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Evaluation of different pest management modules against major insect pests of pearl millet

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Abstract
A field experiment was conducted for the management of major insect pests in pearl millet during *kharif* 2016-18 at Millet Research station, Junagadh Agriculture University, Jamnagar. Results showed that module-IV (seed treatment of imidacloprid 600 FS @ 8.75 ml/kg at the time of sowing, removal of shoot fly dead hearts, installation of fish meal traps @ 10/ha and spraying of dimethoate 30EC @ 0.03% at 35 days after germination was found effective against shoot fly. Whereas, module-II (seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of novaluron 10 EC @ 0.01%, at 35 DAG) recorded lowest stem borer per cent incidence and *Helicoverpa* larval population at ear head stage of crop. But, looking to the cost of management, highest additional income (Rs. 20610/-), net return (Rs. 18961/-) and ICBR (1:12.50) was recorded in module-IV (Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of dimethoate 30 EC 0.03 % at 35 DAG).

Keywords: shoot fly, stem borer, *Helicoverpa armigera*, novaluron, dimethoate, pearl millet

Introduction
Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the staple nutritious food of the poor and small land holders, as well as feed and fodder for livestock in rainfed regions of the country. Pearl millet is a rich source energy, carbohydrate, fat, ash, dietary fibers, iron and zinc. It is a rich source of vitamins like thiamine, riboflavin and niacin and minerals like potassium, phosphorus, magnesium, iron, zinc, copper and manganese. With low prolamine fraction pearl millet is gluten free grain and is the only grain that retains it's alkaline properties after being cooked which is ideal for people with gluten allergy.
Twenty six insects and two non-insect pests were found feeding on pearl millet (Balikai, 2010). Out of these, shoot fly, *Atherigona approximate* Malloch, stem borer, *Chilo partellus* Swinhoe and ear head worm, *Helicoverpa armigera* are comparatively more serious pests attacking the crop. Shoot fly causes 23.3 to 36.5 % grain losses and 37.5 % fodder losses. Stem borer causes between 20-60 % losses (Prem Kishore, 1996) [15]. Juneja and Raghvani (2000) [8] reported that ear head worm, *H. armigera* damages at milky grain stage and around 10-15% reduction in grain yield of pearl millet crop. Yield losses in pearl millet were observed due to insect pest complex and it was revealed that there was a loss of 27.59 % in grain and 21.75% in fodder. Hence, it is suggested to take appropriate recommended management measures in pearl millet to avoid considerable losses (Anonymos, 2017) [1]. Use of insecticides is not the right choice to control these pests due to its cryptic behavior of feeding inside the stem. Moreover, extensive use of chemical insecticides directly increases the cost of cultivation and possesses many health hazards. Integrated pest management (IPM) which involves the use of seed treatment, botanical pesticides, removal of dead hearts, fish meal traps etc. sounds to be a better option for management of these pests. Thus, there is a need to design integrated pest management that have limited adverse effects on the environment and are effective against target insect pests.

Methods and Materials
The experiment was conducted in Randomized Block Design with six modules including control in three replication at Pearl Millet Research Station, Junagadh Agricultural University,

Jamnagar during *Kharif* 2016 to 2018. The pearl millet variety GHB-558 was sown at 60 × 10 cm spacing for this purpose. The gross plot size was 5.0 × 3.6 m and net plot size was 4.0 × 2.4 m. At vegetative stage, observations were recorded from 20 plants randomly selected plants by counting dead hearts and thus, per cent dead heart was worked out for shoot fly. For stem borer, plants showing parallel holes due to stem borer larvae in the leaves were considered as damaged plants and per cent damaged plants were calculated by observing 20 randomly selected plants. At ear head stage, numbers of ear heads showing shoot fly and stem borer damage were recorded separately from randomly selected 20 ear heads in each treatment from net plot and thus per cent ear head damage was worked out. Larval population of *Helicoverpa* was recorded on 5 ear heads in each treatment at ear head stage. Grain and fodder yield was recorded from net plot area at harvest and data thus, obtained was analyzed statistically (Panse and Sukhatme, 1989) [11].

