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Efficacy of poison baits against fall armyworm, *Spodoptera frugiperda* (J.E. Smith) infesting maize

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Abstract
A field experiment was carried out at three experimental farms (Anand, Sansoli and Godhara) of Anand Agricultural University, Anand during *Kharif*, 2019 to evaluate the efficacy of different poison baits against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) infesting maize. Among the different poison baits evaluated, rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha, maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha, rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha, maize flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha were found more effective in managing the population of FAW which reflected plants and cob damage and ultimately on grain and fodder yield of maize.

Keywords: Maize, FAW, *Spodoptera frugiperda*, emamectin benzoate and thiodicarb, yield

Introduction
Among the all cereals, maize (*Zea mays* L.) is the third most important cereal crop. It is used as staple food, animal feed, fuel and even for construction purposes. In the developed world, maize is mostly used for animal feed (70%) and only a small percentage (5%) is consumed by humans. The developing countries consume about 62% of maize as food and 34% is used as feed. The remaining proportion is used for varied industrial uses and as seed. Maize accounts for over 25% and 31% of the total calories consumed by humans with per capita annual consumption of 58 and 84 kg, respectively. FAOSTATE (2012) [1]. Maize is also the most important staple crop in terms of calorie intake in rural families which is widely grown in Gujarat. It is attacked by nearly 130 species of insect pests in India causing considerable yield losses. Atwal and Dhaliwal (2002) [2].

Among the different pests inimical to maize, a, new invasive pest; fall armyworm (FAW), *Spodoptera frugiperda* J. E. Smith (Lepidoptera: Noctuidae) has been causing significant damage to crops resulting in huge economic losses since its appearance in Africa during 2016. Aruna balla *et al.* (2019) [3]. In India, its first appearance reported in Karnataka during May 2018. Sharanabasappa *et al.* (2018) [4]. In Gujarat, it was also first reported from Anklav village, of Anand district of Gujarat. Sisodiya *et al.* (2018) [5]. The fall armyworm, *S. frugiperda*, is a lepidopteran pest that feeds in large numbers on the leaves, stems and reproductive parts of more than 350 plant species, causing major damage to economically important cultivated grasses such as maize, rice, sorghum, sugarcane and wheat but also other vegetable crops and cotton (Cabi datasheet) [6]. According to Hruska and Gould (1997) [7], infestations during the mid-to-late corn stage resulted in yield losses of 15-73%, when 55-100% of the plants were infested with *S. frugiperda*. This pest remains inside the leaf whorl so it is difficult to control by direct spraying so it is required to adopt alternative method to reduce the incidence of the pest. Poison baits are one of an effective and selective method of insect control. Baits based on insecticide are potentially useful in pest management because of the reduced rate and consequently lower cost of application. Johnson and Henry (1987) [8]. Also, use of bait substantially reduces the overall amount of active ingredient needed and therefore, reduces the amount of insecticides load present in the environment. Metcalf (1985) Barbara and Pinera (2003) [9, 10]. Moreover, the poison bait was highly effective in killing a large number of armyworm moths. Hiremath *et al*. (1990) [11]. After the introduction of less toxic insecticides for use in pest management, necessitates investigations on efficacy of alternate toxicant molecules to be used in the preparation of poison baits. Therefore, keeping these points in view, the multi-location field experiment was carried out to assess the

feasibility of using poison baits prepared out of selected chemicals against this pest.

