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Development of integrated pest management module for fall armyworm *Spodoptera frugiperda* (J. E. Smith) on maize

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Abstract
Introduction: Suicidal behavior is seen in the context of a variety of mental disorders and while many believe that, in general, first episode psychosis is a particularly high-risk period for suicide, no general agreement regarding higher prevalence of suicide in first episode psychosis is achievable. In the present study, suicides and suicide attempts among psychiatric in-patients has been evaluated to assess the general profile of suicidal behavior among native psychiatric inpatients and probing any relationship between serum cholesterol level and suicidal behavior.
Methods: five acute academic wards, which have been specified for admission of first episode adult psychiatric patients, and five acute non-academic wards, which have been specified for admission of recurrent episode adult psychiatric patients, had been selected for current study. All inpatients with suicidal behavior (successful suicide and attempted suicide, in total), during the last five years (2013-2018), had been included in the present investigation. Also, assessment of serum lipids, including triglyceride, cholesterol, low density lipoprotein and high density lipoprotein, had been accomplished, for comparing the suicidal subjects with non-suicidal ones.
Results: Among 19160 psychiatric patients hospitalized in Razi psychiatric hospital during a sixty months period, 63 suicidal behaviors, including one successful suicide and sixty two suicide attempts, had been recorded by the safety board of hospital. The most frequent mental illness was bipolar I disorder, which was significantly more prevalent in comparison with other mental disorders ($p<0.04$, $p<0.02$, $p<0.007$, and $p<0.003$ in comparison with schizophrenia, depression, personality disorders and substance abuse, respectively). Self-mutilation, self-poisoning and hanging were the preferred methods of suicide among 61.11%, 19.44% and 19.44% of cases, respectively. In addition, no significant difference was evident between the first admission and recurrent admission inpatients, totally and separately, particularly with respect to psychotic disorders. Besides, with respect to different components of serum lipids, no specific or significant pattern was evident.
Conclusion: While in the present study the suicidal behavior was significantly more evident in bipolar disorder in comparison with other psychotic or no-psychotic disorders, no significant difference was evident between first admission and recurrent admission psychiatric inpatients. Moreover, no significant relationship between suicidal behavior and serum lipids was palpable.

Keywords: Psychiatric disorders, suicide, suicide attempt, first admission, recurrent admission, schizophrenia, bipolar disorder, depression, substance abuse disorder

Introduction

Suicide is derived from the Latin word for "self-murder." It is a fatal act that represents the person's wish to die. A suicide attempt is a behavior that the individual has undertaken with at least some intent to die. The behavior might or might not lead to death, injury or serious medical consequences. Several factors can influence the medical consequences of the suicide attempt, including poor planning, lack of knowledge about the lethality of the method chosen, low intentionality or ambivalence, or chance intervention by others after the behavior has been initiated [1]. Determining the degree of intent can be challenging. Individuals might not acknowledge intent, especially in situations where doing so could result in hospitalization or cause distress to loved ones. Markers of risk include degree of planning, including selection of a time and place to minimize rescue or interruption; the individual's mental state at the time of the behavior, with acute agitation being especially concerning; recent discharge from inpatient care; or recent discontinuation of a mood stabilizer such as lithium or an antipsychotic such as clozapine in the case of schizophrenia. Approximately 25%-30% of persons who attempt suicide will go on to make more attempts. Suicidal behavior is seen in the context of a variety of mental disorders, most commonly

Maize (*Zea mays* L.) belongs to family Gramineae. It is an important cereal crop grown throughout the world (Araus *et al*., 2002) [2]. It is a high yielding crop of considerable commercial and industrial value, as many goods are made from its grains. (Chaudhary *et al*., 1997) [3]. The arthropod pests are one of the main factors leading to low maize yield, and maize production problems. Due to arthropod pests despite the use of pesticides, great crop losses are still present, particularly in developing countries (Ferdu *et al.*, 2001) [10]. The recently introduced pest fall armyworm *Spodoptera frugiperda* is of serious concern due to its polyphagous nature. His good ability to travel and disperse long distance annually during the summer months may be the key reason for its rapid spread (Mallapur *et al.*, 2018) [7]. The use of insecticide spray and genetically modified crop (*Bt* maize) are the common management strategies for fall armyworm in its native ranges of America. Nevertheless, the FAW has developed resistance for several insecticides (Abraham *et al*., 2017) [1], which suggests the use of integrated management strategies for sustainable management of this invasive pest. However, empirical information on different approaches for IPM of fall armyworm is deficient in India. Hence the present investigations were carried out to develop Integrated Pest Management Module for fall armyworm *Spodoptera frugiperda* on maize.