Modules

Modules		
IPM module-I	:	Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg+ removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of NSKE 5% at 35 DAG.
IPM module-II	:	Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of novaluron 10 EC 0.01% at 35 DAG
IPM module-III	:	Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of *B. bassiana* (2 X 10^6 cfu/g) at 35 DAG
IPM module-IV	:	Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of dimethoate 30 EC 0.03 % at 35 DAG
IPM module-V	:	Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of *Bt* 5 WP 0.0075% at 35 DAG
Control	:	Untreated Control

Results and Discussion

Shoot fly incidence

Data presented in Table-1 indicated that differences of per cent incidence of shoot fly at vegetative stage were found significant during all the years and in pooled. So far as pooled data is concerned, least incidence (5.07%) was recorded in IPM module-IV (Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of dimethoate 30 EC 0.03 % at 35 DAG). However, it was statistically at par with IPM module-II (6.08%), module-III (5.43%) & IPM module-V (5.96%). Whereas, at ear head stage the differences in shoot fly infestation were found significant in all the years as well as in pooled. Moreover, during all the years, least shoot fly incidence was recorded in IPM module-IV. The pooled data revealed that the significantly least incidence (4.56%) was recorded in IPM module-IV.

Stem borer incidence

Data presented in Table-2 indicated that differences in stem borer incidence during 2016, 2017, 2018 and in pooled were found significant. During 2016, least stem borer incidence (3.52%) was recorded in IPM module-I. However, it was at par with rest of the modules except control (7.33%). Whereas, during 2017 module-II recorded least stem borer incidence (4.11%) & 2018 (8.25%). In case of pooled data again, least stem borer incidence (5.44%) was recorded in IPM module-II. However, it was at par with module-I (6.45%), IPM module-III (6.27%), IPM module-IV (5.82%) & IPM module-V (5.89%). At ear head stage, difference of stem borer incidence was found significant in all the years as well as in pooled analysis. Least stem borer incidence (3.41%) was recorded in IPM module-V during 2016. However, it was statistically at par with IPM module-II (5.10%) & module-III (4.98%). Significantly least stem borer incidence at ear head stage was recorded in IPM module-II (Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of novaluron 10 EC 0.01%, 35 DAG) during 2017 (7.81%) and 2018 (3.50%). In case of pooled of three years, again IPM module-II, recorded least stem borer incidence (5.47%). However, it was statistically at par with IPM module-III (7.86%), IPM module-IV (8.89%) & IPM module-V (6.93%).

Ear head worm population

Data presented in Table-3 indicated that difference of *Helicoverpa* larval population at ear head stage was found significant in all the years as well as in pooled analysis. Least larval population was recorded in IPM module-V (0.5 larvae/5 ear heads) during 2016 and 4.5 larvae/ 5 ear heads in IPM module-II during 2017. Significantly, least *Helicoverpa* larval population was recorded in IPM module-II (1.0 larvae/5 ear heads) during 2018. In case of pooled data least larval population was again recorded in IPM module-II (2.08 larvae/ 5 ear heads). However, it was at par with rest of the modules except control (8.17 larvae/ 5 ear heads).

There are various types of traps used for controlling the shoot fly. Fishmeal trap is one of the most commonly used for trapping the adults of this pest. The fish meal yeast ammonium sulphide was found the most potent mixture for trapping the maximum females of shoot fly (Reddy *et al.*, 1981) [16]. About 80-97 % females of *A. soccata* were trapped in fishmeal trap (Gahukar, 1987) [5]. Seed dressing with imidacloprid 70 WS @ 10g/100g seeds was found to be most effective in reducing the damage caused by shoot fly (14.3%) and in enhancing the grain yield in sorghum (Balikai *et al.*, 1998) [2]. Balikai (2007) [3] also reported that seed treatment with imidacloprid 70 WS @ 10g/kg seeds recorded lowest shoot fly incidence of 8.4% dead hearts. Further, even with lower dose of imidacloprid 70 WS i.e. 5g/kg seed (Kumar and Prabhuraj, 2007) [9] performed better in reducing shoot fly incidence in sorghum. Foliar spray of azadirachtin 1500 ppm resulted in lowering the egg lying of shoot fly and reduction of dead heart formation in sorghum (Parteti *et al.*, 2014) [12]. Seed treatment with imidacloprid 600 FS @ 7 ml/kg seed was found effective in reducing shoot fly incidence (Sandhu, 2016) [17]. Joshi *et al.* (2016) [7] reported that three sprays (7^{th}, 14^{th} and 21^{st} day after germination) of neem oil 2 % recorded lower oviposition and reduced the dead heart formation in sorghum, considerably. Toxicity of different insecticides was evaluated by Jat *et al.* (2016) [6] against 2^{nd} instar larvae of *H. armigera* under laboratory conditions by leaf dipping method.

novaluron 10 EC was found effective in managing the larvae of *H. armigera* as compared to cypermethrin. The lower percent dead hearts of maize borer with novaluron would suggest this insecticide to be more toxic to the pest compared with the others (Kumar and Alam, 2017) [10]. Similar finding was reported by (Prasad and Ashwani, 2018) [14] that the lowest per cent infestation of dead hearts (9.19%) was recorded in novaluron 10 EC in maize crop. Pateliya *et al.* (2019) [13] showed that seed treatment of fipronil 40% WG + imidacloprid 40% WG @ 2.5 g/kg seed followed by spray of *B. bassiana* WP @ 0.007% found to be most effective in reducing the infestation of shoot fly and stem borer in bajra crop.

