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Testing the efficacy of IPM modules against insect pest complex of pearl millet

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Abstract
An experiment was carried out at the Main Pearl Millet Research Station, Junagadh Agricultural University, Jamnagar, to compare the effectiveness of various IPM modules against the pearl millet pest complex During kharif 2020–2022. In all total six modules in total were tested. Four replications of the experiment were used in a randomized block design. The IPM module-V, which included the furrow application of neem cake at 500 kg/hectare at the time of sowing, 10% higher seed rate, seed treatment with imidacloprid 600 FS @ 8.75 ml/kg + PSB @ 10 ml/kg seed, removal of shoot fly dead hearts, installation of fish meal trap @ 10/ha (Fish meal to be changed weekly), and spraying of azadirachtin 1500 ppm, 0.0006%.

Keywords: IPM module, shoot fly, stem borer, *H. armigera*, grass hopper, additional income, net return

Introduction
Pearl millet [*Pennisetum glaucum* (L.) R. Br.] popularly known as "Bajra" and belongs to the family of Poaceae. This grain is basically originated from India or Africa. Pearl millet is one of the oldest cultivated crops since pre-historic times and ranks as the sixth most important grain in the world. Pearl millet is the staple food of the majority of the poor and small landholders, as well as feed and fodder for livestock in the rain-fed region of the country. Pearl millet is one of the most extensively cultivated cereals in the world, after rice, wheat and sorghum. Pearl millet is well-adapted to survive under drought, high temperature, salinity, lodging and poor soils. Due to low yield potential as well as fluctuating grain prices plant protection measures were hardly taken. However, potentially very high-yielding hybrid varieties attract a heavy incidence of pearl millet insect pests.

According to reports from Prem Kishore and Solomon (1989) [12] and Balikai (2010) [4], this crop is reportedly infested by more than 100 different types of insect pests. Prem Kishore (1996) [13] reported that shoot flies caused grain losses ranging from 23.3 to 36.5 percent. Incidence of shoot flies ranged from 6.4 to 13.2 percent at Jamnagar between 15 and 50 days after crop germination, according to Raghvani *et al*. (2008) [15]. According to Prem Kishore (1996) [13], stem borer losses ranged from 20 to 60%. Helicoverpa armigera has been implicated in losses of up to 10% to 15% in pearl millet at Jamnagar, according to Juneja and Raghvani (2000) [7].

In pearl millet, grass hoppers are also becoming common pests (Balikai, 2010) [4]. The efficiency of chemical foliar spray on pearl millet has already been the subject of some studies (Parmar *et al*., 2015) [10]. The current study was proposed to test the effectiveness of various IPM modules, including seed treatments, soil applications, and some botanicals as a foliar spray, to manage shoot fly, stem borer, grass hopper, and Helicoverpa and reduce the pesticide load in the environment. This is because these pests are very difficult to control using only one method.

Materials and Methods
At the Junagadh Agricultural University's Main Pearl Millet Research Station in Jamnagar, an experiment was carried out during the kharif seasons of 2020 and 2022 to compare the performance of various IPM modules against the pearl millet pest complex. Six courses in total were created in collaboration with the National Center for IPM in New Delhi. Four replications of the experiment were used in a randomized block design. For this investigation, the pearl millet variety GHB 558 was used.

The net plot was 3.0 X 1.8 meters and the gross plot measured 4.0 X 3.0 meters. Plant to plant distance was 10 cm, and there were 60 cm between rows. Initially, soil application and seed treatments were made at the time of sowing. At 30 DAG and ear head stage, two foliar treatments were done. By counting the dead hearts on 20 plants from the net plot, observations were made during the vegetative period. So, the percent occurrence of shot flies was calculated. For the stem borer, a plant was considered injured if it had parallel holes caused by stem borer larvae in the leaves. As a result, the percent incidence was noted.

On five ear heads in each treatment, the Helicoverpa larval population was noted at the ear head stage both before and after spraying. At 45 DAG, grasshopper percent damage was noted. At harvest, grain and fodder yields were recorded from net plot area, and the information gathered was statistically examined.

