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Effect of alley ways on hoppers incidence in rice crop

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ABSTRACT

Plant hoppers are the major yield limiting factor faced by the farmers of Eastern Vidarbha zone of Maharashtra who failed to achieve the control of hoppers with the conventional insecticides which paves the way to introduce the new methods of management practices for the plant hoppers in rice. Therefore alleyways in rice crop and its effect on incidence of plant hoppers are studied at different location as field experimenti. Multi location field trial on effect of alley ways on hoppers incidence in rice crop in randomized block design with five replications of four treatments viz.,T1: Alleyways of 30 cm after every 10 rows or 2 m in rice crop, T2: 2 Chemical sprays at 15 days interval (Flonicamid 50 % WG @ 3 g/10 Liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 Liter water at 75 DAT), T3:T1 + T2 and T4: Untreated control at Agriculture Research Station, Sakoli, Dist. Bhandara and Zonal Agriculture Research Station, Sindewahi, Dist. Chandrapur during kharif 2019 and kharif 2020. The results revealed that treatment with alleyways of 30 cm after every 10 rows or 2 m in rice crop + 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT was found effective for management of hoppers and getting higher grain yield of rice crop and higher monetary return.

Keywords: *Rice, hoppers management, alley ways, Flonicamid, Fipronil*

INTRODUCTION

Rice (*Oryza sativa* L.) being a staple food of millions of people in India, is attacked by number of insect pest *viz*., gall midge, stem borer, leaf folder, brown plant hopper, white backed plant hopper and green leaf hopper. Overall losses due to insect damage in rice were estimated to be 25 % (Dhaliwal*et. al.,* 2010). Plant hoppers are considered as important yield limiting factor in rice crop in Eastern Vidarbha zone of Maharashtra. Leaving alley ways of 30 cm width for every 2 m or 10 rows width of planting tends to inhibit multiplication of BPH and WBPH due to aeration. This also facilitates better sunlight, inter-cultivations, spraying operations and human movement in the field. This has become a normal practice in all BPH endemic areas of tropical Asia and practically adopted under single crop areas also. The loss of yield due to loss of planted area under alley ways is compensated by higher productivity in hills on both sides of alley ways (Krishnaiah, 2014). Although, many insecticides were recommended for the control of this pest, but owing to its feeding behavior at the base of the plant, the farmers were unable to control this pest effectively. Some newer insecticides were found effective againt plant hoppers in rice (Paul *et al.* 2018, Matharu and Tanwar, 2020 and Patil*et al.* 2020). Thus, the trial was conducted to evaluate effect of alley ways on hoppersincidence in rice crop and to study the cost economics of effect of the alley ways on hoppers incidence in rice crop.

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MATERIAL AND METHODS

Multi-location field trial on the effect of alley ways on hoppers incidence in rice crop in randomized block design with five replications of four treatments *viz*.,T1: Alleyways of 30 cm after every 10 rows or 2 m in rice crop, T2: 2 Chemical insecticeides sprays at 15 days interval (Flonicamid 50 % WG @ 3 g/10 Liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 Liter water at 75 DAT), T3: T1 + T2 and T4: untreated control at Agriculture Research Station, Sakoli, Dist. Bhandara and Zonal Agriculture Research Station, Sindewahi, Dist. Chandrapur during *kharif* 2019 and *kharif* 2020.Popular rice variety PKV HMT was transplanted with spacing of 20 cm X 15 cm and the gross plot size was maintained at 40 m^2. 10 hills were selected from each plot for recording the observationns. Observations of brown plant hoppers, white backed plant hoppers and green leaf hoppers were recorded at weekly intervals after 30 days after transplanting (DAT). At the same times the observations of naturalenemies viz., mirids, spiders, coccinellids, dragonflies and damselflies were alsorecorded at weekly intervals at 30 days after transplanting. Yield was recorded from each plot in each replication. Economics of each treatment were worke out.

RESULTS AND DISCUSSION

a) Effect of different treatments on the ttincidence of green leaf hopper

Pooled mean results presented in table 1 indicated that the treatment with alleyways of 30 cm after every 10 rows in rice crop + 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT recorded significantly minimum incidence of green leaf hopper (1.11 no./hill) and it was followed by treatment with 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT (1.36 no./hill) and treatment with alleyways of 30 cm after every 10 rows in rice crop (1.80 no./hill).