Yield

Data of grain yield presented in Table-4 indicated that differences in grain yield in all the years and pooled were found significant. Moreover, during all the years it was highest in IPM module-IV. In case of pooled, significantly, the highest grain yield was recorded in IPM module-IV (3159 kg/ha.) However, it was at par with IPM module-II (3031 kg/ha). In case of fodder yield, the results were found significant during all the years as well as in pooled. During 2016 (4763 kg/ha) & 2018 (7342 kg/ha), highest fodder yield was recorded in IPM module-IV. Whereas, during 2017, it was highest in IPM module-II (5500 kg/ha). The pooled data revealed that highest fodder yield was recorded in IPM module-IV (5821 kg/ha). However, it was at par with IPM module-II (5735 kg/ha) & IPM module-III (5604 kg/ha). Economics of the various treatments presented in Table-4 indicated that highest additional income (Rs. 20610/-), net return (Rs. 18961/-) and ICBR (1:12.50) was recorded in IPM module-IV (Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of dimethoate 30 EC 0.03 % at 35 DAG).

Table 1: Statement showing incidence of shoot fly at vegetative and ear head stage in pearl millet

No	Modules	% Shoot fly incidence at vegetative stage				% Shoot fly incidence at ear head stage			
		2016	2017	2018	Pooled	2016	2017	2018	Pooled
1	IPM module-I	17.16* (8.87)	10.77* (3.57)	15.24* (7.00)	14.39* (6.48)	18.31* (9.93)	18.46* (10.09)	17.60* (9.17)	18.12* (9.73)
2	IPM module-II	17.30 (8.93)	10.02 (3.13)	14.36 (6.19)	13.89 (6.08)	19.53 (11.20)	16.56 (8.19)	11.85 (4.27)	15.98 (7.89)
3	IPM module-III	17.33 (9.03)	9.89 (3.15)	11.66 (4.13)	12.96 (5.43)	16.50 (8.61)	16.94 (8.99)	15.38 (7.19)	16.27 (8.26)
4	IPM module-IV	16.64 (8.27)	9.83 (3.00)	11.21 (3.94)	12.56 (5.07)	13.31 (5.40)	13.25 (5.36)	9.75 (2.92)	12.11 (4.56)
5	IPM module-V	16.88 (8.49)	10.59 (3.39)	14.14 (6.00)	13.87 (5.96)	20.17 (12.17)	19.88 (11.82)	16.60 (8.33)	18.88 (10.77)
6	Untreated-Control	24.65 (17.45)	15.78 (7.45)	23.49 (15.94)	21.31 (13.61)	26.23 (19.57)	23.01 (15.34)	25.02 (17.92)	24.75 (17.61)
	S.Em. ±	1.19	0.50	0.92	0.53	1.40	1.19	0.90	0.68
	C.D. at 5%	3.57	1.49	2.78	1.50	4.22	3.59	2.70	1.94
	C.V.%	12.94	8.89	12.29	12.32	14.73	13.23	11.18	13.35
Y	S.Em. ±	--	--	--	0.37	--	--	--	0.48
	C.D. at 5%	--	--	--	1.06	--	--	--	1.37
YXT	S.Em. ±	-	-	-	0.91	-	-	-	1.18
	C.D. at 5%	--	--	--	NS	--	--	--	NS

- indicates arcsine transformed values, figure in parentheses are original values, DAG - Days After Germination

Table 2: Statement showing incidence of stem borer at vegetative and ear head stage in pearl millet

