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Survey of maize fall armyworm *Spodoptera frugiperda* in Kondagaon district of Chhattisgarh

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Abstract
A field survey was conducted on fall armyworm (FAW) at Kondagaon district to know farmer's knowledge and management practices of fall armyworm. The survey was undertaken of this invasive pest in five blocks of one district. The studied revealed that the major pest of the maize crop was fall armyworm during *kharif* as well as *rabi* season. Overall incidence in *kharif* season of fall armyworm was 73.7% as reported by respondents and in *rabi* overall incidence of fall armyworm was 71%. Majority of the responded (66%) agreed that the incidence of fall armyworm was maximum during seedling stage during *kharif* season and in *rabi* season, 77.2% of the respondents agreed that the incidence of fall armyworm was maximum at knee height stage. Damage caused by fall armyworm in both the season was 83.3%. The majority of respondents said that they learned about pest management through pesticide input shop for the control of fall armyworm and majority of them used chemical insecticides *i.e* emamectin benzoate.

Introduction
The Poaceae family includes maize *Zea mays* L. is one of the most adaptable crop, allowing it to thrive in a wide range of Agro-climatic environments. The ability of maize to grow in many seasons, as well as the high productivity of *rabi* and spring maize, make it an excellent crop for use in cropping systems to satisfy rising food demand. At present, nearly 1147.7 million MT of maize is being produced together by over 170 countries from an area of 193.7 million ha with average productivity of 5.75 t/ha (FAOSTAT, 2020).

Maize is the second most important crop after rice in terms of acreage and output in Chhattisgarh, and mainly it is cultivated it is during the *kharif* season. Despite the fact that the state's output is low when compared to states like as Tamil Nadu, Andhra Pradesh, Karnataka, West Bengal, Punjab, Odisha, Bihar, and others. The most important producers of Chhattisgarh state are the districts Bastar, Bijapur, Dantewada, Sukma, Gariyabhand, Kondagaon Kanker, Korea, Korba, Surajpur, Balrampur, and Sarguja. Balrampur is the district with the most maize farming land.

Fall armyworm (FAW) is native to America and first reported in West Africa in late 2016 as invasive pest (Goergen *et al*., 2016) [3]. In India, it was first reported on maize from Shivamogga district (Karnataka) during May-June, 2018 (Sharanabasappa *et al*., 2018) [6]. The major symptoms caused by fall armyworm are skeletonized leaves, short holes and heavily windowed whorls with frass, and boring into the cob. The infestation caused by FAW is sometimes resemble as an army, as they move across large agriculture fields and earned their common name by eat all plant matter and they encounter in their wide dispersals, like a large army (Smith, 1797) [7]. Survey of fall armyworm were undertaken in different maize growing areas.

Materials and Methods
The data was gathered in-person with the respondents using an interview schedule in their local language. For a simple and rapid approach with respondents, the respondents were reached at their farms or residences, depending on their convenience. A questionnaire was used for farmers knowledge and perception of maize fall armyworm and their indigenous control method in Kondagaon district. The work of data collection from 250 respondents was completed within a period of 2 months *i.e.,* in the month of February and March, 2022.

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Sample and sampling procedure
Selection of blocks
5 blocks of Kondagaon district, namely Kondagaon, Pharasgaon, Makdi, Keshkal, Baderajpur was selected during the survey of maize fall armyworm in Kondagaon district.

Selection of villages
Out of the total villages 5 villages were selected from each block *i.e.,* Chichadi, Korgaon, Barkai, Sambhalpur and Kopra. From each village 50 maize growers were selected for the study.

Selection of respondents
Fifty maize growers were selected randomly from each block. Thus, total 250 maize growers (25*10 = 250) were considered as respondents for this study.

Statistical analysis
Data collected were qualitative as well as quantitative. The quantitative data were interpreted in terms of percentage and qualitative data were tabulated on the basis of approved categorization method as described earlier, the following statistical techniques were used in the study.
1. Frequency (No. of respondents)

2. Percentage P$=\frac{X}{N} \times 100$

Where
P = Percentage

X = Frequency of respondents
N = Total numbers of respondents

Insect- pests incidence	Category	Score
High	3	1
Medium	2	2
Low	1	3
Null	0	0

4 Continuous Likert scale

$$\text{Over all incidence} = \frac{(f \times 3) + (f \times 2) + (f \times 1) + (f \times 0)}{N \times 3}$$

Where,
f = Frequency
N = Total numbers of respondents
3 = Maximum obtainable score