Fish Meal Trap

A 250 ml plastic jar was taken, filled with fish meal to a depth of 2.0 cm, and covered with a mosquito net. Up to 3.0 cm above this, 3.0 mm-diameter holes were constructed. On the top of the inside lid, a sponge was dipped in a solution of malathion 50 EC 0.05% to kill shot flies (weekly). In order to hang the trap in the field on bamboo or pipe, the hook was fastened outside the lid.

Treatment details/IPM modules

1	IPM module-I	10% more seed applied, seed treated with imidacloprid 600 FS at 8.75 ml/kg, shoot fly dead hearts removed, and fish meal trap set at 10/ha.
2	IPM module-II	IPM module-I plus seed treatment with PSB at a rate of 10 ml/kg seed plus azadirachtin spray at a concentration of 1500 ppm (40 ml/10 litres of water) at the 30 DAG and ear head stage.
3	IPM module-III	IPM module I plus seed treatment with PSB at a rate of 10 ml/kg seed plus furrow application of Trichoderma harzianum at a rate of 2.5 kg/ha mixed in 500 kg of well-decomposed FYM at the time of sowing plus spray azadirachtin at a rate of 1500 ppm at 30 DAG and at ear head stage.
4	IPM module-IV	IPM module-I plus seed treatment with PSB at a rate of 10 ml/kg seed plus application of neem cake at a rate of 250 kg/hactare in the furrow at the time of sowing plus spraying with azadirachtin at a rate of 1500 ppm (40 ml/10 litres of water) at the 30 DAG and at the ear head stage.
5	IPM module-V	IPM module-I plus seed treatment with PSB at a rate of 10 ml/kg seed plus application of neem cake at a rate of 500 kg/hactare in the furrow at the time of sowing plus spraying with azadirachtin at a rate of 1500 ppm (40 ml/10 litres of water) at the 30 DAG and at the ear head stage.
6	IPM module-VI	Imidacloprid 600 FS seed treatment at a rate of 8.75 ml/kg, the placement of fish meal traps at a rate of 10/ha, and the application of NSKE 5% at the ear head stage (AICRP Standard check).
7	IPM module-VI I	Untreated-control

N.B.: Seed rate of bajra 4.0kg/ha taken for calculations, the untreated plot was kept 30M far away.

Results and Discussion

Shoot fly incidence at vegetative stage (28 DAG): The data in table 1 showed that differences in the percentage incidence of shoot flies at the vegetative stage were significant across all years and in aggregate. In terms of pooled data, IPM module-V reported the lowest incidence (5.92%). However, statistically speaking, it was comparable to IPM module-IV (6.96%). In contrast, it had a 17.89% control.

Shoot fly incidence at ear head stage: The information in table 2 shows that both individually and collectively; changes in shoot fly infestation at the ear head stage were determined to be significant. Additionally, the IPM module-V showed the lowest incidence of shoot flies across all years. The combined data from three years showed that IPM module-V had the significantly lowest incidence (5.39%), which was comparable to IPM modules-III and IV (6.11% and 6.01%, respectively). In contrast, it had a 15.46% control.

Stem borer incidence at vegetative stage (28 DAG): The information in table 3 showed that there were considerable differences in the incidence of stem borer during the kharifs of 2020, 2021, and 2022. In IPM module-IV for 2020, the least stem borer incidence (6.13%) was noted. It was comparable to IPM Modules II (7.09%), III (7.45%), and V (6.53%), though. In IPM module-V during 2021 and 2022, the least stem borer incidence was observed, and it was comparable to that of modules III and IV. In the case of pooled data, IPM module-V (4.57%) had the lowest stem borer incidence. It was however comparable to IPM module-IV (5.15%). Incidence of stem borer was lowest in IPM module II in 2017 (4.11%). In contrast, it had a 15% control.