Materials and methods

The field experiment was conducted at research field of Department of Agricultural Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Rabi* 2019-20. The sowing was done at 60 cm x 20 cm spacing on 1st December 2019. The experiment executed in randomized block design having 5 treatments and 4 replications. The treatments include different modules having various practices for management of fall armyworm. The details of treatments and their application of timing are presented in Table 1.

Table 1: Treatment details of evaluation of different modules for management of fall armyworm on maize

Tr. No.	Treatment	Treatment name	Application Timing
T_1	IPM excluding seed treatment	Spraying of NSKE 5%	15 DAG
		Realease *of Trichogramma spp.* @ 1.25 lakh/ha 20 DAG	20 DAG
		Spraying of Thiamethoxam 12.6% + Lamda-cyhalothrin 9.5% ZC @ 250ml/ha	30 DAG
		Application of *Metarhizium rileyi* @ 2 kg/ha	45 DAG
T_2	IPM including seed treatment	Seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% ZC@4 ml/kg seed	Sowing
		Spraying of NSKE 5%	15 DAG
		Release *Trichogramma spp.* @ 1.25 lakh/ha	20 DAG
		Spraying of Thiamethoxam 12.6% + Lamda-cyhalothrin 9.5% ZC @ 250 ml/ha	30 DAG
		Application of *Metarhizium rileyi* @ 2 kg/ha	45 DAG
T_3	Biointensive control	Spraying of NSKE 5%	15 DAG
		Release of *Trichogramma spp.* @ 1.25 lakh /ha	20, 30, 40 DAG
		Spraying of *Metarhizium rileyi* @ 2 kg/ha + *Beauveria bassiana* @ 2 kg /ha + EPN @ 750 g/ha	30, 45 DAG
T_4	Chemical control	Spraying of Thiamethoxam 12.6 % + Lamda-cyhalothrin 9.5 % ZC @ 250 ml/ha	15 DAG
		Spraying of Emamectin benzoate 5 % SG @ 220 g/ha	30 DAG
		Spraying of Spinoteram 11.7 % SC @ 450 ml /ha	45 DAG
T_5	Untreated control	No any plant protection measures	--

The observations of larval population and damaged plants were recorded from randomly selected 10 plants in each plot at weekly interval. The grain yield was recorded at harvest from each plot. The observations on natural enemies were recorded from randomly selected 10 plants from each plot.

The data obtained from the different treatments were computed to determine the mean values. The mean values after suitable transformation were subjected to statistical analysis to test significance as per Gomez and Gomez (1984) [6] for interpretation of the results using OPSTAT software. The economics of application of various treatments were calculated and incremental cost benefit ratio was worked out.

Results and discussion

The data on larval population of fall armyworm in different management modules are presented in Table 2. The overall average of larval population revealed that all the modules were found significantly superior over untreated control in reducing larval population. IPM including seed treatment was found most effective than other modules by recording lowest larval population (0.20 larvae / plant). Second better module was IPM excluding seed treatment (0.34 larvae / plant) and followed by chemical control (0.34 larvae / plant) and biointensive control (0.42 larvae / plant). The larval population was highest in untreated control (0.99 larvae / plant).

The observations on damaged plants due to fall armyworm on maize in different management modules are presented in Table 3. The overall average of damaged plants indicated that all the modules were found significantly superior over untreated control in reducing plant damage. IPM including seed treatment was found superior than other modules by recording lowest plant damage (10.30%). Second better treatment was IPM excluding seed treatment (24.27%) followed by chemical control (26.63%) and biointensive control (29.69%). The plant damage was highest in untreated control (62.12%).

The data on coccinellid population in different management modules are given in Table 4. The results regarding seasonal average of coccinellid population revealed the untreated control recorded maximum coccinellid population (0.43 grubs and adult/plant). Among the modules, chemical control was harmful to coccinellids recording lowest coccinellid population (0.11 grubs and adult / plant). Other modules were safer than chemical control. The population was 0.36, 0.35 and 0.25 grubs and adult / plant in biointensive control, IPM excluding seed treatment and IPM including seed treatment, respectively. The observations on predatory bugs in different modules for management of fall armyworm are presented in Table 5. The overall average of predatory bugs population indicated that chemical control was found harmful to bugs than other modules by recording lowest predatory bugs population (0.04 bugs / plant). It was followed by IPM including seed treatment (0.13 bugs / plant) and IPM excluding seed treatment (0.18 bugs / plant). Biointensive control (0.26 bugs / plant) was most safer among modules. Predatory bugs population was highest in untreated control (0.37 bugs / plant).