However, the maximum pooled mean incidence of green leaf hopper was recorded in the untreated control (2.87 no./hill)

b) Effect of different treatments on incidence of white backed plant hopper

Pooled mean results presented in table 2 indicated that the treatment with alleyways of 30 cm after every 10 rows in rice crop + 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT recorded significantly minimum incidence of white backed plant hopper (1.05 no./hill) and it was followed by treatment with 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT (1.30 no./hill) and treatment with alleyways of 30 cm after every 10 rows in rice crop (1.89 no./hill). However, maximum pooled mean incidence of white backed plant hopperwas recorded in untreated control (2.93 no./hill).

c) Effect of different treatments on the incidence of brown plant hopper

Pooled mean results presented in table 3 indicated that the treatment with alleyways of 30 cm after every 10 rows in rice crop + 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT recorded significantly minimum incidence of brown plant hopper (4.37 no./hill) and it was at par with the treatment with 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT (4.55 no./hill) and followed by treatment with alleyways of 30 cm after every 10 rows in rice crop (6.30 no./hill). However, maximum pooled mean incidence of brown plant hopper was recorded in untreated control (8.78 no./hill).

d) Effect of different treatments on population of natural enemies

Non significant difference in population of natural enemies viz., green mirid bug, brown mirid bug, Spider, Coccinellids, dragon flies and damsel flies was noticed in different treatments (table 4).

e) Effect of different treatments on yield of rice crop

The effect of different treatmentson grain yield of rice crop was given in table 5 indicating that the higher yield obtained in the treatment with alleyways of 30 cm after every 10 rows in rice crop + 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT harvested significantly highest grain yield (32.44q/ha) and it was followed by the treatment with 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT (30.47q/ha) and treatment with alleyways of 30 cm after every 10 rows in rice crop (28.43q/ha). However, the lowest grain yield was recorded in the untreated control (25.17q/ha).

f) Effect of different treatments on Net profit and B:C ratio

The higher monetary return of Rs. 36379/- was obtained due to the application of treatment with alleyways of 30 cm after every 10 rows in rice crop + 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT with BC ratio of 1:1.81. It was followed by treatment with alleyways of 30 cm after every 10 rows in rice crop obtained a net profit of Rs. 31875/- with BC ratio 1:1.81 and treatment with 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT obtained a net profit of Rs. 31661/- with BC ratio 1:1.71. However, the lowest monetary return of Rs. 24051/- was obtained in untreated control with BC ratio 1:1.62 (Table 6).

Leaving alley ways of 30 cm width for every 4meters width of planting tends to inhibit multiplication of BPH and WBPHdue to aeration as already discussed. This alsofacilitates inter-cultivation and spraying operations andhuman movement in the field. This has become anormal practice in all BPH endemic areas of tropicalAsia and is practically adaptable under single rice cropareas also. The loss of yield due to loss of planted areaunder alley ways is compensated by higherproductivity in hills on both sides of alley ways (Krishnaiah, 2014). For the success of integrated pest management, 30 cm alley formations at every 2.5 to 3 m distance in plant hopper and sheath blight endemic areas is one component in Cultural Practices (Prakash*et al*. 2014).Line planting facilitates roguing and giving alleyways of 30 cm after every 3 m helps in manuring, plant protection operations and supervision.Similarly, the provision of alley-ways at every 3m rows is an importantcomponent in the IPM (Anonymous. 2016).

