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Efficacy of newer insecticide against White grub (*Holotrichia consanguinea* B.) in pearl millet under semi-arid conditions

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Abstract
Field experiments were conducted at Rajasthan Agricultural Research Institute (SKNAU), Durgapura, India to evaluate the efficacy of newer insecticide against white grub (*Holotrichia consanguinea)* in pearl millet during 2014-15 and 2015-16 in semi-arid arid conditions. Plant damage due to white grub was recorded at 20, 40 and 60 days after germination. It was observed that all insecticidal treatments were found statistically superior over untreated control (29.87% plant damage, 11.88 q/ha grain yield and 25.71 q/ha fodder yield) and maximum plant protection over control (84.87%), least plant damage (4.52%) due to white grub and maximum yields (21.64 q/ha grain yield and 42.58 q/ha fodder yield) were recorded in the treatment of fipronil 40% + imidacloprid 40% 80 WG @ 300 g/ha followed by imidacloprid 17.8 SL @ 300 ml/ha (plant protection over control 82.86%, plant damage 5.12%, 21.62 q/ha grain yield and 42.14 q/ha fodder yield) and fipronil 40% + imidacloprid 40% 80 WG @ 250 g/ha (plant protection over control 79.68%, plant damage 6.07%, 20.00 q/ha grain yield and 40.42 q/ha fodder yield) and these were found at par to each other. The minimum plant protection over control (42.62%), maximum plant damage (17.14%) due to white grub and minimum yield (14.46 q/ha grain yield and 30.29 q/ha fodder yield) was found in standard check (furrow application of carbofuran 3 G @ 12 kg/ha), however found at par with thiamethoxam 35 FS @ 300 ml/ha (plant protection over control 46.23%, plant damage 16.06%, 14.59 q/ha grain yield and 30.53 q/ha fodder yield) and clothianidin 50 WDG @ 250 g/ha. The imidacloprid 17.8 SL gave highest benefit cost ratio (1:12.72) followed by fipronil 40%+ imidacloprid 40% 80 WG (1:3.21).

Keywords: Damage, pearl millet, plant protection, white grub, yield

Introduction
Pearl millet, *Pennisetum glaucum* (L.) R. Br. Emend Stuntz. is a staple food for millions of poor people living in the semi-arid tropical regions of Africa and Asia. It is multipurpose crop which is grown for food, feed, green and dried forage (Karvi). Pearl millet ranks first under the category of millets in India, in terms of area, production and productivity. The states of Rajasthan, Uttar Pradesh, Maharashtra, Haryana and Gujarat account for roughly more than 90% of total area under this crop and contribute similar level of production. Whereas, in Rajasthan state it covers total area of 4.15 million hectares, production 3.76 million tones and its productivity 906 kg/ha of Pearl millet (Anonymous, 2019) [6]. Number of insect-pests have been reported to damage pearl millet and cause economic loss *viz.*, White grub, *Holotrichia consanguinea* Blanchard; Shoot fly, *Atherigon aapproximata* Malloch; Root bug; Red hairy caterpiler, *Amsacta moorei* Butler; Grey weevil, *Myllocerus* spp. F.; Leaf roller, *Marasmia* spp.; Thrips; Shoot bug, *Eysarcoris inconspicuous* (H. and S.); Blister beetle; Chafer beetle and Ear head bug, *Nysiusericae* (Sch.) (Anonymous, 1990) [2]. Besides these insect-pests the termite, stem borer and grass hopper were also reported to cause serious damage to this crop (Anonymous, 1988) [1]. Among these pests the white grub, *H. consanguinea* B. is an important pest of pearl millet. Damage is caused by larvae by feeding on roots. The most obvious and significant damage occurs soon after plants emergence from the soil. Stand loss can occur within seven to ten days after plant emergence in severely infested fields. A single white grub can destroy plants along 0.3 to 0.5 m of a row. Seedlings are severely stunted and may never produce grain. Injured plants may produce panicles after such damage but frequently do not have sufficient roots to prevent lodging. Generally, the damage by white grub in pearl millet is reported to be about 20-30 per cent but sometimes in endemic areas, the damage reported to be 80-100 per cent (Anonymous, 2011) [3].
Besides sugarcane other cultivated crops such as groundnut, cereals, millets, pluses, vegetables