The highest grain yield of maize was recorded from IPM including seed treatment (32.50 q / ha), followed by IPM excluding seed treatment (30.50 q / ha), chemical control (29.25 q / ha). Lowest grain yield was recorded from biointensive control (27.75 q / ha) and untreated control (18.75 q / ha) (Table 6). The IPM including seed treatment was recorded highest value of additional yield over untreated control (Rs 24200 /ha) followed by IPM excluding seed treatment (Rs 21120/ha), chemical control (Rs 18920/ha), biointensive control (Rs 15840/ha) respectively. The lowest value of additional yield over untreated control was biointensive control from among all treatment (Rs 15840 /ha). The highest incremental cost benefit ratio (ICBR) was recorded in IPM excluding seed treatment (1:4.24) followed by biointensive control (1:3.72), IPM including seed treatment (1:3.41), and chemical control (1:2.67).

The various research workers reported effectiveness of individual components against fall armyworm. Mallapur *et al.*, (2018) [7] indicated that spinetoram recorded 98.13 per cent reduction over control at seven days after treatment followed by emamectin benzoate and spinosad. Deshmukh *et al.*, (2021) [4] revealed that the effective insecticides against fall armyworm were chlorantraniliprole 18.5 SC, followed by emamectin benzoate 5 SG, spinetoram, also Srinivasan *et al.*, (2020) [8] revealed that spinoteram 11.7% SC, chlorantraniliprole 18.5% SC, thiodicarb 75 WP and emamectin benzoate 5 % SG registered the lowest mean FAW score of 1.1, 1.2, 1.2, and 1.3, respectively as against 6.8 in untreated control. Usha Rani *et al.*, (2020) [9] reported effectiveness of IPM module against FAW from Tamil Nadu. The findings of present investigations confirmed the results of these workers.

Table 2: Effect of different management practices on larval population of fall armyworm *Spodoptera frugiperda* on maize

Tr. No.	Treatment	Number of larvae / plant											
		14 DAG	21 DAG	28 DAG	35 DAG	42 DAG	49 DAG	56 DAG	63 DAG	70 DAG	77 DAG	84 DAG	Average
T_1	IPM excluding seed treatment	0.63 (1.27)*	0.40 (1.19)	0.30 (1.14)	0.20 (1.09)	0.30 (1.13)	0.17 (1.08)	0.20 (1.11)	0.27 (1.12)	0.37 (1.16)	0.40 (1.18)	0.50 (1.22)	0.34
T_2	IPM including seed treatment	0.00 (1.00)	0.20 (1.13)	0.20 (1.09)	0.07 (1.03)	0.17 (1.08)	0.10 (1.04)	0.13 (1.06)	0.20 (1.11)	0.30 (1.13)	0.37 (1.16)	0.50 (1.22)	0.20
T_3	Biointensive control	0.60 (1.24)	0.43 (1.19)	0.35 (1.16)	0.27 (1.12)	0.37 (1.16)	0.27 (1.12)	0.30 (1.13)	0.37 (1.16)	0.50 (1.22)	0.57 (1.25)	0.63 (1.27)	0.42
T_4	Chemical control	0.63 (1.27)	0.33 (1.16)	0.27 (1.13)	0.13 (1.06)	0.30 (1.13)	0.13 (1.06)	0.20 (1.11)	0.30 (1.13)	0.43 (1.19)	0.50 (1.22)	0.60 (1.26)	0.34
T_5	Untreated control	0.60 (1.24)	0.77 (1.33)	0.70 (1.30)	0.37 (1.16)	0.55 (1.24)	0.93 (1.39)	1.10 (1.34)	1.30 (1.51)	1.37 (1.50)	1.63 (1.60)	1.70 (1.58)	0.99
	SE +	0.03	0.04	0.03	0.03	0.03	0.08	0.03	0.05	0.078	0.07	0.05	
	CD at 5%	0.10	0.13	0.10	NS	0.10	0.24	0.12	0.18	0.24	0.21	0.17	
	CV (%)	5.68	6.94	5.32	6.66	5.58	13.86	6.79	9.65	12.70	10.75	8.22	

*Figures in parenthesis are square root transformed value

Table 3: Effect of different management practices on damaged plants due to fall armyworm *Spodoptera frugiperda* on maize