Flonicamid 50WG is a member of the pyridinecarboxamide class of chemistry and is a novel systemic insecticide with selective activity against hemipterous pests. Flonicamid 50WG controls target pests by contact and ingestion provoking rapid and irreversible feeding cessation. Flonicamida novel class insecticide possessing a unique chemical structure. This compound is very active against a wide range of aphid species and also is effective against some other species of sucking insects. It rapidly inhibits the feeding behavior of aphids and provides long-lasting control. Flonicamid shows no cross-resistance to conventional insecticides and exhibits excellent systemic and translaminar activity. It has no negative impact on beneficial insects and mites. Furthermore, it has a favorable toxicological, environmental and ecotoxicological profile. These characteristics make flonicamid well suited for resistant management strategies and integrated pest-management programs (Morita *et al*., 2014).Matharu and Tanwar (2020) conducted farm trials to determine the efficacy of conventional and novel insecticides against brown planthopper (BPH), *Nilaparvatalugens*(Stål), in rice during *kharif* 2017 and 2018. The results of the firstyear study revealed that the application of Imidacloprid 17.8 SL @ 100 ml ha^{-1} was found superior by registering a lower population of BPH (4.70/ hill) followed by Flonicamid 50 WG @ 150 g ha^{-1} with 5.67 BPH/hill after 7 days after spray. Patil *et al.* (2020) reported that Flonicamid 50 WG @ 0.30g/L found to the most effective treatment for the control of BPH by recording the highest per cent reduction of 95.11% over control among all the treatments. Similarly, the treatment with flonicamid 50 WG @ 0.30g/L recorded highest yield of 56.33 q/ha.

Fipronil is toxic to insects by contact or ingestion. Fipronil blocks GABAA-gated chloride channels in the central nervous system. Disruption of the GABAA receptors by fipronil prevents the uptake of chloride ions resulting in excess neuronal stimulation and death of the target insect. Fipronil 5% SC is an insecticide which is used to control insects like stem borer, brown plant hopper, green leaf hopper, rice leaf folder, rice gall midge, white backed plant hopper, whorl maggot in rice.Naga Bharani*et al.* (2017) showed that Fipronil 5%SC recorded the 94.17, 83.33 and 75.83 per cent BPH mortality at 50%NPK, 100%NPK and 150%NPK level, respectively in *kharif*2015 and; 95.00, 87.50 and 75.83 per cent BPH mortality in *kharif*2016. Paul *et al.* (2018) revealed that the highest reduction in the

population of leaf hoppers and plant hoppers and highest yields were recorded in plots treated with fipronil 5% SC @ 75 gma.i./ha. The insecticide did not have any severe depressing effect on the natural enemies in the field when applied at recommended doses. Patil *et al.* (2020) reported that fipronil 5 SC @ 2.0 ml/Lcan be used for the effective management of brown plant hopper in *kharif* rice.

CONCLUSION

The present findings conclude that the treatment with alleyways of 30 cm after every 10 rows or 2 m in rice crop + 2 Chemical sprays viz., Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT and Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT was found effective for management of hoppers and getting higher grain yield of rice crop and higher monetary return.

Table 1: Effect of different treatments on incidence of green leaf hopper

Tr. No.	Treatment	Population of green leaf hopper (No./hill)									
		Peak incidence					Mean incidence				
		Kharif 2019		*Kharif* 2020		Pooled	*Kharif* 2019		*Kharif* 2020		Pooled
		Sakoli	Sindewahi	Sakoli	Sindewahi	Peak	Sakoli	Sindewahi	Sakoli	Sindewahi	Mean
T_1	**Alleyways of 30 cm after every 10 rows**	2.08 (1.60)	3.50 (2.00)	2.70 (1.79)	3.92 (2.10)	**3.05**b **(1.88)**	1.35 (1.36)	2.05 (1.59)	1.80 (1.52)	2.00 (1.58)	**1.80**c **(1.52)**
T_2	**2Chemical sprays** 1.Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT. 2. Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT.	2.90 (1.84)	2.88 (1.84)	2.44 (1.71)	3.40 (1.97)	**2.91**b **(1.84)**	1.30 (1.34)	1.23 (1.31)	1.73 (1.49)	1.17 (1.29)	**1.36**b **(1.36)**
T_3	**T1 + T2**	1.96 (1.56)	1.44 (1.39)	2.68 (1.78)	1.78 (1.50)	**1.97**a **(1.57)**	1.04 (1.24)	0.77 (1.13)	1.91 (1.55)	0.75 (1.11)	**1.11**a **(1.27)**
T_4	**Untreated Control**	3.04 (1.88)	8.16 (2.94)	2.78 (1.81)	9.08 (3.09)	**5.77**c **(2.50)**	1.80 (1.52)	3.85 (2.08)	1.90 (1.55)	3.92 (2.10)	**2.87**d **(1.83)**
	'f' test	S	S	S	S	**S**	S	S	S	S	**S**
	SE (±M)	0.05	0.06	0.03	0.06	**0.03**	0.01	0.03	0.03	0.03	**0.01**
	CD at 5%	0.15	0.19	0.10	0.19	**0.08**	0.03	0.10	0.10	0.09	**0.04**
	CV (%)	6.38	6.88	4.21	6.50	**3.04**	1.44	4.54	4.90	4.31	**2.11**