Materials and methods

The experiment on efficacy of different poison baits on *S. frugiperda* infesting maize was conducted at three different locations *viz.*, Entomology farm, Department of Entomology, BACA, Anand, Main Maize Research Station, Godhara and Agricultural Research Station, Sansoli of AAU, Anand (Gujarat) during *kharif* 2019. The experiment was carried out in Randomized Block Design with eleven treatments and three replications. Maize variety GAYMH-1 was sown, with a spacing of 60 cm between two rows and 20 cm within the row in gross and net area of 6.0 x 4.8 m and 5.6 x 3.6 m, respectively. All the standard agronomical practices except pest control measures were followed. The first application of poison bait was imposed at sufficient pest pressure and second at 15 days interval. For recording FAW population and its damage, 10 plants were selected randomly from each net plot. The number of larva(e) and damaged plant(s) were counted from randomly selected plants before as well as 5, 10 and 15 days after each application. Numbers of damaged cobs were also recorded at harvest from each net plot. The grain and fodder yield were recorded from each net plot and converted into kg/ha. The data obtained thus, were subjected to statistical analysis after appropriate transformation to draw valid conclusion as per Steel and Torrie (1980) [12].

Results and discussion

Larval population (No. of larvae/10 plants)

The data on larval population pooled over three locations before application of poison bait showed non-significant differences which indicated homogeneous distribution of pest in the experimental plots at three locations *i.e.,* Anand, Sansoli and Godhra (Table 1). All the poison baits treatments were found significantly superior to control till 15 days of first application as well as pooled over three locations (Table 3). The lowest larval population was recorded in plots treated with poison baits containing rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (1.09 larvae/10 plants) which was at par with maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (1.43 larvae/10 plants) and rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (1.60 larvae/10 plants) after first application.

The data on pooled over periods of second application indicated that application of poison bait having rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (0.58 larva /10 plants) recorded the lowest larval population and it was at par with maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (0.87 larva/10 plants) and rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (0.99 larva/10 plants). Of the tested poison baits, application of jowar flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha was least effective by recording the highest (3.30 larvae /10 plants) larval population.

Overall, the data on pooled over periods, applications and locations (Table 1 and 3) showed significantly lowest larval population in application of poison bait having rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (0.82 larva/10 plants) than all the poison bait treatments except maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (1.14 larvae/10 plants) and rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (1.30 larvae/10 plants). The application of poison bait having maize flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (2.00 larvae/10 plants) stood next in position.

Plant damage (%)

The data on plant damage pooled over three locations recorded before applications of poison bait showed non-significant differences which indicated homogeneous incidence of pest in the experimental plots at three locations *i.e.,* Anand, Sansoli and Godhra (Table 2). All the treatments treated with poison baits were found significantly superior to control till 15 days in both the applications, pooled over periods as well as pooled over periods and applications. The lowest plant damage was recorded in plots treated with poison baits containing rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (10.87 %), which was at par with rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (14.79 %) and maize flour 25 kg + jaggery 5 kg+ thiodicarb 75 WP 250 g (15.49 %) after first application.

The data on pooled over periods of second application indicated that whorl application of poison bait having rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (6.06 %) recorded the lowest plant damage and it was at par with application of maize flour 25 kg + jaggery 5 kg+ thiodicarb 75 WP 250 g/ha (10.69 %) followed by rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (11.62 %). The highest (30.61 %) plant damage recorded in the treatment of poison bait containing jowar flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha and proved least effective treatment.

Overall, the data on pooled over periods, applications and locations (Table 2 and 3), exhibited the lowest plant damage in the treatment of rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (8.31 %), which at par with maize flour 25 kg + jaggery 5 kg+ thiodicarb 75 WP 250 g/ha (12.99 %) and rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (13.17 %). The treatment of poison bait having maize flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha stood next by recording 20.16 per cent plant damage.

Cob damage

The data on cob damage pooled over locations showed significant differences among the various poison baits treated treatments plots (Table 4). Whorl application of poison bait having rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (7.95 %) recorded the lowest cob damage and it was at par with maize flour 25 kg + jaggery 5 kg+ thiodicarb 75 WP 250 g (10.96 %) and rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (12.99 %). The treatment of poison bait having wheat flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (21.51 %), wheat flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125g/ha (23.90 %), bajra flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (25.39 %), bajra flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (27.42%) and jowar flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (29.60 %) found mediocre in recording the cob damage (%).

