolhapur (MH). The application of fipronil 40% + imidacloprid 40% WG showed significant effectiveness, leading to plant mortalities of 1.96%, 2.73%, 2.06%, and 2.87% at 30, 50, 70, and 90 DAG (Days After Germination), respectively. Notably, this treatment demonstrated a clear superiority over all other treatments. In contrast, the untreated control displayed the highest plant mortality rates at 9.12%, 13.19%, 17.25%, and 23.28% during observations at 30, 50, 70, and 90 DAG, respectively. The percentage over the control for the fipronil 40% + imidacloprid 40% WG treatment surpassed that of all other treatments, with clothianidin 50 WDG and *Metarhizium anisopliae* following in efficacy. The consistent effectiveness of the fipronil 40% + imidacloprid 40% WG treatment remained significantly superior to all other treatments at 30, 50, 70, and 90 DAG. Clothianidin 50 WDG demonstrated the next level of efficacy, resulting in lower plant mortality at the specified time points.

Keywords: Groundnut, white grub, grub population, fipronil 40%+ imidacloprid 40%, plant mortality

1. Introduction
Groundnut, often colloquially known as the poor man's nut, holds a significant place among the top fifteen global food crops and is cultivated extensively worldwide. Originating from South America, it is known by various names such as peanut, earthnut, monkey nut, and goobers (Biswas *et al.*, 2019) [2]. Groundnut (Arachis hypogaea L.) serves a critical role as a major oilseed and cash crop in Asia and Africa, primarily cultivated during the kharif season as a significant member of the Leguminosae family. Among various pests affecting groundnuts, soil-inhibiting pests, especially white grubs, pose a significant menace. White grubs, representing the early stages of scarab beetles that dwell in the soil and feed on roots, have a broad, fleshy appearance with whitish or grayish-white coloration, forming a curved 'C' shape. These destructive grubs flourish in light soils, particularly around plants with fibrous roots and high organic matter content, but are less prevalent in waterlogged, compacted, stony soils, or areas without vegetation. In regions with widespread infestations, groundnut damage can vary from 20 to 80 percent. Notably, the mere presence of a single grub per square meter of soil can result in plant mortality rates as high as 80 to 100 percent (*Baloda et al.*, 2021) [1]. White grubs pose a substantial threat to field crops due to a significant portion of their life cycle occurring underground, making detection challenging even after causing extensive damage to healthy crops. These pests exhibit a polyphagous nature, feeding on various cultivated crops and trees. Cultivated crops such as groundnut, cereals, millets, pulses, vegetables, and plantation crops are susceptible to white grub attacks (David *et al.*, 1987) [3]. The impact of white grubs on crops can be severe, with reported yield losses reaching up to 70 percent (Yadava and Sharma, 1995) [7], emphasizing the need for effective management strategies to mitigate their impact on agricultural productivity.

2. Material methods
2.1 Experimental site
The experiment was carried during *Kharif* season, 2022-23 on the farmer's field, A/P Tardal, Tal - Hatkanangale, Dist -Kolhapur.

2.3 Location, Climate and Weather Condition

The location is positioned at an altitude of 390 meters above mean sea level, with latitude 16.51° and longitude 73.84°. climate is semi-arid with an average annual rainfall of approximately 492 mm. The region is characterized by low temperatures during the winter season. Weather parameters significantly influence the development of insect pests in this agro-climatic zone.

2.3 Experimental details

The experiment was designed as a randomized block design, consisting of nine treatments and three replications. Each plot had a size of 4.5 m x 3.0 m, with plant spacing set at 45 cm × 15 cm. Throughout the crop growth, standard agronomic practices were followed, with the exception of plant protection measures. The application of various insecticides was carried out using the drenching method, applied at the onset of pest infestation. First application was done at 20 DAG and second application was done at 50 DAG.

2.4 Methods of Recording Observations

The experiment involved recording the total number of plants and plants damaged by white grub at 30, 50, 70 and 90 days after germination. After each count, the damaged plants were removed. Using this data, the percentage of plant mortality due to white grub infestation was calculated. White grub population was measured from one square meter area in each plot by digging the soil up to a depth of 50 cm after harvesting.