**Figures in parentheses are corresponding values of square root (n+0.5) transformation of populationof GLH.*

Table 2: Effect of different treatments on incidence of white backed plant hopper

Tr. No.	Treatment	Population of white backed plant hopper (No./hill)									
		Peak incidence					Mean incidence				
		Kharif 2019		*Kharif* 2020		Pooled	*Kharif* 2019		*Kharif* 2020		Pooled
		Sakoli	Sindewahi	Sakoli	Sindewahi	Peak	Sakoli	Sindewahi	Sakoli	Sindewahi	Mean
T_1	**Alleyways of 30 cm after every 10 rows**	2.92 (1.85)	4.04 (2.12)	1.64 (1.46)	4.30 (2.18)	**3.23c (1.93)**	1.54 (1.43)	2.26 (1.66)	1.65 (1.46)	3.84 (2.07)	**1.89c (1.55)**
T_2	**2 Chemical sprays** 1.Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT. 2. Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT.	3.26 (1.94)	2.46 (1.71)	2.02 (1.57)	2.78 (1.80)	**2.63b (1.77)**	1.43 (1.39)	1.17 (1.29)	1.52 (1.42)	2.24 (1.65)	**1.30b (1.34)**
T_3	**T1 + T2**	2.94 (1.85)	1.42 (1.37)	2.82 (1.81)	1.42 (1.38)	**2.15a (1.63)**	1.21 (1.31)	0.75 (1.12)	1.60 (1.45)	1.28 (1.33)	**1.05a (1.24)**
T_4	**Untreated Control**	3.72 (2.05)	8.56 (3.01)	3.08 (1.89)	9.08 (3.09)	**6.11d (2.57)**	1.94 (1.56)	3.95 (2.11)	1.84 (1.53)	8.22 (2.95)	**2.93d (1.85)**
	'f' test	S	S	S	S	**S**	S	S	S	S	**S**
	SE (±M)	0.04	0.06	0.07	0.06	**0.03**	0.01	0.02	0.01	0.05	**0.01**
	CD at 5%	0.12	0.19	0.23	0.20	**0.11**	0.02	0.08	0.04	0.17	**0.03**
	CV (%)	4.42	6.56	9.94	6.70	**3.86**	1.22	3.58	1.81	6.04	**1.27**

**Figures in parentheses are corresponding values of square root (n+0.5) transformation of population of WBPH.*

Table 3: Effect of different treatments on incidence of brown plant hopper

Tr. No.	Treatment	Population of brown plant hopper(No./hill)									
		Peak incidence					Mean incidence				
		Kharif 2019		*Kharif* 2020		Pooled Peak	*Kharif* 2019		*Kharif* 2020		Pooled Mean
		Sakoli	Sindewahi	Sakoli	Sindewahi		Sakoli	Sindewahi	Sakoli	Sindewahi	
T_1	**Alleyways of 30 cm after every 10 rows**	9.86 (3.22)	8.30 (2.95)	19.38 (4.46)	8.18 (2.93)	**11.43c (3.45)**	5.13 (2.37)	5.74 (2.50)	8.89 (3.06)	5.45 (2.44)	**6.30b (2.61)**
T_2	**2Chemical sprays** 1.Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT. 2. Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT.	7.48 (2.82)	6.44 (2.63)	10.82 (3.36)	5.94 (2.53)	**7.67b (2.86)**	4.22 (2.17)	3.91 (2.10)	6.47 (2.64)	3.61 (2.03)	**4.55a (2.25)**
T_3	**T1 + T2**	6.44 (2.63)	3.72 (2.04)	13.02 (3.68)	3.22 (1.92)	**6.60a (2.66)**	3.82 (2.08)	2.90 (1.84)	8.16 (2.94)	2.62 (1.76)	**4.37a (2.21)**
T_4	**Untreated Control**	10.56 (3.33)	17.06 (4.18)	20.10 (4.54)	16.76 (4.15)	**16.12d (4.08)**	6.24 (2.60)	9.52 (3.16)	9.77 (3.20)	9.58 (3.17)	**8.78c (3.05)**
	'f' test	S	S	S	S	**S**	S	S	S	S	**S**
	SE (±M)	0.05	0.14	0.04	0.13	**0.04**	0.02	0.06	0.01	0.03	**0.02**
	CD at 5%	0.16	0.44	0.12	0.39	**0.11**	0.06	0.17	0.04	0.10	**0.05**
	CV (%)	3.79	10.75	2.10	9.93	**2.52**	1.88	5.15	1.04	3.18	**1.40**