and plantation crops were also attacked by white grub (David *et al.*, 1986) [8]. The yield loss due to white grubs was reported to be as high as 100 per cent in Tamil Nadu (Thamarai Selvi *et al.*, 2010) [11]. The grubs are subterranean having complex life cycle and actively feed on living roots, therefore, the control of this pest becomes difficult. Adult collection and insecticidal applications are the major tactics of management followed against all the white grub species (Veeresh, 1974 and Raodeo *et al.*, 1976) [13, 10]. In the present research paper, an attempt was made to evaluated newer insecticidal molecules against white grub, *H. consanguinea* in pearl millet.

Materials and Methods

The experiment was laid out in randomized block design (RBD) with three replications and ten treatments during *Kharif* 2014-15 and 2015-15. Variety RHB-177 of pearl millet was sown in plot size 3.5 X 3.0 m^2. Row to row and plant to plant distance was kept 50 cm and 15 cm, respectively. The soil applications of insecticides were done at 20th day of mass emergence of white grub beetles. For the application of these insecticides, 80-100 kg/ ha sandy soil was collected from field, dried, sieved and thoroughly mixed with required quantity of insecticides. The insecticide treated soil was uniformly applied in standing crop of pearl millet near the root zone. The application was done after 20 days of first monsoon rain when mass beetle emergence occurred. The application of soil was followed by light irrigation so that the insecticide percolated towards root zone. The details of treatments are shown in table 1.

Table 1: Description of the different treatments

Symbols	Treatments details
T_1	Imidacloprid 17.8 SL @ 300 ml/ha
T_2	Imidacloprid 600 FS @ 500 ml/ha
T_3	Clothianidin 50 WDG @ 250 g/ha
T_4	Clothianidin 50 WDG @ 300 g/ha
T_5	Thiamethoxam 35 FS @ 300 ml/ha
T_6	Thiamethoxam 35 FS @ 500 ml/ha
T_7	Fipronil 40%+ imidacloprid 40% 80 WG
T_8	Fipronil 40%+ imidacloprid 40% 80 WG
T_9	Furrow application of carbofuran 3 G
T_{10}	Untreated control

Plant damage due to white grub was recorded at 20, 40 and 60 days after germination. The total damage due to white grub was recorded at 60 days. The data generated were computed for per cent infestation. The grain and fodder yield were recorded at harvest. The data were subjected to statistical analysis.