Tr. No.	Treatment	Damaged plant (%)											
		14 DAG	21 DAG	28 DAG	35 DAG	42 DAG	49 DAG	56 DAG	63 DAG	70 DAG	77 DAG	84 DAG	Average
T_1	IPM excluding seed treatment	43.33 (41.13)*	27.33 (31.49)	23.33 (28.84)	13.33 (21.37)	23.33 (28.86)	16.33 (23.80)	20.00 (26.48)	23.33 (28.86)	26.67 (30.45)	26.67 (30.45)	23.33 (28.85)	24.27
T_2	IPM including seed treatment	0.00 (0.00)	10.00 (18.34)	6.67 (14.90)	3.33 (10.17)	10.00 (18.34)	6.67 (14.90)	10.00 (18.34)	10.00 (18.34)	16.67 (24.01)	20.00 (26.51)	20.00 (26.51)	10.30
T_3	Biointensive control	40.00 (39.19)	30.00 (33.13)	23.33 (28.86)	16.67 (24.01)	33.33 (35.13)	23.33 (28.86)	26.67 (30.71)	30.00 (33.13)	30.00 (33.16)	33.33 (35.13)	40.00 (35.13)	29.69
T_4	Chemical control	46.67 (43.06)	23.33 (28.86)	20.00 (26.51)	13.33 (21.29)	30.00 (33.17)	16.33 (23.80)	23.33 (28.86)	26.67 (31.06)	30.00 (32.86)	30.00 (33.03)	33.33 (35.13)	26.63
T_5	Untreated control	43.33 (40.97)	60.00 (50.76)	56.67 (48.81)	36.67 (37.24)	46.67 (43.03)	63.33 (52.72)	70.00 (56.79)	73.33 (58.89)	80.00 (64.00)	73.33 (59.20)	80.00 (64.09)	62.12
	SE +	1.21	0.92	0.97	0.67	1.69	0.93	0.84	1.06	1.66	1.75	2.02	
	CD at 5%	3.79	2.87	3.03	2.08	5.2	2.91	2.62	3.32	5.2	5.4	6.3	
	CV (%)	7.40	5.98	6.79	5.87	10.69	6.71	5.33	6.26	9.17	10.26	10.71	

*Figures in parenthesis are angular transformed value

Table 4: Effect of different management practices of fall armyworm on coccinellid population on maize

Tr. No.	Treatment	Number of grubs and adults / plant						
		14 DAG	28 DAG	42 DAG	56 DAG	70 DAG	84 DAG	Average
T_1	IPM excluding seed treatment	0.37 (1.16)	0.40 1.18)	0.27 (1.12)	0.30 (1.13)	0.40 (1.18)	0.40 (1.18)	0.35
T_2	IPM including seed treatment	0.20 (1.09)	0.23 (1.10)	0.17 (1.08)	0.20 (1.11)	0.33 (1.15)	0.37 (1.16)	0.25
T_3	Biointensive control	0.33 (1.15)	0.37 (1.16)	0.33 (1.15)	0.33 (1.17)	0.40 (1.16)	0.43 (1.19)	0.36
T_4	Chemical control	0.30 (1.14)	0.10 (1.04)	0.07 (1.03)	0.00 (1.00)	0.10 (1.04)	0.10 (1.04)	0.11
T_5	Untreated control	0.37 (1.16)	0.43 (1.19)	0.40 (1.18)	0.37 (1.16)	0.50 (1.22)	0.53 (1.23)	0.43
	SE +	0.03	0.02	0.02	0.02	0.05	0.03	
	CD at 5%	0.05	0.09	0.08	0.09	NS	0.11	
	CV (%)	6.68	5.10	5.00	5.14	9.15	6.33	

*Figures in parenthesis are square root transformed value

Table 5: Effect of different management practices of fall armyworm on predatory bugs population on maize

Tr. No.	Treatment	Number of nymphs and adults / plant						
		14 DAG	28 DAG	42 DAG	56 DAG	70 DAG	84 DAG	Average
T_1	IPM excluding seed treatment	0.00	0.23 (1.10)	0.13 (1.09)	0.10 (1.04)	0.23 (1.10)	0.40 (1.18)	0.18
T_2	IPM including seed treatment	0.00	0.07 (1.03)	0.10 (1.04)	0.07 (1.03)	0.20 (1.09)	0.37 (1.16)	0.13
T_3	Biointensive control	0.00	0.23 (1.10)	0.30 (1.14)	0.27 (1.12)	0.30 (1.13)	0.47 (1.20)	0.26
T_4	Chemical control	0.00	0.00 (1.00)	0.07 (1.03)	0.00 (1.00)	0.10 (1.04)	0.10 (1.04)	0.04
T_5	Untreated control	0.00	0.33 (1.15)	0.47 (1.20)	0.37 (1.16)	0.40 (1.20)	0.67 (1.26)	0.37
	SE +		0.032	0.038	0.03	0.03	0.04	
	CD at 5%		0.045	0.11	0.10	NS	NS	
	CV (%)		5.91	6.83	6.12	5.86	7.65	

