Effect of abiotic factors on population fluctuation of Gram pod borer, *Helicoverpa armigera* (Hubner) in chickpea

ABSTRACT

The field experiment was conducted to determine the population fluctuation of *Helicoverpa armigera* (Hubner) larval population in relation to abiotic factors on chickpea for two seasons during (*Rabi*, 2021-22) at Crop Research Centre (CRC), Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The present study revealed that the Gram pod borer larval population were first observed from 50th and 51th standard meteorological week till harvesting the crop *i.e.* 15th standard meteorological week during *Rabi*, 2021-22 and 2022-23, respectively. The highest peak larval population (4.20 and 3.80 larvae per plant) was observed in 12th and 11th standard meteorological week during *Rabi*, 2021-22 and 2022-23, respectively. The data recorded were subjected to correlation with various meteorological parameters on population fluctuation of *H. armigera* on chickpea.

The correlation analysis showed that both minimum and maximum temperature were positively correlated during both years. Relative humidity of both morning and evening showed negative correlation with population of gram pod borer. However, the larval population showed non-significant negative correlation with rainfall both seasons during Rabi, 2021-22 and 2022-23. The information generated in present investigation may be used for the insect pest prediction and sustainable management strategies of *H. armigera* (Hubner) in chickpea crop.

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Keyword: Gram pod borer, *Helicoverpa armigera,* population fluctuation and correlation.

1. INTRODUCTION

Chickpea (*Cicer arietinum*) is most important pulse crop growing in India under irrigated and dryland condition. India ranks first in the production chickpea in the world [1]. It is a rich source of nutritional values in the diet of

Indian people because of containing 21.5 per cent protein, 64.5 per cent carbohydrates and 4.5 per cent fat which is comparatively deficient in the cereals and oilseeds. Its green leaves and pods are used as green vegetables and germinated grains for breakfast and other delicious dishes by the people in their daily meals [2].

In India, chickpea had total pulses area of 10.91 million hectare with production of 13.75 million tonnes and productivity 1260 kg/ha in 2021-22. It is grown in six major states *viz*., Maharashtra, Madhya Pradesh, Rajasthan, Gujarat, Uttar Pradesh, Andhra Pradesh, Karnataka and Chhattisgarh altogether contribute 97.15 per cent of the production and 96.95 per cent of the area. In U.P. chickpea is grown an area of 0.62 million hectare with production of 0.77 million tonnes and productivity 1250 kg/ha in 2021-22. Maharashtra is the single largest producer in the country accounting for over 23.82 percent of total production while Madhya Pradesh, Rajasthan and Uttar Pradesh contribute about 22.05 percent, 19.28 and 5.59 percent, respectively [3].

The incidence of *Helicoverpa armigera* begins from early vegetative to maturity stage of the crop. At early stage, the young larvae start feeding on leaflets, buds, flowers and finally green pods of chickpea. Owing to this, reduction in yield ranged from 40–50% has been recorded and may cause even total loss of the crop [4-5]. Pest population level may be resultant of weather parameters of preceding weeks or months. It thus becomes important to explore relationship of pest population with pre-season and seasonal weather parameters [6]. Several biotic and abiotic constraints limit the production and productivity of chickpea. But, insect-pests are a major constraint to decrease the production and productivity of chickpea [7]. growers can take precautions of sowing dates and other management tactics, in order to escape from peak pest infestation, it also enables the population build up in those climatic conditions recorded in that year. Abiotic meteorological parameters are playing crucial role in regulation of population of *H. armigera* (Hubner) [8]. Among them abiotic factors play an important role in multiplication and distribution of insect-pests. This is possible if timely prediction of the occurrence of the pest can be made. The knowledge of the population fluctuation of Gram pod borer will certainty found to be helpful in informative for the insect pest management strategies for *H. armigera* at U.P. western conditions.