Results and Discussion

The results showed that in table 2 at 20 days after germination of pearl millet, minimum damage was recorded in fipronil 40% + imidacloprid 40% 80 WG @ 300 g/ha (3.81%) and found statistically at par with imidacloprid 17.8 SL @ 300 ml/ha with plant damage of 4.28 per cent and fipronil 40% + imidacloprid 40% 80 WG @ 250 g/ha with plant damage of 4.76 per cent. The moderate damage of white grub was recorded in imidacloprid 600 FS @ 500 ml/ha with plant damage of 7.85 per cent, clothianidin 50 WDG @ 300 g/ha with plant damage of 8.57 per cent and thiamethoxam 35 FS @ 500 ml/ha with plant damage of 9.04 per cent. The maximum plant damage of 14.76 per cent due to white grub in standard check (furrow application of carbofuran 3 G @ 12 kg/ha) followed by thiamethoxam 35 FS @ 300 ml/ha with plant damage of 14.52 per cent and clothianidin 50 WDG @ 250 g/ha with plant damage of 13.81 per cent, however, these were at par to each other. The plant damage in untreated control was 23.57 per cent. At 40 days after germination, the minimum plant damage (4.52%) was recorded in fipronil 40% + imidacloprid 40% 80 WG and found statistically at par with imidacloprid 17.8 SL with plant damage of 5.00 per cent and fipronil 40% + imidacloprid 40% 80 WG with plant damage of 5.47 per cent. The moderate damage in imidacloprid 600 FS with plant damage of 8.81 per cent followed by clothianidin 50 WDG with plant damage of 9.52 per cent and thiamethoxam 35 FS with plant damage of 10.23 per cent were comparable with each other. The maximum plant damage of 16.66 per cent due to white grub in standard check (furrow application of carbofuran 3 G @ 12 kg/ha) was at par to thiamethoxam 35 FS with plant damage of 15.47 per cent and clothianidin 50 WDG with plant damage of 14.75 per cent. However, the plant damage in untreated control was 28.32 per cent. The data at 60 days after germination presented in table 1 showed that all the insecticidal treatments were statistically superior over untreated check (30.70% plant damage, 11.29 q/ha grain yield and 25.11 q/ha fodder yield). It was observed that maximum plant protection over control (83.71%), least plant damage (5.00%) due to white grub and maximum yield (21.17 q/ha grain yield and 42.03 q/ha fodder yield) was found in fipronil 40% + imidacloprid 40% 80 WG followed by imidacloprid 17.8 SL (plant protection over control 82.18%, plant damage 5.47%, 21.15 q/ha grain yield and 41.48 q/ha fodder yield) and fipronil 40% + imidacloprid 40% 80 WG (plant protection over control 79.84%, plant damage 46.19%, 19.24 q/ha grain yield and 39.88 q/ha fodder yield) and these were at par to each other. The moderate plant protection over control (69.77%), plant damage (9.28%) due to white grub and yield (16.73 q/ha grain yield and 35.24 q/ha fodder yield) was found in imidacloprid 600 FS, however, statistically at par with clothianidin 50 WDG (plant protection over control 66.68%, plant damage 10.23%, 16.67 q/ha grain yield and 35.07 q/ha fodder yield) and thiamethoxam 35 FS (plant protection over control 62.80%, plant damage 11.42%, 16.56 q/ha grain yield and 34.89 q/ha fodder yield). The minimum plant protection over control (42.64%), maximum plant damage (17.61%) due to white grub and minimum yield (13.80 q/ha grain yield and 29.67 q/ha fodder yield) was found in standard check (furrow application of carbofuran 3 G), however, it was at par with thiamethoxam 35 FS (plant protection over control 46.51%, plant damage 16.42%, 13.96 q/ha grain yield and 29.98 q/ha fodder yield) and clothianidin 50 WDG (plant protection over control 48.83%, plant damage 15.71%, 14.05 q/ha grain yield and 30.21 q/ha fodder yield). Subsequently, at 20 days after germination, the minimum plant damage (2.86%) was found in fipronil 40% + imidacloprid 40% 80 WG, and statistically at par with imidacloprid 17.8 SL with plant damage of 3.57 per cent and fipronil 40% + imidacloprid 40% 80 WG with plant damage of 4.04 per cent (Table 2). The moderate plant damage in imidacloprid 600 FS (7.14%), clothianidin 50 WDG (7.85%) and thiamethoxam 35 FS (8.81) were comparable with each other. The maximum plant damage of 14.28 per cent in standard check was at par to thiamethoxam 35 FS with plant damage of 13.33 per cent and clothianidin 50 WDG with plant damage of 12.61 per cent. The plant damage in untreated control was 21.42 per cent. At 40 days after