*Figures in parenthesis are square root transformed value

Table 6: Economics of different IPM modules for management of fall armyworm on maize

Tr. No.	Treatments	Grain Yield (q/ha)	Increase in yield over control (q/ha)	Cost of treatment (Rs/ha)		Total cost (Rs/ha)	Value of additional yield over untreated control (Rs/ha)	Net profit (Rs/ha)	ICBR	Rank
				Cost of Insecticides	Labour+Sprayer charges					
T_1	IPM excluding seed treatment	30.50	12.00	1930	2100	4030	21120	17090	1:4.24	I
T_2	IPM including seed treatment	32.50	13.75	2680	2800	5480	24200	18720	1:3.41	III
T_3	Biointensive control	27.75	9.00	1950	1400	3350	15840	12490	1:3.72	II
T_4	Chemical control	29.25	10.50	3050	2100	5150	18920	13770	1:2.67	IV
T_5	Untreated control	18.75	-	-	-	-	-	-	-	-

Rates

i) Emamectin benzoate 5%SG Rs 520/100g.
ii) Spinetoram 11.7% SC Rs 1330/100ml.
iii) Chlorantraniliprole 18.5SC Rs 1950/150ml.
iv) Thiamethoxam 12.6% + Lamda-cyhalothrin 9.5% ZC Rs 580/ 200ml
v) Labour charge Rs 250/day/labour.
vi) Sprayer charge Rs 200/day.
vii) Marketable price maize Rs 1760 /qt.
viii) Trichocard Rs 550/card
ix) Metarhizium riley Rs 150/ kg
x) Azadirachtin 3000 ppm Rs 250/lit.
xi) EPN Rs 500/kg
xii) Beauveria bassiana Rs 150/kg

References

1. Abraham P, Beale T, Cock M, Corniani N, Day R, Godwin J, *et al*. Fall Armyworm Status. Impacts and control options in Africa: Preliminary Evidence Note 2017, 14.
2. Araus JL, Slafer GA, Reynolds MP, Royo C. Plant breeding and drought in C3 cereals: What should we breed for? Ann. Bot 2002;89:925-940.
3. Chaudhary MR, Chaudhary AD, Akbar S. Water and fertilizer conservation by improved irrigation methods. Pak J. Agri. Sci 1997;31:87-90.
4. Deshmukh Sharanabasappa HB, Pavithra CM, Kalleshwaraswamy BK, Shivanna MS, Maruthi David Mota-Sanchez. Field Efficacy of Insecticides for Management of Invasive Fall Armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on Maize in India. Florida Entomologist. 2020;103(2):221-227.
5. Dr. Vittal BG, Dr. Abhijith D. Fasting and non-fasting lipid profile: A comparative study. Int. J Adv. Biochem. Res. 2021;5(1):06-08. DOI: 10.33545/26174693.2021.v5.i1a.56
6. Gomez KA, Gomez AA. Statistical procedures for agricultural research (2 ed.). John wiley and sons, New York 1984.
7. Mallapur CP, Naik AK, Hangri H, Praveen T, Patil RK, Lingappa S. Potentiality of *Nomuraea rileyi* (Farlow) Samson against the fall armyworm, *Spodoptera frugiperda* infesting maize. Journal of Entomology and Zoology Studies 2018;6(6):1062-1067.
8. Srinivasan R, Malini P, Othim STO. Fall Armyworm in Africa: Which ‘Race’ is in the Race, and Why Does it Matter? Current Science 2018;114(1):27-28.
9. Usha Rani, Chelvi Ramesh, Anandhi K. Evaluation of IPM modules for the management of of fall armyworm in maize. International Seminar On Transboundary Pest Management – March, (pp.19). Coimbatore, Tamil Nadu 2020.
10. Ferdu Azerefegne, Demissew Kitaw and Birhane Asayehegne. Major insect pests of maize and their management: A review. Second National Maize Workshop of Ethiopia. November 12-16, Addis Ababa 2001.