Table 1: Details of Treatments

Treatment	Treatment	Formulation dose /ha	Trade name	Manufacture Company
T_1	*Beauveria bassiana*	3 Kg	Phule Beauveria	MPKV, Rahuri
T_2	*Metarhizium anisopliae*	3 Kg	Phule Metarhizium	MPKV, Rahuri
T_3	*Heterorhabditis indica*	5 Kg	Sniper-WP	Nirmal Seeds
T_4	Fipronil 40%+Imidacloprid 40% -80WG	250 g	Lesenta	Bayer Crop Science
T_5	Thiamethoxam 30% FS	1000 ml	Reno	UPL Ltd.
T_6	Clothianidin 50%WDG	250 g	Dantotsu	Sumitomo Chemical India Ltd.
T_7	Chlorantraniliprole 18.5% SC	625 ml	Coragen	FMC India Private Ltd.
T_8	Fipronil 5% SC	1250 ml	Regent	Bayer Crop Science
T_9	Untreated control	-	-	-

3. Results and Discussion

Eight distinct treatments were administered, encompassing five insecticides and three bio-pesticides. These treatments were applied individually to assess their effectiveness in combating white grubs that infest groundnut.

3.1 Efficacy of pesticides against white grub infesting groundnut after 1st application

3.1.1 Efficacy of pesticides against white grub at 30 DAG

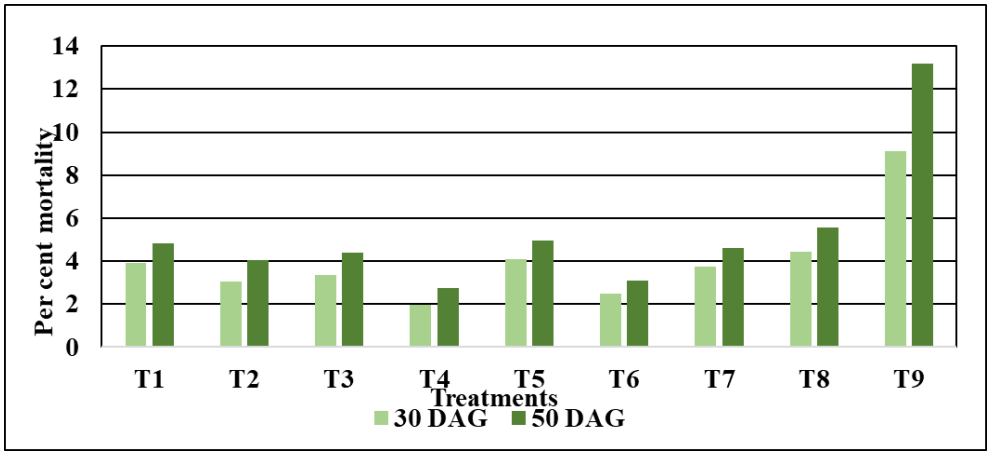
The observations made 30 DAG revealed that all the treatments were significantly more effective than the untreated control. Particularly, treatment involving fipronil 40% + imidacloprid 40% WG at a rate of 250 g per hectare demonstrated superior performance compared to other treatments and was at par with a clothianidin 50 WDG at the same application rate. Plant mortality ranged from 1.96 to 4.43 per cent in the treated plots, in contrast to the 9.12 per cent mortality observed in the untreated control.

3.1.2 Efficacy of pesticides against white grub at 50 DAG

Among the treatments, the application of fipronil 40% + imidacloprid 40% WG at a rate of 250 g per hectare displayed a significantly superior performance compared to all other treatments, resulting in a 2.73 per cent plant mortality. It was at par with the treatment of clothianidin 50 WDG at the same application rate, where 3.11 per cent plant mortality was observed. In contrast, the untreated control had a notably higher plant mortality rate of 13.19 per cent. Plant mortality ranged from 2.73 to 5.56 per cent across the various treatments.

Table 2: Efficacy of different pesticides against white grubs infesting groundnut on 1st application

Tr. No.	Treatments	Dose per lit (g/ml)	Damage percent before drenching	Mean per cent mortality (DAG)		Mean	Per cent over Control
				30 DAG	50 DAG		
1	*Beauveria bassiana*	6	6.50 (14.74)*	3.92 (11.42)	4.82 (12.65)	4.37	60.83
2	*Metarhizium anisopliae*	6	6.67 (14.95)	3.04 (9.97)	4.05 (11.61)	3.54	68.23
3	*Heterorhabditis indica*	10	6.00 (14.17)	3.37 (10.54)	4.40 (12.05)	3.89	65.18
4	Fipronil 40% + Imidacloprid 40% WG	0.5	6.50 (14.76)	1.96 (8.03)	2.73 (9.48)	2.35	78.97
5	Thiamethoxam 30% FS	2	5.67 (13.75)	4.07 (11.57)	4.96 (12.83)	4.52	59.53
6	Clothianidin 50% WDG	0.5	6.17 (14.30)	2.49 (9.06)	3.11 (10.08)	2.80	74.92
7	Chlorantraniliprole 18.5% SC	1.25	6.33 (14.56)	3.74 (11.13)	4.62 (12.38)	4.18	62.53
8	Fipronil 5% SC	2.5	5.83 (13.90)	4.43 (12.13)	5.56 (13.63)	5.00	55.22
9	Untreated Control		6.83 (15.13)	9.12 (17.58)	13.19 (21.28)	11.16	
	S.E.±		0.72	0.57	0.65		
	C.D. (5%)		NS	1.71	1.97		
	CV %		8.72	8.78	8.83		