germination, the minimum plant damage (3.33%) was recorded in fipronil 40% + imidacloprid 40% 80 WG and found statistically at par to imidacloprid 17.8 SL with plant damage of 4.05 per cent and fipronil 40% + imidacloprid 40% 80 WG with plant damage of 4.76 per cent. The moderate plant damage was recorded in imidacloprid 600 FS (7.85 per cent), clothianidin 50 WDG (9.04 per cent) and thiamethoxam 35 FS (9.76 per cent). The maximum plant damage of 15.47 per cent in standard check was followed by thiamethoxam 35 FS with plant damage of 14.75 per cent and clothianidin 50 WDG with plant damage of 14.04 per cent, however, these were comparable with each other. The plant damage in untreated control was 26.89 per cent. The data at 60 days after germination presented in Table 1-2 showed that all the insecticidal treatments were statistically superior over untreated check (29.04% plant damage, 12.46 q/ha grain yield and 26.30 q/ha fodder yield). It was observed that maximum plant protection over control (86.05%), least plant damage (4.05%) due to white grub and maximum yield (22.10 q/ha grain yield and 43.13 q/ha fodder yield) was found in fipronil 40% + imidacloprid 40% 80 WG followed by imidacloprid 17.8 SL (plant protection over control 83.61%, plant damage 4.76%, 22.09 q/ha grain yield and 42.79 q/ha fodder yield) and fipronil 40% + imidacloprid 40% 80 WG (plant protection over control 79.51%, plant damage 5.95%, 20.76 q/ha grain yield and 40.96 q/ha fodder yield) and these were at par to each other. The moderate plant protection over control (68.87%), plant damage (9.04%) due to white grub and yield (18.11 q/ha grain yield and 36.36 q/ha fodder yield) was found in imidacloprid 600 FS (Table 2) followed by clothianidin 50 WDG (plant protection over control 65.56%, plant damage 10.00% and yield 18.01 q/ha grain yield and 36.23 q/ha fodder yield) and thiamethoxam 35 FS (plant protection over control 62.29%, plant damage 10.95%, 17.97 q/ha grain yield and 35.94 q/ha fodder yield), which were found statistically at par. The minimum plant protection over control (42.63%), maximum plant damage (16.66%) due to white grub and minimum yield (15.12 q/ha grain yield and 30.91 q/ha fodder yield) was recorded in standard check, however, at par with thiamethoxam 35 FS (plant protection over control 45.90%, plant damage 15.71% and yield 15.22 q/ha grain yield and 31.08 q/ha fodder yield) and clothianidin 50 WDG @ 250 g/ha (plant protection over control 48.38%, plant damage 14.99%, 15.31 q/ha grain yield and 31.33 q/ha fodder yield).

Table 2: Evaluation of different newer chemicals against whit grub in standing crop of pearl millet

Treatment	Plant damage (%) (2014)			Plant damage (%) (2015)			Plant damage (%) (Pooled)		
	20 day	40 day	60 day	20 day	40 day	60 day	20 day	40 day	60 day
T_1	4.28(11.94)*	5.00(12.92)	5.47(13.53)	3.57(10.89)	4.05(11.60)	4.76(12.60)	3.93(11.42)	4.52(12.26)	5.12(13.07)
T_2	7.85(16.28)	8.81(17.26)	9.28(17.74)	7.14(15.50)	7.85(16.28)	9.04(17.50)	7.50(15.89)	8.33(16.77)	9.16(17.62)
T_3	13.81(21.81)	14.75(22.59)	15.71(23.35)	12.61(20.80)	14.04(22.01)	14.99(22.78)	13.21(21.31)	14.40(22.30)	15.35(23.06)
T_4	8.57(17.02)	9.52(17.97)	10.23(18.66)	7.85(16.27)	9.04(17.50)	10.00(18.43)	8.21(16.65)	9.28(17.74)	10.12(18.54)
T_5	14.52(22.40)	15.47(23.16)	16.42(23.91)	13.33(21.41)	14.75(22.59)	15.71(23.35)	13.92(21.90)	15.11(22.87)	16.06(23.63)
T_6	9.04(17.50)	10.23(18.66)	11.42(19.75)	8.81(17.26)	9.76(18.20)	10.95(19.32)	8.93(17.38)	10.00(18.43)	11.19(19.54)
T_7	4.76(12.60)	5.47(13.53)	6.19(14.40)	4.04(11.60)	4.76(12.60)	5.95(14.12)	4.40(12.10)	5.12(13.07)	6.07(14.26)
T_8	3.81(11.25)	4.52(12.27)	5.00(12.92)	2.86(9.73)	3.33(10.52)	4.05(11.60)	3.33(10.49)	3.93(11.40)	4.52(12.26)
T_9	14.76(22.59)	16.66(24.09)	17.61(24.81)	14.28(22.20)	15.47(23.16)	16.66(24.09)	14.52(22.40)	16.07(23.63)	17.14(24.45)
T_{10}	23.57(29.04)	28.32(32.15)	30.70(33.65)	21.42(27.57)	26.89(31.24)	29.04(32.61)	22.50(28.31)	27.61(31.70)	29.87(33.13)
SEm±	1.06	1.09	1.04	1.02	1.05	1.01	0.74	0.76	0.73
CD at 5%	3.15	3.23	3.08	3.04	3.12	3.01	2.11	2.17	2.08