**Figures in parentheses are corresponding values of square root (n+0.5) transformation of population of BPH.*

Table 4 a): Effect of different treatments on mean population of natural enemies

Tr. No.	Treatment	Population of Mirid Bug (No./Hill)									
		Green Mirid Bug					Brown MiridBug				
		Kharif 2019		*Kharif* 2020		Pooled Mean	*Kharif* 2019		*Kharif* 2020		Pooled Mean
		Sakoli	Sindewahi	Sakoli	Sindewahi		Sakoli	Sindewahi	Sakoli	Sindewahi	
T_1	**Alleyways of 30 cm after every 10 rows**	1.19 (1.30)	0.66 (1.08)	2.35 (1.69)	0.62 (1.06)	**1.20 (1.30)**	1.81 (1.52)	0.11 (0.78)	4.25 (2.18)	0.11 (0.78)	**1.57 (1.44)**
T_2	**2 Chemical sprays** 1.Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT. 2. Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT.	1.11 (1.27)	0.64 (1.07)	2.07 (1.60)	0.57 (1.03)	**1.10 (1.26)**	1.71 (1.49)	0.12 (0.78)	3.46 (1.99)	0.10 (0.77)	**1.34 (1.36)**
T_3	**T1 + T2**	1.12 (1.27)	0.67 (1.08)	1.98 (1.58)	0.58 (1.04)	**1.09 (1.26)**	1.72 (1.49)	0.11 (0.78)	5.77 (2.50)	0.10 (0.77)	**1.92 (1.56)**
T_4	**Untreated Control**	1.25 (1.32)	0.68 (1.08)	2.47 (1.72)	0.66 (1.08)	**1.26 (1.33)**	1.88 (1.54)	0.10 (0.77)	5.89 (2.53)	0.11 (0.78)	**1.99 (1.58)**
	'f' test	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

**Figures in parentheses are corresponding values of square root (n+0.5) transformation ofnatural enemies.*

Table 4 b): Effect of different treatments on mean population of natural enemies

Tr. No.	Treatment	Population of natural enemies (No./Hill)									
		Spider					Coccinellids				
		Kharif 2019		*Kharif* 2020		Pooled Mean	*Kharif* 2019		*Kharif* 2020		Pooled Mean
		Sakoli	Sindewahi	Sakoli	Sindewahi		Sakoli	Sindewahi	Sakoli	Sindewahi	
T_1	**Alleyways of 30 cm after every 10 rows**	0.39 (0.94)	0.42 (0.96)	0.45 (0.97)	0.38 (0.94)	**0.41 (0.95)**	0.31 (0.90)	0.25 (0.87)	0.28 (0.88)	0.23 (0.85)	**0.27 (0.88)**
T_2	**2 Chemical sprays** 1.Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT. 2. Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT.	0.42 (0.96)	0.40 (0.95)	0.43 (0.96)	0.36 (0.93)	**0.40 (0.95)**	0.32 (0.90)	0.25 (0.87)	0.26 (0.87)	0.21 (0.84)	**0.26 (0.87)**
T_3	**T1 + T2**	0.47 (0.98)	0.46 (0.98)	0.44 (0.97)	0.37 (0.93)	**0.43 (0.97)**	0.30 (0.89)	0.25 (0.87)	0.28 (0.88)	0.21 (0.84)	**0.26 (0.87)**
T_4	**Untreated Control**	0.40 (0.95)	0.45 (0.98)	0.44 (0.97)	0.41 (0.96)	**0.43 (0.96)**	0.30 (0.89)	0.24 (0.86)	0.27 (0.88)	0.24 (0.86)	**0.26 (0.87)**
	'f' test	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