*Figures in parenthesis are arcsine transformed values.
** Figures in parenthesis are square root transformed values.

Fig 1: Efficacy of different pesticides against white grubs infesting groundnut on 1st application

3.2 Efficacy of pesticides against white grub infesting groundnut after 2nd application

3.2.1 Efficacy of pesticides against white grub at 70 DAG

The findings indicated that application of fipronil 40% + imidacloprid 40% WG at a rate of 250 g per hectare demonstrated the highest efficacy, resulting in the lowest plant mortality rate (2.06%). This performance was at par with clothianidin 50 WDG at 250 g per hectare (2.64%) and *Metarhizium anisopliae* at 3 kg per hectare (3.07%). In the untreated control group, a plant mortality rate of 17.25% was observed.

3.2.2 Efficacy of pesticides against white grub at 90 DAG

The application of fipronil 40% + imidacloprid 40% - 80% at a rate of 250 g per hectare demonstrated significant superiority over all other treatments and was at par with clothianidin 50 WDG at 250 g per hectare and *Metarhizium anisopliae* at 3 kg per hectare. Plant mortality rates ranged from 2.87% to 6.82%, significantly lower than the 23.28% observed in the untreated control group.

The application of fipronil 40% + imidacloprid 40% WG demonstrated significant efficacy, leading to plant mortalities of 1.96%, 2.73%, 2.06%, and 2.87% at 30, 50, 70, and 90 DAG (Days after Germination), respectively. This treatment exhibited superiority over all other treatments. In contrast, the untreated control showed the highest plant mortality at 9.12%, 13.19%, 17.25%, and 23.28% at 30, 50, 70, and 90 DAG, respectively. The percentage over control for the fipronil 40% + imidacloprid 40% WG treatment exceeded that of all other treatments, with clothianidin 50 WDG and *M. anisopliae* following, as detailed in Table 2 & 3. The consistent effectiveness of the fipronil 40% + imidacloprid 40% WG treatment remained superior to all other treatments at 30, 50, 70, and 90 DAG. Clothianidin 50 WDG demonstrated the next level of efficacy, resulting in lower clump mortality at the specified time points.

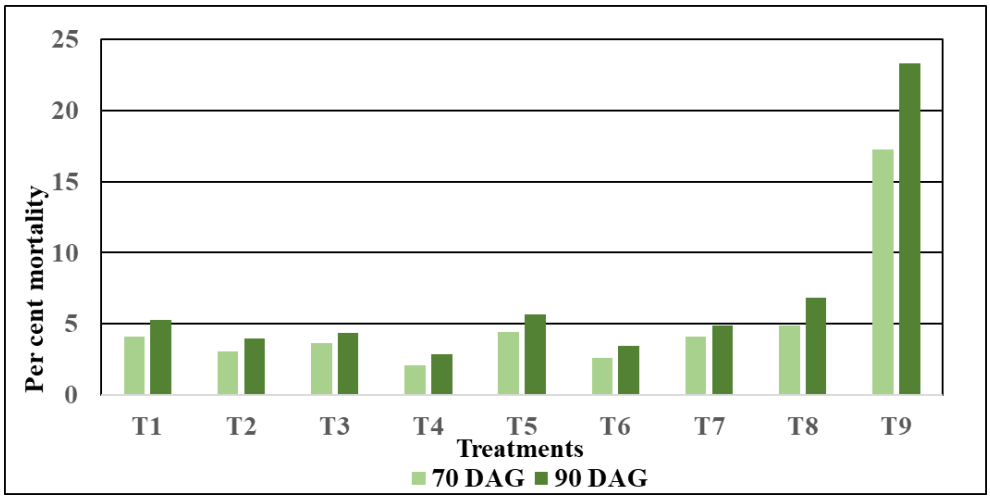


Fig 2: Efficacy of different pesticides against white grubs infesting groundnut on 2nd application

3.2.3 Grub population of white grub after harvesting

The data presented in Table 3 indicates a significant reduction in the grub population across all treated plots compared to the untreated control group, which recorded 2.27 grubs per square meter. Particularly noteworthy is the treatment involving fipronil 40% + imidacloprid 40% WG at a rate of 250 g per hectare, where the lowest grub population of 1.05 grubs per square meter was observed. This result was at par with treatment utilizing clothianidin 50 WDG at the same application rate, with a recorded population of 1.22 grubs per square meter.