Operationalization of different variables and their measurement

Table 1: Major insect-pests of maize crop as reported by the respondents

Insect- pests	Score
High	1
Medium	2
Low	3
Null	0

Table 2: Damage caused by fall armyworm during *kharif* season on maize crop stages as reported by the respondents

Crop stages	Score
During kharif	1
Seedling stage	2
Knee height stage	3
Vegetative stage	4
Cob formation stage	
During rabi	
Seedling stage	2
Knee height stage	1
Vegetative stage	3
Cob formation stage	4

Table 3: Damage Caused by fall armyworm on maize crop as reported by the respondents

During *kharif*	Score
10-33%	2
33-50%	1
Above 50%	3
During rabi	
10-33%	3
33-50%	1
Above 50%	2

Table 4: Occurrence of natural enemies on maize crop as reported by the respondents

During *kharif*	Score
Ladybird beetle	1
Rove beetle	2
Hover fly	3
During rabi	
Ladybird beetle	1
Rove beetle	2
Hover fly	3

Table 5: Distribution of respondents according to adoption of pest control measures in maize crop

Pest management strategy	Score
Physical Method	2
Cultural Method	4
Biological Method	0
Chemical Method	1
ITK method	3

Table 6: Distribution of respondents according to their source of information about insect-pests control in maize crop

Source of information	Score
Progressive farmers	4
KVK (SMS)	3
RAEO	2
Input Shop	1
Social Media	5
Literature / Print Media	0

Results and Discussion

Major insect-pests of maize crop during *kharif* and *rabi* season as reported by the respondents

All the 250 respondents under studied area considered maize fall armyworm (*Spodoptera furgiperda*) as the most common insect pest in *kharif* season (Table 1). It was found that incidence was recorded as 33.6% high, 54.8% medium, 10.8% low and 0.8% null incidence by fall armyworm during *kharif* season. Pink stem borer (*Sesamia inference*) incidence was recorded as 0% high, 13.2% medium, 50% low and 36.8% null incidence during the *kharif* season. Aphid (*Rhopalosiphum maidis*) incidence was recorded as 5.6% high, 5.2% medium, 41.2% low and 60% null incidence during *kharif* season. Tobacco caterpillar (*Spodoptera litura*) incidence was recorded as 4% high, 30% medium. 42% low and 24% null during *kharif* season. Stem borer (*Chilo partellus*) incidence was recorded found 4% high, 5.2% medium, 33.6% low and 57% null notable pests in the study area during *kharif* season, respectively.

All the 250 respondents under studied area considered maize fall armyworm (*Spodoptera furgiperda*) as the most common insect pest during *rabi* season also (Table 4.2). It was found that 26.4% high, 61.6% medium, 12% low and 0% null incidence by fall armyworm during *rabi* season. Pink stem borer (*Sesamia inference*) incidence was recorded as 0% high, 20.4% medium, 62.8% low and 16.8% null incidence during *Rabi* season. Aphid (*Rhopalosiphum maidis*) incidence was recorded as 0% high, 0.8% medium, 41.6% low and 57.6% null incidence during *rabi* season. Tobacco caterpillar (*Spodoptera litura*) incidence was recorded as 0% high, 14% medium. 53.6% low and 32.4% null by the tobacco caterpillar during *rabi* season. Stem borer (*Chilo partellus*) incidence was recorded as it was found 0% high, 1.2% medium, 31.2% low and 67.6% null noticeable pests in the study area during *rabi* season respectively.

The overall incidence of fall army worm, pink stem borer, aphid, tobacco caterpillar and stem borer was 73.7%, 25.4%, 22.8%, 38% and 18%, respectively during *kharif* season whereas during the *rabi* season the overall incidence of fall army worm, pink stem borer, aphid, tobacco caterpillar and stem borer was 71%, 34.5%, 14.4%, 27.2% and 11%, respectively.

Table 7: Major insect-pests of maize crop as reported by the respondents (Total no. of respondents (n) = 250)

S. No.	Incidence in *kharif* season	Respondents									
		Fall armyworm		Pink stem borer		Aphid		Tobacco caterpillar		Stem borer	
		f	%	f	%	f	%	f	%	f	%
1	High	84	33.6	0	0	14	5.6	10	4	10	4
2	Medium	137	54.8	33	13.2	13	5.2	75	30	13	5.2
3	Low	27	10.8	125	50	103	41.2	105	42	84	33.6
4	Null	2	0.8	92	36.8	120	48	60	24	143	57.2
	Overall incidence	73.7%		25.4%		22.8%		28%		18%	
	Incidence in *rabi* season										
1	High	66	26.4	0	0	0	0	0	0	0	0
2	Medium	154	61.6	51	20.4	2	0.8	35	14	3	1.2
3	Low	30	12	157	62.8	104	41.6	134	53.6	78	31.2
4	Null	0	0	42	16.8	144	57.6	81	32.4	169	67.6
	Overall incidence	71%		34.5%		14.4%		27.2%		11%	

Incidence of fall armyworm at different crop stage on maize crop as reported by the respondents

In the study area incidence of fall armyworm on different crop stages is presented in Table 2.