Yield (Kg/ha)

The data on grain yield (Kg/ha) of pooled over locations, (Table 5) revealed that the highest grain yield recorded in the treatment of rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (2635 kg/ha) followed by maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (2525 kg/ha) and rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG

125 g/ha (2514 kg/ha). Jowar flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ ha (2018 kg/ha) registered the lowest yield of maize followed by bajra flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (2035 kg/ha).

The highest fodder yield recorded in rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (3510 kg/ha) followed by maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (3411 kg/ha) and rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (3424 kg/ha).

Ompraksh *et al.* (2019) [13] found that seed treatment with imidacloprid 600FS, 20DAG-Chlorantraniliprole18.5 SC (0.3 ml/litre), 30 DAG – spinetorum (0.5 ml/litre), 40DAG-Poison bait with thiodicarb (100g/acre) was recorded lowest per cent plant damage and severity after the imposition of treatments in maize for the control of FAW. Shahanaz (2018) [14] concluded that Emamectin benzoate 5% SG, thiodicarb 75% WP and chlorpyriphos 20% EC found superior poison baits which showed 100 per cent mortality at 25 % concentration of recommended dose within 12 h against *S. litura* infesting tobacco. The rice bran baits prepared with emamectin benzoate 5 SG was evaluated and found effective for management of *S. litura* with comparison of chlorpyriphos 20 EC bait and untreated check in tobacco. Sreedhar, *et al.* (2016) [15]. Shankaragouda *et al*. (2015) [16] used poison bait with chlorfenpyr 10 EC against *S. litura* in groundnut and found that poison bait was significantly superior over all other treatments at 72 hours after exposure of larvae. The poison bait containing monocrotophos was found superior giving 98 per cent mortality compared to spraying and dusting of some other chemicals. Hiremath *et al*. (1992) [17]. Efficacy of chlorpyriphos bait against larvae of armyworm is in accordance with earlier report by Mallapur (1993) [18] who obtained >60% mortality of larvae in sorghum environment. Severe outbreak of the armyworm (up to 35 larvae/plant) during 1988 in the transitional tract of North-western Karnataka was contained by use of monocrotophos poison bait. Also, the poison bait was highly effective in killing a large number of armyworm moths. Hiremath *et al*. (1990) [11]. Muddasar *et al.* (2017) [19] mentioned that jaggery bait mixed with spinosad (rice bran + jaggery 20% + yeast 0.1% + spinosad @ 2.5 ml/kg) proved best next to spinosad spray in reducing the larval population and leaf damage caused by *S. litura* in spinach and thereby increased leaf yield over other baits and untreated control.

Table 1: Effect of poison baits on larval population of fall armyworm, *S. frugiperda* infesting maize (Pooled over periods, applications and locations)