Stem borer incidence at ear head stage: The information in table 4 showed that in all the years and in the pooled analysis, the difference in stem borer incidence at the ear head stage was considered significant. According to pooled data, IPM module-V (5.82%) had the lowest incidence of stem borers, which was comparable to IPM modules-III (6.76%) and IV (6.43%). 12.35% incidence was seen in the control group.

Ear head worm, *Helicoverpa armigera* population at ear head stage

1. **24 hours before spray:** According to the information in table 5, there was no variation in the number of Helicoverpa larvae at the ear head stage in any of the years during the kharif seasons of 2020, 2021, and 2022, 24 hours before spray. The least larval population in the pooled data was found in IPM module-V (2.92 larvae/5 ear heads), which was comparable to the other modules with the exception of control (4.17 larvae/5 ear heads).
2. **24 hours after spray:** In 2020, the findings were substantial when combined. While in 2021 and 2022, it had no real impact. In the case of pooled, IPM modules IV and V reported the lowest larval population (2.75 larvae/5 ear heads). IPM Module II (2.67 larvae/5 ear heads), IPM Module III (2.92 larvae/5 ear heads), and IPM Module VI (3.17 larvae/5 ear heads) were all higher than it. In contrast, the control group had 4.17 larvae per 5 ear heads (Table 6).
3. **3 days after spray:** The information in table 7 showed that the results were considered significant across all years and when pooled. IPM module-II recorded the lowest larval population in 2020 (1.00 larvae/5 ear heads). In contrast, the IPM module-V recorded data for

the years 2021 (1.00 larvae/5 ear heads) and 2022 (2.50 larvae/5 ear heads). In the case of pooled, IPM module-V reported the lowest larval population (1.67 larvae/5 ear heads). IPM Module II (1.83 larvae/5 ear heads), IPM Module III (1.92 larvae/5 ear heads), and IPM Module IV (1.75 larvae/5 ear heads) were all higher than it. In contrast, the control group had 4.83 larvae per 5 ear heads.

4. **7 days after spray:** The information in table 8 showed that the results were considered significant throughout the course of the three years and when pooled. Additionally, during the course of the three years, IPM module-V reported the lowest larval population. IPM module-V recorded the lowest larval population in the case of pooled data (0.58 larvae/5 ear heads), which was comparable to IPM module-II's (0.83 larvae/5 ear heads), IPM module-III's (0.83 larvae/5 ear heads), and IPM module-IV's (0.75 larvae/5 ear heads). In contrast, 5.17 larvae/5 ear heads were in charge.
5. **Grass hopper damage at 45 DAG (vegetative stage):** All three years' worth of results were deemed noteworthy when aggregated. The IPM module-V in 2020 recorded the least grass hopper damage (4.10%), followed by IPM module-II (5.76%), IPM module-III (5.19%), and IPM module-IV (5.64%) in april. It was under control by 11.16%, however. IPM module-V substantially recorded the least damage in 2021 (3.59%). IPM module-V suffered the least damage in 2022 (2.33%), and it was only slightly worse than IPM module-IV (2.80%). IPM module-V recorded the least damage (3.34%) when pooled again, and it was barely on par with IPM module-IV (4.22%). In the control, it was 11.10% (Table 9).
6. **Grain yield:** Due to high rainfall at the maturation stage in 2020, the grain production was lower than the state average (1600 kg/ha), and the data was therefore ignored. The results from 2021 and 2022 were found to be substantial, and IPM module-V had the highest yield. According to pooled data, IPM module-V had the highest grain yield (3131 kg/ha), which was comparable to IPM modules-III (2881 kg/ha) and IV (2915 kg/ha). While in control, it was 1780 kg/ha.
7. **Fodder yield:** During 2021 and 2022, the results of the fodder yield were found to be considerable. In the case of pooled, IPM module-V (6200 kg/ha) had the maximum fodder yield and was comparable to modules III (5429 kg/ha) and IV (5962 kg/ha). While in control, it was 3416 kg/ha.
8. **Economics of the treatments:** IPM Module V showed the highest Additional Income of Rs. 35288/ha and the highest Net Return of Rs. 26861/ha. The ICBR for this module was 1:4.19 (Table 11). IPM module-III (1:7.84) has the highest ICBR.