The incidence of fall army worm appeared during seedling stage according to 66% respondents. According to 62.4% respondent's, incidence occurs at knee height stage. 31.6% respondents said, it occurs at vegetative stage and 14% of respondents said that it occurs at cob formation stage during *kharif* season.

The incidence of fall army worm appeared during seedling stage according to 68% respondents. According to 77.2% respondent's, incidence occurs at knee height stage 51.6%. respondents said, it occurs at vegetative stage and 14% of respondents said that it occurs at cob formation stage during *rabi* season.

Table 8: Damage caused by fall armyworm on maize crop stages as reported by the Respondents

S. No.	Incidence at crop stage	Respondents	
A.	During *kharif* season	f	%
1	Seedling Stage	165	66
2	Knee Height Stage	156	62.4
3	Vegetative Stage	79	31.6
4	Cob Formation Stage	35	14
B.	During *rabi* season		
1	Seedling Stage	170	68
2	Knee Height Stage	193	77.2
3	Vegetative Stage	129	51.6
4	Cob Formation Stage	35	14

(*f*= frequency, % = per cent)

Harmfulness/Damage Caused by fall armyworm on maize crop as reported by the respondents

During the *kharif* season, 23.2% of respondents said that 10 – 33% damage caused by fall armyworm is presented in Table

3. 33-50% damage caused according to the 54% of respondents and according to 22.8% of respondents, fall armyworm caused more than 50% damage to maize crop.

During the *rabi* season, 16.8% responders revealed that the

fall army worm caused 10-33% damage. According to 60% responders, fall armyworm caused 35-50% damage and according to 23.2% respondents, fall armyworm worm caused more than 50% damage to maize crop.

Table 9: Damage Caused by fall armyworm on maize crop as reported by the respondents

S. No.	Damaged caused by fall armyworm	Respondents	
		f	**%**
A.	**During *Kharif* Season**		
1	10-33%	58	23.2
2	33-50%	135	54
3	Above 50%	57	22.8
B.	**During *Rabi* Season**		
1	10-33%	42	16.8
2	33-50%	150	60
3	Above 50%	58	23.2
	Average damage per cent	83.3%	

(*f*= frequency, % = per cent)

Occurrence of natural enemies on maize crop as reported by the respondents

Farmers noticed that three different types of natural enemies namely, *viz.* lady bird beetle, rove beetle and hover fly in the *kharif* and *rabi* season of 2021-22. Among the natural enemies the relative abundance of coccinellid beetles was recorded. During *Kharif* season 2021-22, the total ladybird beetle population contributed 78% which were the dominating species during the crop period. Followed by rove beetle contributed 64.4% population, then hover fly 47.6% (Table 4) During *rabi* season 2021-22, the total ladybird beetle population contributed 80.8% which were the dominating species during the crop period, followed by rove beetle contributed 66.4% population, followed by hover fly 47.6% (Table 4)

Table 10: Occurrence of natural enemies on maize crop as reported by the respondents

S. No.	Natural enemies	Respondents	
	Occurrence in *kharif*	**f**	**%**
1	Ladybird beetle	187	78.8
2	Rove beetle	161	64.4
3	Hoverfly	119	47.6
	Occurrence in *rabi*		
1	Ladybird beetle	202	80.8
2	Rove beetle	116	66.4
3	Hoverfly	119	47.6

(*f*= frequency, % = per cent)

Distribution of respondents according to adoptions of pest control measures in maize crop

It is observed from Table 5 that farmers relied solely on adoption of pest control measure in fall armyworm where 97.2% used chemical method, 1.6% used integrated pest management, 1.2% used cultural method and 2 per cent respondents used indigenous technology knowledge in the cultivation of maize. In physical method farmers use sun drying of grains, in cultural method farmers use weeding, crop rotation and deep ploughing and in Indigenous technology Knowledge farmers use dry neem leaves for storing of grains.