Figures in the parentheses are angular transformed values

In pooled results, at 20 days after germination, the minimum plant damage (3.33%) was found in fipronil 40% + imidacloprid 40% 80 WG followed by imidacloprid 17.8 SL with plant damage of 3.93 per cent and fipronil 40% + imidacloprid 40% 80 WG with plant damage of 4.40 per cent (Table 2 & 3). The moderate damage in imidacloprid 600 FS with plant damage of 7.50 per cent, clothianidin 50 WDG with plant damage of 8.21 per cent and thiamethoxam 35 FS with plant damage of 8.93 per cent were at par to each other. The maximum damage in standard check with plant damage 14.52 per cent was followed by thiamethoxam 35 FS with plant damage of 13.92 per cent and clothianidin 50 WDG with plant damage of 13.21 per cent and found at par to each other. However, the plant damage in untreated control was 22.50 per cent. At 40 days after germination, the fipronil 40% + imidacloprid 40% 80 WG with 3.93 per cent plant damage recorded as best treatment, however it was statistically at par with imidacloprid 17.8 SL with plant damage of 4.52 per cent and fipronil 40% + imidacloprid 40% 80 WG with plant damage of 5.12 per cent. The moderate damage in imidacloprid 600 FS with plant damage of 8.33 per cent, clothianidin 50 WDG with plant damage of 9.28 per cent and thiamethoxam 35 FS with plant damage of 10.00 per cent were comparable with each other. The maximum plant damage of 16.07 per cent in standard check was followed by thiamethoxam 35 FS with plant damage of 15.11 per cent and clothianidin 50 WDG with plant damage of 14.40 per cent, however, these were at par to each other. The plant damage in untreated control was 27.61 per cent. Perusal of the pooled data of two years at 60 days after germination presented in Table 2 & 3 showed that all the insecticidal treatments were statistically superior over untreated check, (29.87% plant damage, 11.88 q/ha grain yield and 25.71 q/ha fodder yield). It was observed that maximum plant protection over control (84.87%), least plant damage (4.52%) due to white grub and maximum yield (21.64 q/ha grain yield and 42.58 q/ha fodder yield) was found in fipronil 40% + imidacloprid 40% 80 WG followed by imidacloprid 17.8 SL (plant protection over control 82.86%, plant damage 5.12%, 21.62 q/ha grain yield and 42.14 q/ha fodder yield) and fipronil 40% + imidacloprid 40% 80 WG (plant protection over control 79.68%, plant damage 6.07%, 20.00 q/ha grain yield and 40.42 q/ha fodder yield) and these were at par to each other. The moderate plant protection over control (69.33%), plant damage (9.16%) due to white grub and yield (17.42 q/ha grain yield and 35.80 q/ha fodder yield) was recorded in imidacloprid 600 FS and at par with clothianidin 50 WDG (plant protection over control 66.12%, plant damage 10.12%,17.34 q/ha grain yield and 35.65 q/ha fodder yield) and thiamethoxam 35 FS (plant protection over control 62.54%, plant damage 11.19%, 17.27

q/ha grain yield and 35.42 q/ha fodder yield). The minimum plant protection over control (42.62%), maximum plant damage (17.14%) due to white grub and minimum yield (14.46 q/ha grain yield and 30.29 q/ha fodder yield) was found in standard check, however found at par with thiamethoxam 35 FS @ 300 ml/ha (plant protection over control 46.23%, plant damage 16.06%, 14.59 q/ha grain yield and 30.53 q/ha fodder yield) and clothianidin 50 WDG (plant protection over control 48.61%, plant damage 15.35%, 14.68 q/ha grain yield and 30.77 q/ha fodder yield).