The present results are consistent with Patel *et al*., (2020) [6] research, demonstrating that imidacloprid 40% + fipronil 40% WG at a rate of 250 gm per hectare and clothianidin 50 WDG at the same rate exhibited equal and superior efficacy compared to alternative treatments. Patel *et al*, (2020) [6] observed the minimal grub population in imidacloprid 40% + fipronil 40% WG, which was comparable to clothianidin 50

WDG. In the study conducted by Mane and Mohite (2014) [4], it was determined that, out of the three entomopathogenic fungi investigated (*M. anisopliae*, *B. brongniartii*, and *B. bassiana*), M. anisopliae exhibited the highest efficacy in controlling third instar grubs.

The results are consistent with the research conducted by More, G.B. *et al*., (2023) [5], indicating that the application of imidacloprid 40% + fipronil 40% and clothianidin 50 WDG through soil drenching has proven to be a successful method for controlling white grub infestations. Furthermore, More, G.B. *et al*., (2023) concluded that among the three biopesticides *M. anisopliae*, *B. bassiana*, and *Heterorhabditis indica*, the *M. anisopliae* exhibited the highest efficacy in managing white grub populations.

Table 3: Efficacy of different pesticides against white grubs infesting groundnut on 2nd application

Tr. No.	Treatments	Dose per lit (g/ml)	Damage percent before drenching	Mean per cent mortality (DAG)		Mean	Per cent over Control	Average No. of grubs/m^2
				70 DAG	90 DAG			
1	*Beauveria bassiana*	6	4.82 (12.65)*	4.09 (11.65)	5.28 (13.27)	4.69	76.87	2 (1.58)**
2	*Metarhizium anisopliae*	6	4.05 (11.61)	3.07 (10.02)	3.95 (11.42)	3.51	82.67	1.33 (1.34)
3	*Heterorhabditis indica*	10	4.40 (12.05)	3.65 (10.96)	4.38 (12.08)	4.02	80.18	1.33 (1.34)
4	Fipronil 40% + Imidacloprid 40% WG	0.5	2.73 (9.48)	2.06 (8.19)	2.87 (9.61)	2.47	87.83	0.67 (1.05)
5	Thiamethoxam 30% FS	2	4.96 (12.83)	4.46 (12.18)	5.68 (13.73)	5.07	75.00	2.33 (1.68)
6	Clothianidin 50% WDG	0.5	3.11 (10.08)	2.64 (9.33)	3.48 (10.72)	3.06	84.91	1 (1.22)
7	Chlorantraniliprole 18.5% SC	1.25	4.62 (12.38)	4.08 (11.63)	4.86 (12.71)	4.47	77.96	1.67 (1.46)
8	Fipronil 5% SC	2.5	5.56 (13.63)	4.92 (12.78)	6.82 (15.12)	5.87	71.05	2.67 (1.77)
9	Untreated Control		13.19 (21.28)	17.25 (24.53)	23.28 (28.85)	20.27		4.67 (2.27)
	S. E.±		0.65	0.65	0.68			0.081
	C.D. (5%)		1.97	1.95	2.04			0.24
	CV %		8.83	9.10	8.31			9.20

*Figures in parenthesis are arcsine transformed values. ** Figures in parenthesis are square root transformed values.

3.3 Average yield (Kg/ha)

3.3.1 Pod yield

The findings from Table-4 revealed that the soil drenching with fipronil 40% + imidacloprid 40% WG at a rate of 250 g per hectare demonstrated the highest effectiveness, yielding the maximum pod yield at 2036 kg/ha. This performance was followed by clothianidin 50 WDG at 250 g per hectare, which achieved a pod yield of 2000 kg/ha. However, other treatments, including *Metarhizium anisopliae* at 3 kg per hectare (1940 kg/ ha), *Heterorhabditis indica* at 5 kg per hectare (1920 kg/ ha), chlorantraniliprole 18.5 SC at 625 gm per hectare (1884 kg/ha), *Beauveria bassiana* at 3 kg per hectare (1864 kg/ha), thiamethoxam 30 FS at 1000 ml per hectare (1860 kg/ ha), and fipronil 5 SC at 1250 ml per hectare (1808 kg/ ha), demonstrated moderate yields.