**Figures in parentheses are corresponding values of square root (n+0.5) transformation ofnatural enemies.*

Table 4 c): Effect of different treatments on mean population of natural enemies

Tr. No.	Treatment	Population of natural enemies (No./Hill)									
		Dragon flies					Damsel flies				
		Kharif 2019		*Kharif* 2020		Pooled Mean	*Kharif* 2019		*Kharif* 2020		Pooled Mean
		Sakoli	Sindewahi	Sakoli	Sindewahi		Sakoli	Sindewahi	Sakoli	Sindewahi	
T_1	**Alleyways of 30 cm after every 10 rows**	0.25 (0.87)	0.21 (0.84)	0.19 (0.83)	0.19 (0.83)	**0.21 (0.84)**	0.32 (0.91)	0.00 (0.71)	0.29 (0.89)	0.00 (o.71)	**0.15 (0.81)**
T_2	**2 Chemical sprays** 1.Flonicamid 50 % WG @ 3 g/10 liter water at 60 DAT. 2. Fipronil 5% SC @ 20 ml/10 liter water at 75 DAT.	0.24 (0.86)	0.17 (0.82)	0.20 (0.84)	0.14 (0.80)	**0.19 (0.83)**	0.33 (0.91)	0.00 (0.71)	0.25 (0.87)	0.00 (o.71)	**0.15 (0.80)**
T_3	**T1 + T2**	0.25 (0.87)	0.20 (0.83)	0.20 (0.83)	0.17 (0.82)	**0.20 (0.84)**	0.35 (0.92)	0.00 (0.71)	0.27 (0.88)	0.00 (o.71)	**0.16 (0.81)**
T_4	**Untreated Control**	0.25 (0.86)	0.21 (0.84)	0.20 (0.84)	0.19 (0.83)	**0.21 (0.84)**	0.29 (0.89)	0.01 (0.71)	0.24 (0.86)	0.01 (o.71)	**0.14 (0.80)**
	'f' test	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

**Figures in parentheses are corresponding values of square root (n+0.5) transformation ofnatural enemies.*

Table 5: Effect of different treatments on yield of rice crop

Tr. No.	Treatment	Yield (q/ha)				
		Kharif 2019		*Kharif* 2020		Pooled Mean
		Sakoli	Sindewahi	Sakoli	Sindewahi	
T_1	**Alleyways of 30 cm after every 10 rows**	33.50	30.84	20.87	28.53	**28.43c**
T_2	**2 Chemical sprays** 1.Flonicamid 50 % WG @ 3 g/10 Liter water at 60 DAT. 2. Fipronil 5% SC @ 20 ml/10 Liter water at 75 DAT.	33.07	33.70	23.71	31.40	**30.47b**
T_3	**T1 + T2**	35.03	35.79	25.43	33.52	**32.44a**
T_4	**Untreated Control**	30.16	27.35	18.13	25.06	**25.17d**
	'f' test	S	**S**	S	S	**S**
	SE (±M)	0.76	0.72	1.34	0.72	**0.44**
	CD at 5%	2.34	2.22	4.12	2.21	**1.37**
	CV (%)	5.16	5.04	13.56	5.41	**3.41**

Table 6: Effect of different treatments onB:C ratio

Tr. No.	Treatment	Yield (q/ha)	Price of paddy (Rs./q)	Gross return (Rs.)	Cost of cultivation (variable cost) (Rs.)	Net returns (Rs.)	B:C ratio
1	**Alleyways of 30 cm after every 10 rows**	28.43	2500	71075	39200	31875	1.81
2	**2 Chemical sprays**	30.47	2500	76175	44514	31661	1.71
3	**T1 + T2**	32.44	2500	**81100**	**44721**	**36379**	**1.81**
4	**Untreated Control**	25.17	2500	62925	38874	24051	1.62

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