No	Modules	% Stem borer incidence at vegetative stage				% Stem borer at ear head stage			
		2016	2017	2018	Pooled	2016	2017	2018	Pooled
1	IPM module-I	10.74* (3.52)	12.96* (5.09)	19.01* (10.75)	14.24* (6.45)	11.23* (6.09)	17.53* (14.53)	13.71* (9.00)	14.15* (9.87)
2	IPM module-II	11.49 (3.97)	11.68 (4.11)	16.55 (8.25)	13.24 (5.44)	9.97 (5.10)	12.72 (7.81)	8.36 (3.50)	10.35 (5.47)
3	IPM module-III	11.79 (4.19)	12.69 (4.86)	18.16 (9.75)	14.21 (6.27)	10.06 (4.98)	15.58 (11.60)	12.00 (7.00)	12.55 (7.86)
4	IPM module-IV	12.37 (4.60)	12.10 (4.41)	16.76 (8.44)	13.74 (5.82)	11.11 (6.22)	16.15 (12.46)	12.79 (8.00)	13.35 (8.89)
5	IPM module-V	10.93 (3.64)	12.59 (4.84)	17.63 (9.19)	13.72 (5.89)	8.23 (3.41)	14.98 (10.72)	11.65 (6.67)	11.62 (6.93)
6	Untreated-Control	15.65 (7.33)	19.63 (11.36)	24.24 (16.88)	19.84 (11.85)	12.51 (7.53)	21.96 (22.42)	20.87 (20.33)	18.45 (16.76)
	S.Em. ±	0.58	0.64	1.07	0.46	0.84	0.64	0.78	0.96
	C.D. at 5%	1.74	1.92	3.21	1.30	2.54	1.93	2.35	3.04
	C.V.%	9.51	9.37	11.38	10.66	16.02	7.77	11.78	11.32
Y	S.Em. ±	--	--	--	0.32	--	--	--	0.31
	C.D. at 5%	--	--	--	0.92	--	--	--	0.88
YXT	S.Em. ±	-	-	-	0.79	-	-	-	0.76
	C.D. at 5%	--	--	--	NS	--	--	--	2.16

- indicates arcsine transformed values, figure in parentheses are original values, DAG - Days After Germination

Table 3: Statement showing incidence of *Helicoverpa armigera* at ear head stage

No	Modules	*Helicoverpa armigera* larval population/ 5 ear heads			
		2016	2017	2018	Pooled
1	IPM module-I	1.31#(1.25)	2.56# (6.25)	1.98# (3.5)	1.95# (3.67)
2	IPM module-II	1.10 (0.75)	2.22 (4.50)	1.22 (1.0)	1.51 (2.08)
3	IPM module-III	1.22 (1.00)	2.34 (5.00)	1.83 (3.0)	1.80 (3.00)
4	IPM module-IV	1.31 (1.25)	2.67 (6.75)	2.10 (4.0)	2.03 (4.00)
5	IPM module-V	0.97(0.50)	2.34 (5.00)	1.56 (2.0)	1.62 (2.50)
6	Control	1.65 (2.25)	3.19 (9.75)	3.60 (12.5)	2.82 (8.17)
	S.Em. ±	0.10	0.16	0.09	0.19

	C.D. at 5%	0.31	0.48	0.26	0.59
	C.V.%	16.33	12.37	8.50	12.28
Y	S.Em. ±	--	--	--	0.05
	C.D. at 5%	--	--	--	0.14
YXT	S.Em. ±	-	-	-	0.12
	C.D. at 5%	--	--	--	0.34

(#) indicates square root transformed values, figure in parentheses are original values

Table 4: Effect of different treatments on yield of pearl millet

No	Modules	Grain yield kg/ha				Fodder yield kg/ha			
		2016	2017	2018	Pooled	2016	2017	2018	Pooled
1	IPM module-I	2138	2800	3024	2654	4213	4979	6851	5348
2	IPM module-II	2276	3351	3466	3031	4444	5500	7262	5735
3	IPM module-III	2297	3122	2883	2767	4654	5208	6951	5604
4	IPM module-IV	2426	3397	3655	3159	4763	5358	7342	5821
5	IPM module-V	2124	2969	3062	2718	4450	5208	6320	5326
6	Control	1920	2301	2528	2250	4038	4469	5313	4606
	S.Em. ±	83.31	203.24	171.34	92.86	141.70	212.59	408.60	160.63
	C.D. at 5%	251.07	612.49	516.36	264.71	427.07	640.67	1231.41	457.92
	C.V.%	7.58	13.59	11.04	11.64	6.40	8.30	12.25	10.29
Y	S.Em. ±	--	--	--	65.66	--	--	--	113.59
	C.D. at 5%	--	--	--	187.18	--	--	--	323.80
YXT	S.Em. ±	-	-	-	160.83	-	-	-	278.23
	C.D. at 5%	--	--	--	NS	--	--	--	NS