3.3.2 Dry fodder yield

The results presented in Table-4 demonstrate significantly higher dry fodder yields in all insecticidal treatments compared to the control plots (1680 kg/ha). The treatment with fipronil 40% + imidacloprid 40% at 250 g per hectare exhibited the greatest dry fodder yield, reaching 3054 kg/ ha. Similarly, clothianidin 50 WDG at 250 gm per hectare showed a high yield of 3000 kg/ ha, followed by *Metarhizium anisopliae* at 3 kg per hectare (2910 kg/ha), *Heterorhabditis indica* at 5 kg per hectare (2880 kg/ha), chlorantraniliprole 18.5 SC at 625 g per hectare (2826 kg/ha), *Beauveria bassiana* at 3 kg per hectare (2796 kg/ha), and thiamethoxam 30 FS at 1000 ml per hectare (2790 kg/ha). The treatment with fipronil 5 SC at 1250 ml per hectare yielded the lowest amount at 2712 kg/ha.

Table 4: Cost benefit ratio of different pesticides against white grub infesting groundnut

Tr.no.	Treatments	Cost of cultivation (Rs/ha)			Average Yield (kg/ha)		Additional yield over control		Gross returns			Net profit Rs/ha	Additional income over control	B:C ratio	ICBR
		Cost of insecticide	Common cultivation practices	Total (Rs/ha)	Pod	Dry fodder	Pod	Dry fodder	Pod	Dry fodder	total				
1.	*Beauveria bassiana*	1200	52400	53600	1864	2796	744	1116	93200	3355	104011	50411	41515	1.94	1:34.60
2.	*Metarhizium anisopliae*	1200	52400	53600	1940	2910	820	1230	97000	3492	108252	54652	45756	2.02	1:38.13
3.	*Heterorhabditis indica*	7800	52400	60200	1920	2880	800	1200	96000	3456	107136	46936	44640	1.78	1:5.72
4.	Fipronil 40% + Imidacloprid +40% WG	5750	52400	58150	2036	3054	916	1374	101800	3665	113609	55459	51113	1.95	1:8.89
5.	Thiamethoxam 30% FS	5600	52400	58000	1860	2790	740	1110	93000	3348	103788	45788	41292	1.79	1:7.37
6.	Clothianidin 50%WDG	8000	52400	60400	2000	3000	880	1320	100000	3600	111600	51200	49104	1.85	1:6.14
7.	Chlorantraniliprole 18.5% SC	18900	52400	71300	1884	2826	764	1146	94200	3391	105127	33827	42631	1.47	1:2.26
8.	Fipronil 5% SC	3400	52400	55800	1808	2712	688	1032	90400	3254	100886	45086	38390	1.81	1:11.29
9.	Untreated control	0	52400	52400	1120	1680			56000	2016	62496	10096		1.19	

4.4 Cost benefit analysis of pesticides treatment

The data from the Table-4 indicates that maximum gross return was achieved with the application of fipronil 40% + imidacloprid 40% WG at a dose of 250 g/ha (Rs 113609/ha), closely followed by clothianidin 50 WDG (Rs 111600/ha) at the same dose. Treatment T_9 i.e. control showed lowest gross return at Rs 62496/ha among all treatments. The treatment with *Metarhizium anisopliae* demonstrated the highest cost-benefit ratio (2.02), followed by treatments with fipronil 40 + imidacloprid 40% WG and *Beauveria bassiana* (1.95 and 1.94, respectively). However, the treatment T_2 i.e. *Metarhizium anisopliae* exhibited the highest incremental cost-benefit ratio (38.13), attributed to its lower cost, which was followed by treatment T_1 i.e. *Beauveria bassiana* (34.60).

5. Conclusion

Based on the comprehensive results, it can be deduced that application of fipronil 40% + imidacloprid 40% WG at a rate of 250 g per hectare and clothianidin 50 WDG at the same rate proved equally efficient and superior to other treatment methods. Out of the tested insecticides, fipronil 40% + imidacloprid 40% WG and clothianidin 50 WDG demonstrated superior efficacy in controlling white grubs.

6. Acknowledgement

Special thanks are extended to the research guide and colleagues for their encouragement and constructive feedback, crucial to the successful completion of this project.

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