Table 11: Distribution of respondents according to adoption of pest control measures in maize crop

S. No.	Pest management strategy	Respondents	
		f	**%**
1	Physical Method	6	2.4
2	Cultural Method	4	1.6
3	Biological Method	0	0
4	Chemical Method	235	94
5	ITK method	5	2

(*f*= frequency, % = per cent)

Distribution of respondents according to application of various insecticides for controlling fall armyworm in maize crop

It was observed from Table 6, that majority of the respondents (30 per cent) primarily used Emamectin benzoate 5% SG for the control of maize fall armyworm. The second most frequently used insecticides (25.2 per cent) was Thiamethoxan 12.6% + lamdacyhalothrin 9.5% ZC, followed by Novaluron 5.25% + Emamectin benzoate 0.9% (9.6 per cent) used among all responders. The other notable insecticides used by the respondents were Profenofos 40% + Cypermethrin 4% EC (7.6 per cent), Spinetoram 11.7 SC (5.2 per cent), Indoxacarb 14.5% SC (5.6 per cent), Chlorantraniliprole 18.5% SC (4.4 per cent), Cypermethrin 10% EC 4 per cent, Spinetoram 11.7 SC (5.2 per cent) and Lamdacyhalothrin 5%EC A rare percentage of the respondents

A small minority of the responders, used biopesticides such as *Bacillus thuringiens* for the control of maize fall armyworm.

Table 6: Distribution of respondents according to application of various insecticides for controlling fall armyworm in maize crop (On the basis of multiple response)

Sr. No	Chemical name of insecticides	Respondents	
		f	**%**
1.	Emamectin benzoate 5% SG	75	30
2.	Novaluron 5.25% + Emamectin benzoate 0.9%	24	9.6
3.	Profenofos 40% + Cypermethrin 4% EC	19	7.6
4.	Thiamethoxan 12.6% + lamdacyhalothrin 9.5%	63	25.2
5.	Spinetoram 11.7 SC	13	5.2
6.	Indoxacarb 14.5% SC	14	5.6
7.	Cypermethrin 10 % EC	8	3.2
8.	*Bacillus thuringiensis*	5	2
9.	Chlorantraniliprole 18.5% SC	11	4.4
10.	Lamdacyhalothrin 5% EC	10	4
11.	Indoxacarb 10% SC	8	3.2

(*f*= frequency, % = per cent)

Distribution of respondents according to their source of information about insect-pests control in maize Crop

Most of the respondents (56.4%) reported that they received advice for the selection of chemical and its doses from input shop representatives, followed by RAEO (19.2%), then by KVK (11.6%), then followed by progressive farmers (8.4%). Only 4.4% of maize growers receive advice from social media (Table 7). This indicates that the retailers of pesticides are an important factor for pesticide recommendation in the study area. On the other hand, the widespread misuse of pesticides also indicates that pesticide dealers do not have the expertise

to guide farmers in effectively controlling maize insect-pest. The results of this survey also imply that either the extension workers in the area do not have proper technical expertise or their communication with farmers is not convincing enough.

Table 7: Distribution of respondents according to their source of information about insect-pests control in maize crop

Source of information	Respondents	
	f	**%**
Progressive farmers	11	8.4
KVK (SMS)	29	11.6
RAEO	48	19.2
Input Shop	141	56.4
Social Media	21	4.4
Literature / Print Media	0	0

(*f*= frequency, % = per cent)

Ganiger *et al.*, 2018 [2] recorded that the occurrence of fall armyworm, in Bangalore Rural and Chikkaballapur district were devastated by caterpillars during May and June, 2018. Paikra *et al.*, 2019 conducted a field survey on fall armyworm (FAW), to determine the presence and infestation by the caterpillar of fall armyworm on maize crop. This invasive pest was studied in twenty-six villages across seven blocks in two districts, Surajpur and Surguja.

Fig 1: Respondents at their maize field

Conclusion
As per the findings and the respondents' reports, the main pest of the maize crop was fall armyworm during *kharif* as well as *rabi* season. Overall incidence in *kharif* season of fall armyworm was 73.7% as reported by respondents. And in *rabi* overall incidence of fall armyworm was 71%. Majority of the responded (66%) agreed that the incidence of fall armyworm was maximum during seedling stage during *kharif* season and in *rabi* season, 77.2% of the respondents agreed that the incidence of fall armyworm was maximum at knee height stage. Damage caused by fall armyworm in both the season was 83.3%. The majority of respondents said that they learned about pest management through pesticide input shop for the control of fall armyworm and majority of them used chemical insecticides *i.e* emamectin benzoate.

Acknowledgement

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