Table 3: Evaluation of different insecticides applied in standing crop in pearl millet against white grub and their yields

Treatments	Plant damage (%) after 60 days	Protection over control (%)	Pooled yield (q/ha)		Increase yield over control (q/ha)	
	Pooled	Pooled	Grain	Fodder	Grain	Fodder
T_1	5.12(13.07)*	82.86	21.62	42.14	9.74	16.43
T_2	9.16(17.62)	69.33	17.42	35.80	5.54	10.09
T_3	15.35(23.06)	48.61	14.68	30.77	2.71	4.82
T_4	10.12(18.54)	66.12	17.34	35.65	5.46	9.94
T_5	16.06(23.63)	46.23	14.59	30.53	2.80	5.06
T_6	11.19(19.54)	62.54	17.27	35.42	5.39	9.71
T_7	6.07(14.26)	79.68	20.00	40.42	8.12	14.71
T_8	4.52(12.26)	84.87	21.64	42.58	9.76	16.87
T_9	17.14(24.45)	42.62	14.46	30.29	2.58	4.58
T_{10}	29.87(33.13)	-	11.88	25.71	-	-
SEm±	0.73	-	0.61	1.06	-	---
CD at 5%	2.08	-	1.75	3.04	-	---

Figures in the parentheses are angular transformed values

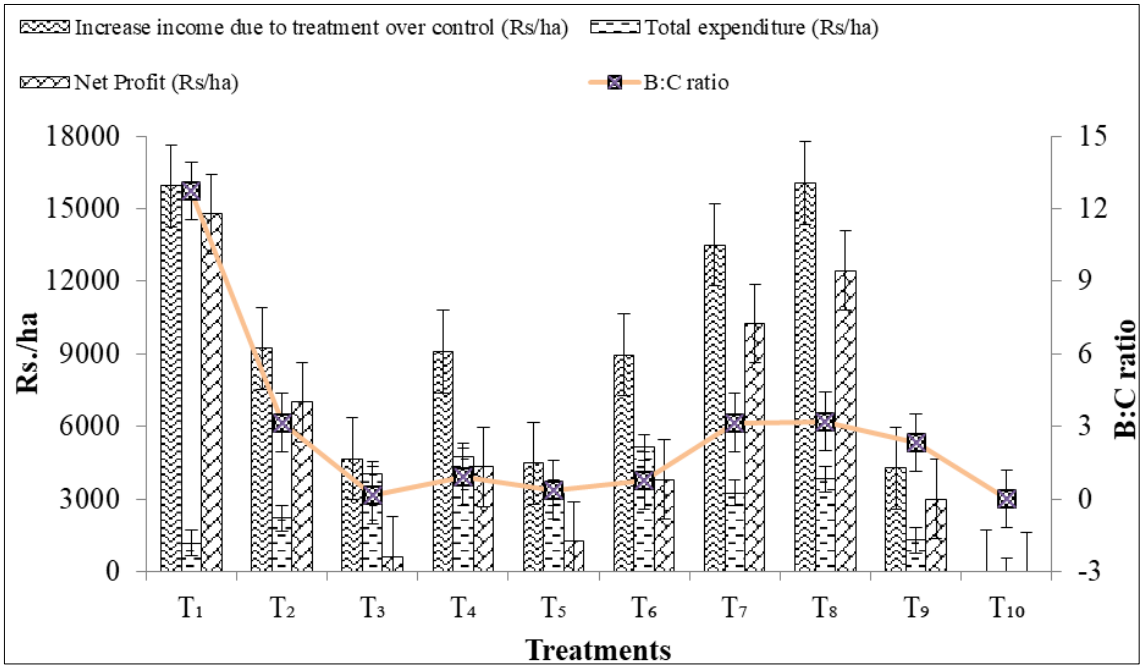

Fig 1: Profitability of different insecticides applied in standing crop in pearl millet against white grub

The present findings corroborate with the results of Pradnya and Pandurang (2014) [9] who reported that the soil drenching of imidacloprid 40 per cent + fipronil 40 per cent - 80 WG @ 300 g ha^{-1} was found to be most effective treatment for control of white grub followed by clothianidin 50 WDG @ 250 g ha^{-1}, flubendiamide 480 SC @ 400 ml ha^{-1} and rynaxypyr 0.4% G @ 125 g ha^{-1}. Bhatnagar *et al.* (2012) [7] tested clothianidian 50 WDG at 240 g/ ha, thiamethoxam 25 WG at 600 g/ ha, fipronil 5 SC at 3.0 l/ha, fipronil 80 WG at 300 g/ ha, quinalphos 25 EC at 4000 ml/ ha, imidacloprid 17.8 SL at 333 ml/ ha, bifenthrin 10 EC 2000 ml/ ha and chlorpyriphos 20 EC at 4000 ml/ ha against *H. consanguinea* damage of groundnut. It was observed that maximum protection over control was recorded in imidacloprid (81.51%) and clothianidian (78.60%) with maximum pod yield of 21.13 and 18.61 q/ ha, respectively.