The most successful method for controlling shoot flies and stem borer in pearl millet was seed treatment with imidacloprid 600 FS @ 8.75 g/kg seed, followed by dusting with fenvalerate 0.4 D @ 20 kg/ha at 35 days after germination (Anon., 2012). Imidacloprid 600 FS @ 8.75 ml/kg at the time of sowing, the removal of shoot fly dead hearts, the installation of fish meal traps @ 10/ha, and the spraying of dimethoate 30EC @ 0.03% at 35 days after germination were all included in the IPM module that Parmar *et al*., 2021 [11] found to be effective against shoot fly.

The IPM module, which included treating seeds with imidacloprid 600 FS at a rate of 8.75 ml/kg, removing shoot fly dead hearts, setting up fish meal traps at a rate of 10/ha, and spraying novaluron 10 EC at a rate of 0.01% at 35 DAG, had the lowest stem borer incidence rate and *Helicoverpa* larval population at the ear head stage of the crop. One of the most popular traps for this pest's adults is the fishmeal trap. The most effective mixture for capturing the most shoot fly females was discovered to be fish meal yeast ammonium sulphide (Reddy *et al*., 1981) [14] imidaclopri14d. A. soccata females made up about 80–97% of the fishmeal trap catch (Gahukar, 1987) [5]. In order to reduce the damage caused by shoot fly (14.3%) and to increase the grain production in sorghum, seed dressing with imidacloprid 70 WS @ 10g/100g seeds was shown to be the most efficient method (Balikai *et al*., 1998) [2]. Additionally, according to Balikai (2007) [3], seeds treated with imidacloprid 70 WS @ 10g/kg seeds had the lowest incidence of shoot flies (8.4% dead hearts). Additionally, even at a lower dose of 5g/kg seed, imidacloprid 70 WS performed better in lowering the prevalence of shoot flies in sorghum (Kumar and Prabhuraj, 2007) [8]. According to Parteti *et al*. (2014) [9], azadirachtin 1500 ppm foliar spray reduced the production of dead hearts in sorghum and decreased shoot fly egg laying. In sorghum, seed treatment with imidacloprid 600 FS @ 7 ml/kg seed was reported to be efficient in lowering the incidence of shoot flies (Sandhu, 2016) [17]. According to Jemla *et al*. (2006) [6], applying neem ckae increases the development of side suckers in comparison to other treatments while also reducing the incidence of cardamom shoot flies. Neem cake @ 250 kg/ha was discovered to be the most effective organic in lowering the oviposition as well as the percentage of dead hearts by shoot fly in small millet (Ravulapenta *et al*., 2017) [16].

Table 1: Statement showing percent shoot fly incidence at 28 DAG (Vegetative stage)

No.	Treatments	2020	2021	2022	Pooled
T_1	Module-I	18.72*(10.40)	19.35* (11.09)	18.35* (9.94)	18.81* (10.48)
T_2	Module-II	17.10(8.68)	16.75 (8.34)	15.17 (6.86)	16.34 (7.96)
T_3	Module-III	17.70 (9.27)	16.45 (8.03)	14.27 (6.08)	16.14 (7.79)
T_4	Module-IV	16.10 (7.78)	15.30 (7.05)	14.17 (6.04)	15.19 (6.96)
T_5	Module-V	15.01 (6.76)	14.03 (5.93)	13.00 (5.08)	14.02 (5.92)
T_6	Module-VI	22.21 (14.37)	18.00 (9.58)	20.42 (12.22)	20.21 (12.06)
T_7	Control	25.37 (18.49)	24.44 (17.21)	25.07 (17.96)	24.96 (17.89)
T	S.Em +/-	0.99	0.90	0.63	0.49
	C.D. at 5%	2.95	2.67	1.87	1.40
Y	S.Em +/-	-	-	-	0.32
	C.D. at 5%	-	-	-	0.92
YXT	S.Em +/-	-	-	-	0.86
	C.D. at 5%	-	-	-	NS
	C.V.%	-	-	-	9.53