Table 5: Economics of various treatments for the management of pest complex in pearl millet

No	Modules	Yield increase Over control (kg/ha)		Additional Income (Rs)/ha	Total Expenditure (Rs.)/ha	Net return Rs./ha	ICBR
		Grain	fodder				
1	IPM module-I	404	742	9564	2179	7385	1:4.39
2	IPM module-II	781	1129	17878	2079	15799	1:8.60
3	IPM module-III	517	998	12336	1619	10717	1:7.62
4	IPM module-IV	909	1215	20610	1649	18961	1:12.50
5	IPM module-V	468	720	10800	2309	8491	1:4.68

Conclusion

From the above study, it is quite clear that IPM module-IV (Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of dimethoate 30 EC 0.03% at 35 DAG) recorded significantly lowest shoot fly incidence at ear head stage, highest grain yield & fodder yield. Whereas, IPM module-II (Seed treatment of imidacloprid 600 FS @ 8.75 ml/kg + removal of shoot fly dead hearts + fish meal trap @ 10/ha + spraying of novaluron 10 EC 0.01%, at 35 DAG) recorded lowest stem borer incidence and lowest *Helicoverpa* larval population at ear head stage.

References

1. Anonymous. Annual Research Report published by ICAR All India co-ordinated Research Project on Pearl millet Mandor, Jodhpur, Rajasthan, India 2017.
2. Balikai RA, Biradar AP, Kolhar RC. Management of sorghum shoot fly, *Atherigona soccata* Rondani. Ad. Agric. Res. India 1998;9:47-49.
3. Balikai RA. Management of shoot fly (*Atherigona soccata* Rondani) through seed treatment in rabi sorghum. Indian Journal Entomology 2007;69(2):178-180.
4. Balikai RA. Insect pest status of pearl millet [*Pennisetum glaucum* (L) R. Br.] in Karnataka. International Journal of Plant Protection 2010;2(2):189-190.
5. Gahukar RT. Population dynamics sorghum shoot fly *Atherigona soccata* (Diptera: Muscidae) in sonegal. Environment Entomology 1987;16:910-916.
6. Jat BL, Yadav SS, Roshan Lal. Bioassay of new chemistry insecticides against pod borer, *Helicoverpa armigera* on chickpea. Indian Journal of Plant Protection 2016;44(2):185-188.
7. Joshi ST, Hussain Kirar VS, Nagar R. Management of sorghum shoot fly, *Atherigona soccata* Rondani (Diptera: Muscidae) through botanicals. Journal of Biopesticides 2016;9:23-26.
8. Juneja RP, Raghvani KL. Feeding behavior of *Helicoverpa armigera* (Hubner) and its damage in pearl millet. Insect Environment 2000;6(3):141-142.
9. Kumar LV, Prabhuraj A. Bio-efficacy of chemicals for seed treatment against sorghum shoot fly, *Atherigona soccata* and shoot bug, *Peregrinus maidis*. Annals of Plant Protection Sciences 2007;15:312-315.
10. Kumar R, Alam T. Bio-efficacy of some newer insecticides against maize stem borer, *Chilo partellus* (Swinhoe), Journal of Entomology and Zoology Studies 2017;5(6):1347-1351.
11. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Publication and Information division, Indian Council of Agricultural Research, New Delhi, India 1989.
12. Parteti SR, Kalinkar AS, Gurve SS, Gawe, RW. Efficacy of botanicals for the management of sorghum shoot fly. Bio Science Trends 2014;7:2566-2569.
13. Pateliya VR, Parmar GM, Kelaiya DS, Vikani RM. Ecologically sustainable management of shoot fly and stem borer in pearl millet. Journal of Entomology and Zoology Studies 2019;7(5):597-599.
14. Prasad SS, Ashwani K. Field efficacy of selected insecticides against maize stem borer, *Chilo partellus*

(Swinhoe). Journal of Entomology and Zoology Studies 2018;6(5):468-470.
15. Prem Kishore S. Evolving management strategies for pests of millets in India. Journal of Entomological Research 1996;20(4):287-293.
16. Reddy KV, Skinner JD, Davies JC. Attractants for *Atherigona spp*. including sorghum shoot fly, *Atherigona soccata* Rond. (Muscidae: Diptera), Insect Science and Its Application 1981;2:83-86.
17. Sandhu GS. Evaluations of management components against shoot fly in sorghum. Annals of Plant Protection Sciences 2016;4:67-70.