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Efficacy of insecticides and biopesticides against white grub, *Phyllognathus dionysius* (Fabricius) infesting sugarcane in western Maharashtra

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Abstract
An experiment entitled "Efficacy of insecticides and biopesticides against white grub *Phyllognathus Dionysius* (Fabricius) infesting Sugarcane in Western Maharashtra." was conducted at research field of Department of Agricultural Entomology, Central Sugarcane Research Station, Padegaon, Satara (MH) during *Suru* 2021-22. A field experiment comprised of six insecticides and three bio-pesticides tested over untreated control against white grub in sugarcane. The results showed that treatment with soil drenching of fipronil 40% + imidacloprid 40% WG @ 300 g ha^{-1} was found to be most effective treatment for control of white grub followed by clothiandin 50 WDG @ 240 g ha-1, chlorantraniliprole 18.5 SC @ 500 ml ha-1 and *M. Anisopliae* @ 5 Kg ha-1.

Keywords: Sugarcane, biopesticides, insecticides, white grub

Introduction
Sugarcane, *Saccharum officinarum* L. is a tropical plant belongs to the Gramineae family. It is an important commercial crop of the nation. It is cultivated all over the worldwide under extremely divergent agro-climatic conditions. Significant losses in cane yield and sugar production have been linked to pests in the past. The white grub, a subterranean pest, has the power to completely reduce yield. Grubs of the white grub species consume the main roots, harming the underground portion of the stalk. (Thamarai Chelvi *et al.*, 2010) [7]. The immature stage of beetles commonly referred to as cochafers, chafers beetles, May beetles, or June beetles. The soil-inhibiting, root-feeding immature stages of scarab beetles, whose larval stage is destructive in nature, are known as white grubs (Coleoptera: Scarabaeidae) (Theurkar *et al.*, 2013) [8]. The two main management strategies used against all species of white grubs are adult collection and insecticidal applications (Raodeo *et al.*, 1976) [6]. Considering the facts, more emphasis is now being laid on use of chemical pesticides and biopesticides as one of the important components of control strategies. Now-a-days large numbers of newer insecticidal formulation in the form of ready mixture and individuals are also available in market. So, a different insecticides was made to test the efficacy against white grub in sugarcane crop.
Due to use of chemicals on large scale, they may create problem of environment pollution, pest resistance. (Kumbar *et al.*, 2019) [2] reported that the application of the chemical insecticide on the banks of the river cause river pollution to the next villages and also creates the chances of resistance development in pest. So utilization of various formulations of bio-pesticides increases the efficiency of control by reduction of the amount of applied insecticides.
In the present research paper, an attempt was made to study the efficacy of some insecticides and biopesticides against white grub in sugarcane.

Material and Methods
The experiment was laid out in randomized block design with ten treatments and three replications. The plot size was 5×5 m2 and plant spacing was 120×120 cm. The crop was raised following all the agronomical practices as per recommended Co 86032 cultivation practices except plant protection measures. The drenching of insecticides was carried by hand operated knapsack sprayer by removing nozzle. The first application of drenching was done when there was white grub population at ETL and started showing symptoms of clumps mortality and second drenching was given 80 days after first application.

The care was taken during drenching that it was covering all root zone of plant by means of making hole near root zone with the help of crow bar and the field was irrigated immediately after application. (Manisegaran *et al.*, 2011) [5]. The spray pump was thoroughly washed with water while switching from one treatment to another.

The observations of field experiments was recorded in 10 meter row length area from per plot and number of damaged clumps was counted at 40, 60, and 80 days after treatment. Clump mortality (%) = No. of plants damaged in 10 meter row length/ total no. of plants in 10 meter row length × 100 and the mortality percentage was calculated for each treatment. Data were subjected to analysis of variance.