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2. MATERIALS AND METHODS

The experiment was conducted for two seasons during (*Rabi*, 2021-22) at Crop Research Centre (CRC), Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. In order to study the population fluctuation of *Helicoverpa armigera* on chickpea with relation to abiotic factor's *i.e.,* temperature, relative humidity and rainfall. A plot size of 10×10 m^2 by adopting 30 cm row to row 10 cm plant to plant spacing with chickpea variety 'WCG- 2' was sown manually during *Rabi*, 2021-22 for the first year experiment and 2022-23 for the second year experiment. Observation of *H. armigera* larvae were recorded at weekly intervals starting from three week after sowing to harvesting of crop from 10 randomly selected tagged plants in chickpea plots. Meteorological parameters *i.e*., temperature, relative humidity and rainfall has to be collected throughout the crop period from ICAR-IIFSR, Modipuram, Meerut and this data has to be correlated with the pest population. The influence of meteorological parameters on the pest incidence will be worked out with simple correlation.

$$r = \frac{\sum xy - \frac{\sum (x) \sum y}{N}}{\left(\sum x^2 - \frac{\sum (x)^2}{N} \right) \left(\sum y^2 - \frac{\sum (y)^2}{N} \right)}$$

Where,

r = Simple correlation coefficient

x = Population of pest

y = Meteorological parameter

n = Number of observation

3. RESULTS AND DISCUSSION

The data pertaining to population fluctuation of *H. armigera* (Hubner) in chickpea with respect to meteorological parameters and the correlation analysis between them were presented in the Table 1 and 2 during *Rabi*, 2021-22 and 2022-23, respectively.

3.1. Seasonal population fluctuation of *H. armigera* (Hubner) during *Rabi*, 2021-22

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The observations on population fluctuation of *H. armigera* in chickpea were recorded from 49th to 15th standard meteorological week with *H. armigera* larval population ranged from 0.20 to 4.20 larvae per plant during *Rabi,* 2021-22 (Table 1 and Fig 1). The larval population of *H. armigera* during *Rabi,* 2021-22 was first reported at 50th standard meteorological week (Third week of December) with 0.40 larvae per plant when the maximum and minimum temperature were 22.40 ^{0}C and 9.36 ^{0}C, relative humidity at morning and evening was 83.43 and 39.43 per cent, respectively, and rainfall was recorded 0.00 mm. The Gram pod borer activity increased from second week of March and reached its peak at 12th standard meteorological week (Fourth week of March) with 4.20 larvae per plant when the maximum and minimum temperature were 37.50 ^{0}C and 20.10 ^{0}C, relative humidity at morning and evening was 67.40 and 34.30 per cent, respectively, whereas, 0.00 mm rainfall was recorded. Further larval pest population was started gradually decline 1.90 larvae per plant towards the maturity of the crop at 14th standard meteorological week (second week of April) when the maximum and minimum temperature were 39.80 ^{0}C and 21.70 ^{0}C, relative humidity at morning and evening was 52.10 and 24.70 per cent, respectively, whereas, 0.00 mm rainfall was recorded.

3.2. Seasonal population fluctuation of *H. armigera* (Hubner) during *Rabi*, 2022-23

The observations on population fluctuation of *H. armigera* in chickpea were recorded from 49th to 15th standard meteorological week with *H. armigera* larval population ranged from 0.30 to 3.80 larvae per plant during *Rabi,* 2022-23 (Table 2 and Fig 2). The larval population of *H. armigera* during *Rabi,* 2022-23 was first reported at 51th standard meteorological week (fourth week of December) with 0.30 larvae per plant when the maximum and minimum temperature were 21.80 ^{0}C and 7.00 ^{0}C, relative humidity at morning and evening was 95.10 and 75.00 per cent, respectively, and rainfall was recorded 0.00 mm. The Gram pod borer activity gradually increased from second week of March and reached its peak at 11th standard meteorological week (Third week of March) with 3.80 larvae per plant when the maximum and minimum

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temperature were 33.04 ^{0}C and 15.60 ^{0}C, relative humidity at morning and evening was 61.43 and 46.00 per cent, respectively, whereas, 2.00 mm rainfall was recorded. Further larval pest population was started gradually decline 0.80 larvae per plant towards the maturity of the crop at 15th standard meteorological week (Third week of April) when the maximum and minimum temperature were 34.93 ^{0}C and 17.80 ^{0}C, relative humidity at morning and evening was 45.14 and 26.86 per cent, respectively, whereas, 0.00 mm rainfall was recorded. It's indicated that the *H. armigera* population was active during March. This period coincided with the flowering and pod formation stage of the chickpea crop.