N.B.: (*) indicates arcsine values. Whereas, figure in brackets are original values

Table 2: Statement showing percent shoot fly incidence at ear head stage

No.	Treatments	2020	2021	2022	Pooled
T_1	Module-I	21.24* (13.14)	20.06* (11.78)	19.73* (11.40)	20.34* (12.11)
T_2	Module-II	15.10 (6.93)	14.83 (6.73)	15.36 (7.18)	15.10 (6.95)
T_3	Module-III	15.21 (6.63)	14.08 (6.07)	13.50 (5.64)	14.08 (6.11)
T_4	Module-IV	14.79 (6.60)	14.00 (5.98)	13.35 (5.44)	14.05 (6.01)
T_5	Module-V	13.82 (5.90)	12.88 (5.17)	12.88 (5.10)	13.19 (5.39)
T_6	Module-VI	19.38 (11.07)	17.89 (9.48)	17.30 (8.90)	18.19 (9.82)
T_7	Control	22.97 (15.26)	22.06 (14.22)	24.20 (16.89)	23.08 (15.46)
T	S.Em +/-	0.72	0.73	0.78	0.44
	C.D. at 5%	2.15	2.18	2.31	1.24
Y	S.Em +/-	-	-	-	0.29
	C.D. at 5%	-	-	-	NS
YXT	S.Em +/-	-	-	-	0.76
	C.D. at 5%	-	-	-	NS
	C.V.%	-	-	-	8.99

N.B.: (*) indicates arcsine values. Whereas, figure in brackets are original values

Table 3: Statement showing percent stem borer incidence at 28 DAG (Vegetative stage)

No.	Treatments	2020	2021	2022	Pooled
T_1	Module-I	17.49* (9.09)	18.43* (10.20)	18.10* (9.72)	18.01* (9.67)
T_2	Module-II	15.44 (7.09)	14.98 (6.84)	15.21 (6.90)	15.21 (6.94)
T_3	Module-III	15.80 (7.45)	13.56 (5.85)	11.51 (4.19)	13.62 (5.83)
T_4	Module-IV	14.28 (6.13)	13.20 (5.55)	11.20 (3.90)	12.89 (5.19)
T_5	Module-V	14.75 (6.53)	11.32 (4.23)	9.56 (2.94)	11.88 (4.57)
T_6	Module-VI	18.58 (10.22)	18.37 (10.25)	16.93 (8.72)	17.96 (9.73)
T_7	Control	21.84 (13.86)	23.10 (15.69)	23.02 (15.46)	22.65 (15.00)
T	S.Em +/-	0.64	1.00	1.10	0.54 ()
	C.D. at 5%	1.90	2.97	3.27	1.53
Y	S.Em +/-	-	-	-	0.35
	C.D. at 5%	-	-	-	1.00
YXT	S.Em +/-	-	-	-	0.93
	C.D. at 5%	-	-	-	NS
	C.V.%	-	-	-	11.66

N.B.: (*) indicates arcsine values. Whereas, figure in brackets are original values.

Table 4: Statement showing percent stem borer incidence at ear head stage

No.	Treatments	2020	2021	2022	Pooled
T_1	Module-I	19.94* (11.71)	18.85* (10.51)	18.52* (10.14)	19.10* (10.79)
T_2	Module-II	15.77 (7.63)	15.50 (7.42)	16.65 (8.33)	15.98 (7.79)
T_3	Module-III	15.65 (7.38)	15.00 (6.76)	14.27 (6.13)	14.97 (6.76)
T_4	Module-IV	15.35 (7.04)	14.59 (6.39)	13.93 (5.85)	14.62 (6.43)
T_5	Module-V	14.92 (6.64)	13.95 (5.82)	12.73 (4.99)	13.87 (5.82)
T_6	Module-VI	18.72 (10.34)	17.29 (8.86)	17.51 (9.09)	17.84 (9.43)
T_7	Control	21.38 (13.33)	20.64 (12.44)	19.55 (11.29)	20.52 (12.35)
T	S.Em +/-	0.71	0.74	0.58	0.39
	C.D. at 5%	2.12	2.20	1.72	1.12
Y	S.Em +/-	-	-	-	0.26
	C.D. at 5%	-	-	-	0.73
YXT	S.Em +/-	-	-	-	0.68
	C.D. at 5%	-	-	-	NS
	C.V.%	-	-	-	8.15

N.B.: (*) indicates arcsine values. Whereas, figure in brackets are original values.