Table 1: Treatment details

Tr. No	Treatments	Formulation dose/ha	Trade name	Source
T_1	Chlorantraniliprole 18.5 SC	500 ml	Coragen	FMC India Pvt. Ltd, TCG Financial ND Centre, 2 Floor, C-53, Bandra Kurla, Complex, Bandra (E), Mumbai- 400098
T_2	Fipronil 40% + Imidacloprid 40% WG	300g	Lassenta	Bayer CropScience Limited, Factory: Plot No. 66/1-75/2, GIDC Estate, Himatnagar-383001, Sabarkantha (G
T_3	Imidacloprid 70 WG	429g	Ad-fyre	Dhanuka Agritech limited, Factory: G, Daultabad Road, Gurgaon-122002 (HR).
T_4	Fipronil 0.3 G	34 kg	Regent	Bayer CropScience Limited, Bayer House, Central Avenue, Hiranandan Thane (West) - 400607.
T_5	Clothianidin 50 WDG	240g	Dantotsu	Sumitomo Chemical India Ltd Factory: C-5/184-185, GIDC, Dist- Valsad, Vapi 396195, Gujrat.
T_6	Thiamethoxam 25WG	320g	Actra	Syngenta India Ltd, Amar Paradigm, 110/11/3, Baner Road, Baner Pune- 411045, Maharashtra, India.
T_7	*Metarhizium anisopliae*	5 kg	Farmer	Foundation for Agricultural Resources Management and Environmental Remediation (FARMER) S J 14, Shastri Nagar, Ghaziabad- 202002 Uttar pradesh, India.
T_8	*Beauveria bassiana*	5 kg	Farmer	
T_9	*Heterorhabditis indica*	5 kg	Farmer	
T_{10}	Untreated check	--	--	-

Result and Discussion

The results obtained during the course of investigations are presented under the following heads.

Efficacy of insecticides and bio-pesticides against white grub infesting sugarcane (1st Application):

Nine different treatments consisting of Six insecticides and Three bio-pesticides applied individually and tested for determining their efficacy against white grubs infesting sugarcane.

Efficacy of insecticide and bio-pesticides at 40 DAT

The mortality of the clump ranged from 5.84 to 22.07 per cent when the observations were taken at 40 DAT (Table 2). The treatment with fipronil 40% + imidacloprid 40% WG at the dose of 300 g per ha. Recorded lowest 5.84 per cent mean clump mortality and found to be significantly superior over all other treatments. The treatment with clothianidin 50 WDG was next in order of efficacy recorded 6.79 per cent clump mortality. The treatment with chlorantraniliprole 18.5 SC and *Metarhizium anisopliae* was found to be equally effective where 7.33 and 7.49 per cent clump mortality was recorded respectively. The treatment with fipronil 40% + imidacloprid 40% WG, clothianidin 50 WDG, chlorantraniliprole 18.5 SC and

M. Anisopliae found to be equally effective in controlling clump mortality due to white grub. The significant differences did not existed among rest of the treatments. In untreated control 22.07 per cent clump mortality was recorded.

Efficacy of insecticide and bio-pesticides at 60 DAT

The data presented in Table 2. Revealed that the treatment with fipronil 40% + imidacloprid 40% WG at the dose of 300 g per ha. Recorded lowest 7.12 per cent mean clump mortality and found to be significantly superior over all other treatments as compared to

24.26 per cent clump mortality in untreated control. When the observations were recorded 60 DAT the treatment with clothianidin 50 WDG was next in order of 7.54 per cent clump mortality was recorded. The treatment with chlorantraniliprole 18.5 SC and *M. anisopliae* found to be equally effective where 8.21 and 8.53 per cent mortality of the clump, respectively were recorded.

Efficacy of insecticide and bio-pesticides at 80 DAT

At 80 DAT the treatment with of fipronil 40% + imidacloprid 40% WG at the dose of 300 g per ha was found to be constantly superior over all other treatment and recorded 7.52 per cent clump mortality as against 27.45 per cent mortality in untreated control (Table 2). Treatment with clothianidin 50 WDG was next in order of efficacy where 8.64 per cent clump mortality was recorded. The treatment with chlorantraniliprole 18.5 SC and *M. anisopliae* next in order of efficacy where 9.92 and 10.08 per cent clump mortality, respectively were recorded. The treatment with fipronil 40 + imidacloprid 40% WG, clothianidin 50 WDG, chlorantraniliprole 18.5 SC and *M. anisopliae* were found to be equally effective in controlling the clump mortality

Table 2: Evaluation of insecticides and bio-pesticides against white grubs in Field condition on 1st application