Application of quinalphpos 25 EC at 4 l/ ha + imidacloprid 17.8 SL at 300 ml/ ha and clothinanidin 50 WDG at 300 g/ ha was statistically at par with standard checks, imidacloprid 17.8 SL and quinalphos 25 EC with respect to protection as well as production (Anonymous, 2015) [5]. However, in these treatments 13.32, 14.08, 10.29 and 12.96 per cent mortality, 58.87, 56.53, 68.23 and 59.99 per cent protection over control and 24.42, 24.75, 25.67 and 25.00 q/ ha pod yield was recorded. This was followed by imidacloprid 600 FS at 1042 ml/ ha, where,18.14 per cent plant damage 43.99 per cent protection over control and 24.67 q/ ha pod yield was recorded in standing crop of groundnut at Durgapura during *Kharif*, 2014.

Imidacloprid 17.8 SL (standard check) at 333 ml/ ha dose was found as protection and production wise and at par with clothinanidin 50 WDG at 240 g/ ha with plant damage 7.38 and 8.02 per cent and yield of 16.75 and 21.13 q/ ha in groundnut during *Kharif*, 2009 and 2010 (pooled), respectively (Anonymous 2011b) [4]. The moderate plant protection over control, plant damage due to white grub and

yield was recorded with imidacloprid 600 FS @ 500 ml/ ha and at par with clothianidin 50 WDG @ 300 g/ ha and thiamethoxam 35 FS @ 500 ml/ ha. The minimum plant protection over control, maximum plant damage due to whitegrub and minimum yield was found in standard check (furrow application of carbofuran 3 G @ 12 kg/ ha), however, it was at par with thiamethoxam 35 FS @ 300 ml/ ha and clothianidin 50 WDG @ 250 g/ ha.

The maximum net profit of Rs. 14786/ ha was computed in imidacloprid 17.8 SL @ 300 ml/ ha followed by Rs 12449/ ha in fipronil 40%+ imidacloprid 40% 80 WG @ 300 g/ ha and Rs 10254/ ha in fipronil 40% + imidacloprid 40% 80 WG @ 250 g/ ha (Fig. 1). The minimum net profit of Rs 627/ ha was recorded in the clothianidin 50 WDG @ 250 g/ ha followed by Rs 1237/ ha in thiamethoxam 35 FS @ 300 ml/ ha. The net profit ranging from Rs 2982 to 7005/ ha was computed in imidacloprid 600 FS @ 500 ml/ ha, clothianidin 50 WDG @ 300 g/ ha, thiamethoxam 35 FS @ 500 ml/ ha and furrow application of carbofuran 3 G @ 12 kg/ ha. The imidacloprid 17.8 SL @ 300 ml/ ha in the standing crop of pearl millet was evaluated against whitegrub which resulted in highest benefit cost ratio (12.72) followed by fipronil 40%+ imidacloprid 40% 80 WG @ 250 g/ ha (3.21), fipronil 40%+ imidacloprid 40% 80 WG @ 300 g/ ha (3.16) and imidacloprid 600 FS @ 500 ml/ ha (3.16). The furrow application of carbofuran 3G @12 kg/ ha resulted in B:C ratio 2.32. Other treatment result in lower order of efficacy with regards to B:C. The present findings are in agreement with that of Anonymous (2011b) [4] who reported that the B:C ratio was highest in the treatment of imidacloprid 17.8 SL (1:2.5). Bhatnagar *et al.* (2012) [7] reported that the B: C ratio was highest in the treatment of imidacloprid 17.8 SL (1:33.9) in present investigation.

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