Table 5: Statement showing *Helicoverpa armigera* larval population 24 hours before spray at ear head stage.

No.	Treatments	*Helicoverpa armigera* larval population/5 ear heads			
		2020	2021	2022	Pooled
T_1	Module-I	1.98# (3.50)	1.79# (2.75)	2.12# (4.50)	1.87# (3.58)
T_2	Module-II	1.65 (2.25)	1.86 (3.00)	1.99 (4.00)	1.73 (3.08)
T_3	Module-III	1.70 (2.50)	1.86 (3.00)	2.05 (4.25)	1.77 (3.25)
T_4	Module-IV	1.64 (2.25)	1.86 (3.00)	1.99 (4.00)	1.73 (3.08)
T_5	Module-V	1.56 (2.00)	1.79 (2.75)	1.99 (4.00)	1.67 (2.92)
T_6	Module-VI	1.86 (3.00)	1.86 (3.00)	1.96 (4.00)	1.80 (3.33)
T_7	Control	2.11 (4.00)	2.00 (3.50)	2.23 (5.00)	2.03 (4.17)
T	S.Em +/-	0.14	0.08	0.14	0.08
	C.D. at 5%	NS	NS	NS	0.22
Y	S.Em +/-	-	-	-	0.05
	C.D. at 5%	-	-	-	0.14
YXT	S.Em +/-	-	-	-	0.13
	C.D. at 5%	-	-	-	NS
	C.V.%	-	-	-	14.65

N.B.: (#) indicates SQR X+0.5 values. Whereas, figure in brackets are original values.

Table 6: Statement showing *Helicoverpa armigera* larval population 24 hours after spray at ear head stage.

No.	Treatments	*Helicoverpa armigera* larval population/5 ear heads			
		2020	2021	2022	Pooled
T_1	Module-I	1.98# (3.50)	1.79# (2.75)	2.12# (4.50)	1.87# (3.58)
T_2	Module-II	1.40 (1.5)	1.80 (2.75)	1.93 (3.75)	1.60 (2.67)
T_3	Module-III	1.64 (2.25)	1.77 (2.75)	1.93 (3.75)	1.67 (2.92)
T_4	Module-IV	1.56 (2.00)	1.77 (2.75)	1.81 (3.50)	1.60 (2.75)
T_5	Module-V	1.56 (2.00)	1.79 (2.75)	1.86 (3.50)	1.63 (2.75)
T_6	Module-VI	1.86 (3.00)	1.77 (2.75)	1.90 (3.75)	1.74 (3.17)
T_7	Control	2.11 (4.00)	2.00 (3.50)	2.23 (5.00)	2.03 (4.17)
T	S.Em +/-	0.13	0.10	0.16	0.08
	C.D. at 5%	0.40	NS	NS	0.23
Y	S.Em +/-	-	-	-	0.05
	C.D. at 5%	-	-	-	0.15
YXT	S.Em +/-	-	-	-	0.14
	C.D. at 5%	-	-	-	NS
	C.V.%	-	-	-	16.28

N.B.: (#) indicates SQR X+0.5 values. Whereas, figure in brackets are original values.

Table 7: Statement showing *Helicoverpa armigera* larval population 3 days after spray at ear head stage.