Tr. No.	Treatment	Initial clumps /10 meter row length			Mean per cent of clump mortality (DAT)			Mean	Per cent over control
		No. of clumps	No. of clumps damaged	% Damage	40 DAT	60 DAT	80 DAT		
1	Chlorantraniliprole 18.5 SC	10 (3.24)*	2 (1.58)	20 (26.57)**	7.33 (15.70)	8.21 (16.65)	9.92 (18.35)	8.49	65.4965
2	Fipronil 40% + imidacloprid 40% WG	10 (3.24)	2 (1.58)	20 (26.57)	5.84 (13.98)	7.12 (15.47)	7.52 (15.91)	6.83	72.2328
3	Imidacloprid 70 WG	10 (3.24)	2 (1.58)	20 (26.57)	11.84 (20.12)	13.16 (22.26)	14.03 (21.99)	13.01	47.1085
4	Fipronil 0.3 G	10 (3.24)	2 (1.58)	20 (26.57)	8.24 (16.68)	9.88 (18.31)	11.27 (19.61)	9.80	60.1699
5	Clothiandin 50 WDG	10 (3.24)	2 (1.58)	30 (33.21)	6.79 (15.10)	7.54 (15.93)	8.64 (17.09)	7.65	68.8759
6	Thiamethoxam 25 WG	10 (3.24)	3 (1.87)	20 (26.57)	11.14 (19.49)	12.97 (21.11)	13.53 (21.58)	12.55	48.9835
7	*Metarhizium anisopliae*	10 (3.24)	2 (1.58)	20 (26.57)	7.49 (15.87)	8.53 (16.98)	10.08 (18.51)	8.70	64.6291
8	*Beauveria bassiana*	10 (3.24)	2 (1.58)	20 (26.57)	10.60 (18.99)	11.97 (20.23)	13.21 (21.31)	11.93	51.5090
9	*Heterorhabditis indica*	10 (3.24)	3 (1.87)	30 (33.21)	9.43 (17.88)	10.36 (18.77)	12.48 (20.69)	10.76	56.2619
10	Untreated control	10 (3.24)	2 (1.58)	20 (26.57)	22.07 (28.02)	24.26 (29.50)	27.45 (31.59)	24.59	
	S.Em ±	0.14	0.081	1.86	0.89	1.00	1.06		
	CD (p= 0.05)	NS	NS	NS	2.65	2.99	3.17		
	CV	7.75	8.65	11.64	8.50	9.00	8.94		

* Figures in parenthesis are square root transformed values for numbers. ** Figures parenthesis are arcsine transformed values for per cent

The overall performance of the treatment with fipronil 40% + imidacloprid 40% WG was most effective recorded 5.84, 7.12 and 7.52 per cent mean clump mortality when the observations were recorded at 40, 60 and 80 DAT, respectively and it was found to be significantly superior over all other treatments. The highest 22.07, 24.26 and 27.45 per cent mean clump mortality was recorded in untreated control when observations were recorded at 40, 60 and 80 DAT, respectively. The per cent over control of fipronil 40% + imidacloprid 40% WG treatment was more than all over the treatment followed by clothiandin 50 WDG, chlorantraniliprole 18.5 SC, *M. Anisopliae*, respectively (Table 2). The treatment with fipronil 40% + imidacloprid 40% WG consistently effective and found to be significantly superior over all other treatments at 40, 60 and 80 DAT. The treatment with clothiandin 50 WDG next in order of efficacy causing low clump mortality at 40, 60 and 80 DAT.

Efficacy of insecticides and bio-pesticides against white grub infesting sugarcane (2nd Application)

Efficacy of insecticides and bio-pesticides at 40 DAT

The mean mortality of clump ranged from 6.85 to 12.26 per cent as compared to 30.52 per cent in untreated control when the observations are taken at 40 DAT (Table 3). The treatment with fipronil 40% + imidacloprid 40% WG at the dose of 300 g per ha was significantly superior over all treatments (6.85%) in reducing the clump mortality. The treatment with clothiandin 50 WDG was next in order of efficacy recorded 7.33 per cent clump mortality. The treatment with chlorantraniliprole 18.5 SC was next best treatment (8.39) in reducing mortality of clump. The treatment with *M. Anisopliae* was found to be equally effective where 8.44 per cent clump mortality was recorded.

Efficacy of insecticides and bio-pesticides at 60 DAT

The data recorded at 60 DAT presented in Table 3. The treatment with fipronil 40% + imidacloprid 40% WG at the dose of 300 g per ha found to be significantly superior over all other treatment and recorded 7.96 per cent clump mortality as compared to 32.12 per cent clump mortality in untreated control. The treatment with clothiandin 50 WDG was next best treatment (8.65) in reducing mortality of clump. The treatment with chlorantraniliprole 18.5 SC and *M. anisopliae*, found to be equally effective where 9.41 and 10.04 per cent clump mortality was recorded, respectively was recorded under field condition.