T. No.	Treatments	No. of larva(e)/10 plants days after application									Pooled over applications
		Before application	First				Second				
			5	10	15	Pooled	5	10	15	Pooled	
1	Rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	2.14 (4.08)	1.41^{a} (1.49)	1.09^{a} (0.69)	1.28^{a} (1.14)	1.26^{a} (1.09)	1.07^{a} (0.64)	0.93^{a} (0.36)	1.13^{a} (0.78)	1.04^{a} (0.58)	1.15^{a} (0.82)
2	Wheat flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	2.13 (4.04)	1.84^{bc} (2.89)	1.66^{c} (2.26)	1.73^{cde} (2.49)	1.74^{c} (2.53)	1.63^{cd} (2.16)	1.46^{b} (1.63)	1.71^{cd} (2.42)	1.60^{cd} (2.06)	1.67^{cd} (2.29)
3	Bajra flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	1.98 (3.42)	1.81^{bc} (2.78)	1.69^{c} (2.36)	1.95^{def} (3.30)	1.82^{c} (2.81)	1.80^{def} (2.74)	1.74^{cd} (2.53)	1.83^{cd} (2.85)	1.79^{de} (2.70)	1.80^{cde} (2.74)
4	Jowar flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	2.07 (3.78)	1.98^{c} (3.42)	1.83^{c} (2.85)	2.11^{f} (3.95)	1.97^{c} (3.38)	2.00^{b} (3.50)	1.85^{d} (2.92)	1.96^{d} (3.34)	1.94^{e} (3.26)	1.95^{e} (3.30)
5	Maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	2.29 (4.74)	1.50^{b} (1.75)	1.24^{a} (1.04)	1.42^{ab} (1.52)	1.39^{a} (1.43)	1.20^{ab} (0.94)	1.09^{a} (0.69)	1.22^{ab} (0.99)	1.17^{a} (0.87)	1.28^{a} (1.14)
6	Rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	2.38 (5.16)	1.55^{b} (1.90)	1.31^{ab} (1.22)	1.49^{abc} (1.72)	1.45^{ab} (1.60)	1.30^{b} (1.19)	1.09^{a} (0.69)	1.27^{ab} (1.11)	1.22^{ab} (0.99)	1.34^{ab} (1.30)
7	Wheat flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125g/ha (6.25 g a.i./ha)	2.14 (4.08)	1.93^{c} (3.22)	1.71^{c} (2.42)	1.85^{def} (2.92)	1.83^{c} (2.85)	1.73^{cde} (2.49)	1.56^{bc} (1.93)	1.74^{cd} (2.53)	1.67^{cd} (2.29)	1.75^{cde} (2.56)
8	Bajra flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	2.35 (5.02)	1.93^{c} (3.22)	1.82^{c} (2.81)	2.00^{ef} (3.50)	1.91^{c} (3.15)	1.89^{ef} (3.07)	1.79^{d} (2.70)	1.94^{d} (3.26)	1.87^{de} (3.00)	1.89^{de} (3.07)
9	Jowar flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	2.13 (4.04)	1.96^{c} (3.34)	1.71^{c} (2.42)	2.08^{f} (3.83)	1.92^{c} (3.19)	2.00^{f} (3.50)	1.82^{cd} (2.81)	2.02^{d} (3.58)	1.95^{e} (3.30)	1.93^{de} (3.22)
10	Maize flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	2.25 (4.56)	1.78^{bc} (2.67)	1.61^{bc} (2.09)	1.69^{bcd} (2.36)	1.69^{bc} (2.36)	1.52^{c} (1.81)	1.35^{b} (1.32)	1.51^{bc} (1.78)	1.46^{bc} (1.63)	1.58^{bc} (2.00)
11	Control	2.24 (4.52)	2.50^{d} (5.75)	2.69^{d} (6.74)	2.87^{g} (7.74)	2.69^{d} (6.74)	2.92^{g} (8.03)	2.99^{e} (8.44)	2.96^{e} (8.26)	2.96^{e} (8.26)	2.83^{f} (7.51)
S. Em.±	Treatment (T)	0.09	0.11	0.10	0.09	0.09	0.07	0.08	0.10	0.09	0.09
Location (L)		0.05	0.03	0.03	0.03	0.02	0.03	0.04	0.03	0.02	0.01
T x L		0.16	0.11	0.12	0.10	0.07	0.12	0.13	0.12	0.07	0.05
CD at 5% T		NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. %		13.03	11.18	13.20	10.16	11.83	11.93	14.91	12.17	13.03	12.41

Notes:
1. Figures in parenthesis are retransformed values; those outside are $\sqrt{x+0.5}$ transformed values
2. Treatment means with the letter(s) in common are not significant by DNMRT at 5% level of significance
3. Significant parameters and its interactions : T, L, P, A, T x A, T x L and P x A x L

Table 2: Effect of poison baits on plant damage caused by fall armyworm, *S. frugiperda* in maize (Pooled over periods, applications and locations)