No.	Treatments	*Helicoverpa armigera* larval population/5 ear heads			
		2020	2021	2022	Pooled
T_1	Module-I	2.03# (3.75)	1.86# (3.00)	2.17 # (4.75)	1.93# (3.83)
T_2	Module-II	1.22 (1.00)	1.31 (1.25)	1.80 (3.25)	1.30 (1.83)
T_3	Module-III	1.40 (1.50)	1.31 (1.25)	1.72 (3.00)	1.34 (1.92)
T_4	Module-IV	1.31 (1.25)	1.31 (1.25)	1.64 (2.75)	1.28 (1.75)
T_5	Module-V	1.40 (1.50)	1.22 (1.00)	1.54 (2.50)	1.25 (1.67)
T_6	Module-VI	1.73 (2.50)	1.70 (2.50)	1.85 (3.50)	1.65 (2.83)
T_7	Control	2.22 (4.50)	2.18 (4.25)	2.40 (5.75)	2.19 (4.83)
T	S.Em +/-	0.12	0.10	0.13	0.07
	C.D. at 5%	0.36	0.28	0.38	0.20
Y	S.Em +/-	-	-	-	0.05
	C.D. at 5%	-	-	-	0.13
YXT	S.Em +/-	-	-	-	0.12
	C.D. at 5%	-	-	-	NS
	C.V.%	-	-	-	15.74

N.B.: (#) indicates SQR X+0.5 values.Whereas, figure in brackets are original values.

Table 8: Statement showing *Helicoverpa armigera* larval population 7 days after spray at ear head stage.

No.	Treatments	*Helicoverpa armigera* larval population/5 ear heads			
		2020	2021	2022	Pooled
T_1	Module-I	2.10# (4.00)	2.00# (3.50)	2.28# (4.75)	2.13# (4.08)
T_2	Module-II	0.84 (0.25)	0.97 (0.50)	1.49 (1.75)	1.10 (0.83)
T_3	Module-III	0.97 (0.50)	0.97 (0.50)	1.40 (1.50)	1.11 (0.83)
T_4	Module-IV	0.84 (0.25)	0.97 (0.50)	1.40 (1.50)	1.07 (0.75)
T_5	Module-V	0.84 (0.25)	0.84 (0.25)	1.31 (1.25)	1.00 (0.58)
T_6	Module-VI	1.22 (1.00)	1.22 (1.00)	1.68 (2.50)	1.38 (1.50)
T_7	Control	2.40 (5.25)	2.23 (4.50)	2.50 (5.75)	2.38 (5.17)
T	S.Em +/-	0.12	0.12	0.13	0.07
	C.D. at 5%	0.35	0.36	0.38	0.20
Y	S.Em +/-	-	-	-	0.05
	C.D. at 5%	-	-	-	0.13
YXT	S.Em +/-	-	-	-	0.12
	C.D. at 5%	-	-	-	NS
	C.V.%	-	-	-	16.87

N.B.: (#) indicates SQR X+0.5 values. Whereas, figure in brackets are original values.

Table 9: Statement showing grass hopper per cent incidence at 45 DAG (Vegetative stage)

No.	Treatments	2020	2021	2022	Pooled
T_1	Module-I	17.09* (8.83)	17.60* (9.38)	18.19* (9.94)	17.63* (9.38)
T_2	Module-II	13.83 (5.76)	16.06 (7.69)	14.65 (6.52)	14.85 (6.66)
T_3	Module-III	13.09 (5.19)	16.20 (7.72)	13.04 (5.23)	14.11 (6.08)
T_4	Module-IV	13.72 (5.64)	11.81 (4.23)	9.55 (2.80)	11.69 (4.22)
T_5	Module-V	11.60 (4.10)	10.84 (3.59)	8.74 (2.33)	10.39 (3.34)
T_6	Module-VI	16.51 (8.24)	16.28 (7.93)	17.13 (8.69)	16.64 (8.29)
T_7	Control	19.39 (11.16)	18.71 (10.40)	19.99 (11.73)	19.36 (11.10)
T	S.Em +/-	1.20	1.13	0.92	0.63
	C.D. at 5%	3.57	3.35	2.73	1.78
Y	S.Em +/-	-	-	-	0.41
	C.D. at 5%	-	-	-	NS
YXT	S.Em +/-	-	-	-	1.09
	C.D. at 5%	-	-	-	NS
	C.V.%	-	-	-	14.57

N.B.: (*) indicates arcsine values. Whereas, figure in brackets are original values.