Efficacy of insecticides and bio-pesticides at 80 DAT

The mortality of clump ranged from 9.69 to 15.19 per cent as compared to 30.52 per cent in untreated control (Table 3) when observation are taken at 80 DAT. Treatment with of fipronil 40% + imidacloprid 40% WG at the dose of 300 g per ha was found to be constantly superior over all other treatment and recorded 9.69 per cent clump mortality. The treatment with clothiandin 50 WDG was next in order of efficacy where 10.94 per cent clump mortality was recorded. The treatment with chlorantraniliprole 18.5 SC and *M. anisopliae* was next in order of efficacy where 11.16 and 11.80 per cent clump mortality were recorded.

Table 3: Evaluation of insecticides and bio-pesticides against white grubs in field condition on 2nd application:

Tr. No.	Treatment	Initial clumps /10 meter row length			Mean per cent of clump mortality (DAT)			Mean	Per cent over control
		No. of clumps	No. of clumps damaged	% Damage	40 DAT	60 DAT	80 DAT		
1	Chlorantraniliprole 18.5 SC	8 (2.90)*	1 (1.22)	10.79 (19.16)**	8.39 (16.84)	9.41 (17.86)	11.16 (19.51)	9.87	69.1120
2	Fipronil 40 + Imidacloprid 40% WG	9 (3.08)	1 (1.22)	11.11 (19.42)	6.85 (15.17)	7.96 (16.38)	9.69 (18.13)	8.17	74.4304
3	Imidacloprid 70 WG	7 (2.73)	1 (1.22)	14.36 (22.19)	12.26 (20.49)	14.23 (22.16)	15.19 (22.93)	13.89	56.5028
4	Fipronil 0.3 G	9 (3.08)	2 (1.58)	11.44 (19.75)	9.47 (17.92)	11.67 (19.97)	13.21 (21.31)	11.45	64.1553
5	Clothiandin 50 WDG	9 (3.08)	1 (1.22)	11.18 (19.53)	7.33 (15.70)	8.65 (17.10)	10.94 (19.31)	8.97	71.9155
6	Thiamethoxam 25 WG	8 (2.90)	2 (1.58)	12.54 (20.65)	11.48 (19.80)	13.86 (21.85)	14.92 (22.72)	13.42	57.9951
7	*Metrhizium anisopliae*	9 (3.08)	1 (1.22)	11.33 (19.62)	8.44 (16.89)	10.04 (18.47)	11.80 (20.08)	9.88	69.0737
8	*Beauveria bassiana*	7 (2.73)	1 (1.22)	14.42 (22.24)	11.07 (19.43)	12.87 (21.02)	14.16 (22.10)	12.70	60.2456
9	*Heterorhabditis indica*	9 (3.08)	1 (1.22)	12.57 (20.72)	9.65 (18.10)	12.07 (20.33)	13.66 (21.68)	11.79	63.0770
10	Untreated control	7 (2.73)	3 (1.87)	28.56 (32.30)	30.52 (33.53)	32.12 (34.52)	33.19 (35.17)	31.94	
	S.E.M.±	0.13	0.080	1.009	0.95	1.02	1.07		
	CD (p= 0.05)	NS	0.24	3.00	2.82	3.05	3.18		
	CV	7.83	10.25	8.10	8.50	8.49	8.33		

*Figures in parenthesis are square root transformed value for numbers. **Figures in parenthesis arcsine transformed values for per cent

Present findings are in conformity with that of Mane and Mohite (2015) [4] they reported that soil drenching of imidacloprid 40% + fipronil 40% and clothianidin 50 WDG was found to be effective treatment for control of white grub. (Mane, 2011) concluded that *M. anisopliae* was found to be most effective among the three different entomopathogenic fungi *viz*., *M. anisopliae*, *B. Bassiana* and *B. Brongniartii* against third instar grub.

The results are also in consonance with Patel *et al.* ,(2020). They reported that imidacloprid 40% + fipronil 40% WG @ 250 gm per ha and clothianidin 50% WDG @ 250 gm per ha proved equally effective and better than other treatments and also revealed that lowest grub population was found in imidacloprid 40% + fipronil 40% WG and which was at par with clothianidin 50% WDG.

Thamarai chelvi *et al.*, (2010) [7] reported that the bio-pesticide *M. anisopliae* found to be effective in controlling the white grub population and also reported that yield and quality parameters recorded were higher in treated plots as compared to control plots. Thirumurugan *et al.* (2020) [9] revealed that the highest (48.46%) grub population reduction was recorded *Metarhizium anisopliae* on 15th day after application as compared to untreated check. Manisekaran *et al.* (2011) reported that application of *M. anisopliae* against sugarcane white grub *Holotrichia serrata* (Blanch) was found effective and registered 92% reduction in grub population on 60th days after planting.

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