T. No.	Treatments	Plant damage (%) days after application									Pooled over applications
		Before application	First				Second				
			5	10	15	Pooled	5	10	15	Pooled	
1	Rice bran 25 kg + jaggery 5 kg +	32.32	21.63^{a}	14.09^{a}	22.03^{a}	19.25^{a}	17.28^{a}	11.14^{a}	14.33^{a}	14.25^{a}	16.75^{a}

	thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	(28.58)	(13.59)	(5.93)	(14.07)	(10.87)	(8.82)	(3.73)	(6.13)	(6.06)	(8.31)
2	Wheat flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	32.75 (29.27)	29.84^{cd} (24.76)	24.01^{bc} (16.56)	33.72^{d} (30.82)	29.19^{cd} (23.79)	30.91^{c} (26.39)	25.99^{bc} (19.20)	27.70^{cde} (21.61)	28.20^{cd} (22.33)	28.69^{bc} (23.05)
3	Bajra flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	30.67 (26.02)	28.60^{bcd} (22.91)	26.22^{c} (19.52)	35.77^{d} (34.17)	30.20^{d} (25.30)	33.05^{c} (29.74)	28.76^{bc} (23.15)	31.65^{de} (27.53)	31.15^{e} (26.76)	30.68^{bc} (26.03)
4	Jowar flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	34.70 (32.41)	31.85^{d} (27.85)	26.79^{c} (20.32)	36.44^{d} (35.28)	31.69^{d} (27.60)	34.31^{c} (31.77)	32.25^{c} (28.47)	33.53^{e} (30.51)	33.38^{e} (30.27)	32.54^{c} (28.93)
5	Maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	33.56 (30.56)	25.15^{abc} (18.06)	18.92^{ab} (10.51)	25.48^{ab} (18.51)	23.18^{abc} (15.49)	22.03^{a} (14.07)	16.13^{a} (7.72)	19.08^{ab} (10.69)	19.08^{ab} (10.69)	21.13^{a} (12.99)
6	Rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	31.55 (27.38)	23.94^{ab} (16.47)	17.78^{ab} (9.32)	26.15^{abc} (19.42)	22.62^{ab} (14.79)	22.77^{ab} (14.98)	16.13^{a} (7.72)	20.89^{abc} (12.71)	19.93^{bc} (11.62)	21.28^{a} (13.17)
7	Wheat flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125g/ha (6.25 g a.i./ha)	32.08 (28.21)	29.10^{cd} (23.65)	26.06^{c} (19.30)	32.96^{cd} (29.60)	29.37^{cd} (24.05)	31.58^{c} (27.42)	26.72^{bc} (20.22)	29.03^{de} (23.55)	29.11^{de} (23.67)	29.24^{bc} (23.86)
8	Bajra flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	31.98 (28.05)	30.67^{d} (26.02)	27.86^{c} (21.84)	35.80^{d} (34.22)	31.44^{d} (27.21)	34.46^{c} (32.02)	31.58^{c} (27.42)	33.63^{de} (30.67)	33.22^{e} (30.01)	32.23^{bc} (28.44)
9	Jowar flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	33.39 (30.29)	33.36^{d} (30.24)	28.37^{c} (22.58)	36.44^{d} (35.28)	32.72^{d} (29.22)	34.43^{c} (31.97)	32.98^{c} (29.63)	33.36^{de} (30.24)	33.59^{e} (30.61)	33.16^{c} (29.92)
10	Maize flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	33.16 (29.92)	28.94^{cd} (23.42)	23.94^{bc} (16.47)	31.41^{bcd} (27.16)	28.10^{bcd} (22.19)	28.37^{bc} (22.58)	23.27^{b} (15.61)	24.18^{bcd} (16.78)	25.27^{cd} (18.22)	26.68^{b} (20.16)
11	Control	34.67 (32.36)	43.00^{e} (46.51)	49.64^{d} (58.06)	55.16^{e} (67.36)	49.27^{e} (57.42)	59.05^{d} (73.55)	59.78^{d} (74.67)	66.11^{f} (83.60)	61.65^{f} (77.45)	55.46^{d} (67.85)
S. Em.±	Treatment (T)	1.65	1.53	2.02	2.17	2.02	1.96	2.11	2.22	1.80	1.76
Location (L)		0.81	0.76	0.97	0.72	0.49	0.74	1.12	0.84	0.53	0.36
T x L		2.69	2.52	3.23	2.38	1.64	2.47	3.73	2.79	1.78	1.22
CD at 5% T		NS	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. %		14.23	14.72	21.68	12.25	16.74	13.54	23.32	15.93	17.86	17.36
Notes:	1. Figures in parenthesis are retransformed values, those outside are arc sine transformed values 2. Treatment mean(s) with the letter(s) in common are not significant by DNMRT at 5% level of significance 3. Significant parameters and its interactions: T, L, P, T x P, T x A, T x L, A x L, P x L and P x A x L										