Table 10: Statement showing yield of pearl millet

No.	Treatments	Grain yield kg/ha			Fodder yield/kg/ha		
		2021	2022	Pooled	2021	2022	Pooled
1	T_1	1669.45	2028.82	1849.13	3489.93	3820.14	3655.04
2	T_2	2213.89	2521.18	2367.54	4754.17	5325.35	5039.76
3	T_3	2777.09	2984.72	2880.91	4970.49	5886.81	5428.65
4	T_4	2784.38	3045.84	2915.11	5493.75	6429.87	5961.81
5	T_5	2995.49	3266.67	3131.08	5578.82	6821.88	6200.35
6	T_6	1927.08	2286.81	2106.95	4271.88	4630.91	4451.39
7	T_7	1626.74	1933.33	1780.04	3053.47	3780.21	3416.84
T	S.Em +/-	112.70	140.33	89.99	486.38	438.89	327.56
	C.D. at 5%	334.86	416.95	258.32	1445.18	1304.06	940.30
Y	S.Em +/-			48.10			175.09
	C.D. at 5%			138.08			502.61
YXT	S.Em +/-			127.27			463.25
	C.D. at 5%			NS			NS
	C.V.%			10.46			18.99

N.B.: The grain yield during 2020 was below state average (1638 kg/ha) due to heavy rain at maturity stage. Hence, it was not considered.

Table 11: Economics of various treatments for the management of shoot fly and stem borer in pearl millet

Sr. No.	Treatments	Yield increase Over control kg/ha		Additional income (Rs.)	Total Expenditure (Rs.)	Net return (Rs.)	I.C.B.R.
		Grain	fodder				
1	IPM module-I	69	238	1994	422	1572	1:4.73
2	IPM module-II	588	1623	16182	3427	12755	1:4.72
3	IPM module-III	1101	2012	28246	3602	24644	1:7.84
4	IPM module-IV	1135	2545	30060	5924	24133	1:5.07
5	IPM module-V	1351	2783	35288	8427	26861	1:4.19
6	IPM module-VI (AICRP check)	327	1034	9262	1882	7380	1:4.92

N.B.:
Bajra grains @ Rs. 22.0 / kg, Bajra fodder @ Rs. 2.0 / kg
Seed trt. Of Imidachlorprid 600 FS @ 8.75 ml/kg, total 35 ml used/ 4.0 kg seed, cost is Rs. 5.20 per ml
Cost of Azdirachtin 1500 ppm Rs. 500/- litre, total 2.0 litre used per spray
10 Fish meal traps/ha., such 10 traps were installed, cost of each trap @ Rs. 20 per trap.
Cost of Azadirachtin 1500 pmm, 470/- per litre, total 2.0 litre used
Cost of Neem cake Rs. 500/- per 50 kg, total 250 & 500 Kg used as per trt.
500 Litres of water used for spray, Labour charges were Rs 500/-ha.
Cost of Trichoderma Rs. 70/- per kg, total 2.5 kg used
Cost of PSB RS. 120/- litre, total 44 ml used
Cost of NSKE @ 20.00/ kg, total 25.0 kg/ha used per ha, Rs 500/- plus 500 labour charge for preparation, total Rs. 1000/-

Conclusion

Imidacloprid 600 FS @ 8.75 ml/kg + PSB @ 10 ml/kg seed, removal of shoot fly dead hearts, installation of fish meal trap @ 10/ha, fish meal to be changed weekly, and spraying of azadirachtin 1500 ppm, 0.0006%, at 30 DAG and at ear head stage give effective control of shoot fly, stem borer, grass hopper, and Helicoverpa with higher grain and fodder yields) Additionally, this module recorded the highest net return and increased income. As a result, farmers should be encouraged to adopt this module.

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