Table 3: Effect of poison baits on larval population and plant damage of fall armyworm, *S. frugiperda* infesting maize (Pooled over locations)

T. No.	Treatment	No. of larva(e)/10 plants				Plant damage (%)			
		Anand	Sansoli	Godhara	Pooled over locations	Anand	Sansoli	Godhara	Pooled over locations
1	Rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	1.1^{a} (0.71)	1.09^{a} (0.69)	1.27^{a} (1.11)	1.15^{a} (0.82)	18.18^{a} (9.73)	10.69^{b} (3.44)	21.38^{a} (13.29)	16.75^{a} (8.31)
2	Wheat flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	1.90^{cd} (3.11)	1.39^{cd} (1.43)	1.73^{de} (2.49)	1.67^{cd} (2.29)	33.09^{cd} (29.81)	21.84^{de} (13.84)	31.16^{de} (26.77)	28.69^{bc} (23.05)
3	Bajra flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	1.98^{cde} (3.42)	1.73^{e} (2.49)	1.71^{de} (2.42)	1.80^{cd} (2.74)	34.11^{cde} (31.45)	29.15^{f} (23.73)	28.76^{cde} (23.15)	30.68^{bc} (26.03)
4	Jowar flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	2.26^{g} (4.61)	1.67^{e} (2.29)	1.93^{f} (3.22)	1.95^{d} (3.30)	39.49^{f} (40.44)	26.11^{ef} (19.37)	32.02^{e} (28.11)	32.54^{c} (28.93)
5	Maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	1.18^{ab} (0.89)	1.25^{bc} (1.06)	1.41^{ab} (1.49)	1.28^{a} (1.14)	21.83^{b} (13.83)	16.71^{c} (8.27)	24.87^{b} (17.69)	21.13^{a} (12.99)
6	Rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	1.31^{b} (1.22)	1.17^{ab} (0.87)	1.54^{bc} (1.87)	1.34^{ab} (1.30)	23.84^{b} (16.34)	12.74^{a} (4.86)	27.26^{bc} (20.98)	21.28^{a} (13.17)
7	Wheat flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125g/ha (6.25 g a.i./ha)	2.06^{def} (3.74)	1.41^{d} (1.49)	1.79^{ef} (2.70)	1.75^{cde} (2.56)	35.82^{def} (34.25)	23.60^{e} (16.03)	28.31^{cd} (22.49)	29.24^{bc} (23.86)
8	Bajra flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	2.12^{efg} (3.99)	1.80^{e} (2.74)	1.76^{def} (2.60)	1.89^{d} (3.07)	37.16^{ef} (36.49)	30.34^{f} (25.52)	29.50^{cde} (24.25)	32.23^{bc} (28.44)
9	Jowar flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	2.18^{fg} (4.25)	1.70^{e} (2.39)	1.92^{f} (3.19)	1.93^{d} (3.22)	38.77^{f} (39.21)	28.86^{f} (23.30)	31.85^{e} (27.85)	33.16^{c} (29.92)
10	Maize flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	1.84^{c} (2.89)	1.31^{bcd} (1.22)	1.59^{cd} (2.03)	1.58^{bc} (2.00)	31.98^{c} (28.05)	17.73^{cd} (9.27)	30.34^{cde} (25.52)	26.68^{b} (20.16)
11	Control	3.19^{h}	2.61^{f}	2.73^{g}	2.83^{f}	60.13^{g}	51.03^{g}	55.21^{f}	55.46^{d}

		(9.68)	(6.31)	(6.95)	(7.51)	(75.20)	(60.45)	(67.44)	(67.85)
S. Em.±	Treatment (T)	0.05	0.05	0.05	0.09	1.14	1.42	1.06	1.76
Location (L)		-	-	-	0.01	-	-	-	0.36
T x L		-	-	-	0.05	-	-	-	1.22
CD at 5% T		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. %		11.60	12.72	12.95	12.41	14.28	24.70	14.56	17.36
Notes:	1. Figures in parenthesis are retransformed values; those outside are √ X+0.5 transformed values 2. Treatment mean(s) with the letter(s) in common are not significant by DNMRT at 5% level of significance 3. Significant parameters and its interactions: T, L, P, A, T x A, T x L and P x A x L 3. Significant parameters and its interactions: T, L, P, T x P, T x A, T x L, A x L, P x L and P x A x L								

Table 4: Effect of poison baits on cob damage caused by fall armyworm, *S. frugiperda* in maize (Pooled over locations)

T. No.	Treatments	Cob damage (%)			
		Anand	Sansoli	Godhra	Pooled
1	Rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha(187.5 g a.i./ha)	12.28^{a} (4.52)	18.43^{a} (9.99)	18.42^{a} (9.98)	16.38^{a} (7.95)
2	Wheat flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha(187.5 g a.i./ha)	32.98^{b} (29.63)	21.14^{ab} (13.01)	28.76^{abc} (23.15)	27.63^{cde} (21.51)
3	Bajra flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha(187.5 g a.i./ha)	33.19^{bc} (29.97)	28.77^{c} (23.16)	28.76^{abc} (23.15)	30.24^{de} (25.36)
4	Jowar flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha(187.5 g a.i./ha)	43.06^{c} (46.62)	23.84^{abc} (16.34)	33.19^{d} (29.97)	33.36^{e} (30.24)
5	Maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha(187.5 g a.i./ha)	18.42^{a} (9.98)	18.43^{a} (9.99)	21.13^{ab} (12.99)	19.33^{ab} (10.96)
6	Rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha(6.25 g a.i./ha)	21.13^{a} (12.99)	18.43^{a} (9.99)	23.84^{abc} (16.34)	21.13^{abc} (12.99)
7	Wheat flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125g/ha(6.25 g a.i./ha)	35.20^{bc} (33.23)	23.84^{abc} (16.34)	28.76^{bcd} (23.15)	29.27^{de} (23.90)
8	Bajra flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha(6.25 g a.i./ha)	37.21^{bc} (36.57)	26.55^{bc} (19.98)	30.98^{cd} (26.50)	31.58^{de} (27.42)
9	Jowar flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha(6.25 g a.i./ha)	39.13^{bc} (39.83)	28.77^{c} (23.16)	30.98^{cd} (26.50)	32.96^{de} (29.60)
10	Maize flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha(6.25 g a.i./ha)	30.98^{b} (26.50)	21.14^{ab} (13.01)	23.84^{abc} (16.34)	25.32^{bcd} (18.29)
11	Control	61.19^{d} (76.78)	44.98^{d} (49.97)	46.90^{e} (53.31)	51.02^{f} (60.43)
S. Em.±	Treatment (T)	2.94	3.23	2.43	2.35
Location (L)		-	-	-	0.73
T x L		-	-	-	2.42
CD at 5% T		Sig.	Sig.	Sig.	Sig.
C. V. %		15.34	25.00	14.64	14.50
Notes:	1. Figures in parenthesis are retransformed values; those outside are arc sine transformed values 2. Treatment mean(s) with the letter(s) in common are not significant by DNMRT at 5% level of significance 3. Significant parameters and its interactions: T, L, T x L				

Table 5: Effect of poison baits on yield of maize (Pooled over locations)

T. No.	Treatments	Grain yield (kg/ha)				Fodder yield (kg/ha)			
		Anand	Sansoli	Godhra	Pooled	Anand	Sansoli	Godhra	Pooled
1	Rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	2547^{a}	3007^{a}	2353^{a}	2635^{a}	3508^{a}	4211^{a}	2810^{a}	3510^{a}
2	Wheat flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	2095^{cd}	2687^{abcd}	1988^{bcd}	2257^{cd}	2908^{b}	3766^{abc}	2505^{ab}	3060^{cd}
3	Bajra flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	1977^{cd}	2294^{e}	1901^{cd}	2058de	2856^{b}	3200^{d}	2430^{ab}	2829^{cd}
4	Jowar flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	1783^{d}	2443^{cde}	1903^{cd}	2043de	2640^{b}	3416^{cd}	2333^{ab}	2796^{cd}
5	Maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha (187.5 g a.i./ha)	2488^{a}	2867^{ab}	2220^{ab}	2525^{ab}	3414^{a}	4022^{ab}	2798^{a}	3411^{ab}
6	Rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	2441^{ab}	2980^{a}	2121^{abc}	2514^{ab}	3394^{a}	4169^{a}	2710^{a}	3424^{ab}
7	Wheat flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125g/ha (6.25 g a.i./ha)	1901^{cd}	2590b^{cde}	1965^{cd}	2152^{cde}	2757^{b}	3628^{bcd}	2418^{ab}	2934^{cd}
8	Bajra flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	1889c^{d}	2268^{e}	1948^{cd}	2035de	2709^{b}	3181^{d}	2396^{ab}	2762^{d}
9	Jowar flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha (6.25 g a.i./ha)	1805^{cd}	2413de	1836de	2018^{e}	2692^{b}	3358^{cd}	2426^{ab}	2825^{cd}
10	Maize flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha	2125^{bc}	2797^{abc}	2041^{bcd}	2321^{bc}	2943^{b}	3919^{ab}	2516^{ab}	3126^{bc}

	(6.25 g a.i./ha)								
11	Control	1404^{e}	1749^{f}	1636^{e}	1597^{f}	2006^{c}	2436^{e}	2073^{b}	2172^{e}
S. Em.±	Treatment (T)	99.71	106.44	71.62	72.20	131.06	145.76	58.21	105.73
Location (L)		-	-	-	28.28	-	-	-	35.59
T x L		-	-	-	93.81	-	-	-	118.05
CD at 5%	T	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
C. V. %		8.46	7.22	6.23	7.39	7.84	7.07	5.04	6.84
Notes:	1. Treatment mean(s) with the letter(s) in common are not significant by DNMRT at 5% level of significance 2. Significant parameters and interactions for Grain and Fodder : T, L, T x L								

Conclusion

In nutshell, it can be concluded that rice bran 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha, maize flour 25 kg + jaggery 5 kg + thiodicarb 75 WP 250 g/ha, rice bran 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha, maize flour 25 kg + jaggery 5 kg + emamectin benzoate 5 SG 125 g/ha were found more effective in managing the population of FAW, registering higher grain and fodder yield of maize. Poison baits are often environment friendly, inexpensive methods of insect control with little or no insecticidal drift, Henceforth, it can be the best suited as one of the components of Integrated Pest Management (IPM) for sustainable pest management.

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