The present findings are supported by the findings of Sagar *et al.* [9] who reported that peak larval population of *H. armigera* was observed during second week of March, 12th standard meteorological week (SMW). Ray and Banerjee [10] who also reported that peak larval population of *H. armigera* was observed in second week of March, 12th SMW. Naveen and Ghosh [11] who also reported that peak larval population of *H. armigera* was observed in second week of March, 12th SMW. The results obtained in the study are in line with Meena and Bhatiya [12]. Thus, the present studied on *H. armigera* population on chickpea crop are in accordance with earlier workers.

3.3. Correlation coefficient between larval population of *H. armigera* with Meteorological Parameters during *Rabi*, 2021-22 and 2022-23

3.3.1. Correlation coefficient during *Rabi*, 2021-22

Correlation (r) coefficient of *H. armigera* with different meteorological parameters, demonstrate that the correlation between minimum and maximum temperature and *H. armigera* larvae population had significant positive correlation r = 0.613 and r = 0.656 respectively (Table 3). Relative humidity of both morning and evening showed non-significant negative correlation with population of gram pod borer in chickpea exhibiting simple correlation coefficient value of r = -0.393 and r = -0.422 respectively. However, the Gram pod borer population showed non-significant negative correlation with rainfall r = -0.319.

3.3.2. Correlation coefficient during *Rabi*, 2022-23

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Correlation (r) coefficient of *H. armigera* with different meteorological parameters, demonstrate that the correlation between minimum and maximum temperature and *H. armigera* larvae population had significant positive correlation r = 0.531 and r = 0.603 respectively (Table 3). Relative humidity of both morning and evening showed significant negative correlation with population of gram pod borer in chickpea exhibiting simple correlation coefficient value of r = -0.475 and r = -0.619 respectively. However, the Gram pod borer population showed non-significant negative correlation with rainfall r = -0.078.

These findings are supported by Sagar *et al.* [9] and Nitharwal *et al*. [13] who reported that *H. armigera* had significant positive correlation with minimum and maximum, Morning and evening relative humidity were negatively correlated with Gram pod borer. The present findings are in conformity with Pandey [14] who reported that *H. armigera* had significant positive correlation with minimum and maximum temperature. The larval population showed non-significant negative correlation with rainfall. Ray and Banerjee [10] who also reported that *H. armigera* had significant positive correlation with minimum and maximum, whereas the association was found significant negative correlation with morning and evening relative humidity. The *H. armigera* larval population was showed significant negative correlation with rainfall.

4. CONCLUSIONS

The present study result revealed that Gram pod borer larval population were first observed from 50th and 51th standard meteorological week till harvesting of the crop *i.e.,* 15th standard meteorological week during *Rabi*, 2021-22 and 2022-23, respectively. The Gram pod borer activity increased from second week of March and reached its peak at 12th standard meteorological week (Fourth week of March) with 4.20 larvae per plant during 2021-22 and 3.80 larvae per plant were reached in peak at 11th standard meteorological week (Third week of March) in 2022-23. The information generated in present investigation may be used for the sustainable management strategies of *H. armigera*.

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Table 1: **Seasonal population fluctuation of *H. armigera* larval population in relation to abiotic factors on Chickpea during *Rabi* season, 2021-22**

Standard Week	Date	Larval Population of *H. armigera* / Plant	Meteorological Parameters				
			Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)
			Maximum	Minimum	Morning	Evening	
49	Dec 06 – Dec 12	0.00	23.07	11.64	84.29	48.14	0.90
50	Dec 13 – Dec 19	0.40	22.40	9.36	83.43	39.43	0.00
51	Dec 20 – Dec 26	0.30	20.74	7.17	82.43	38.43	0.00
52	Dec 27 - Jan 02	0.40	20.00	6.49	88.63	49.50	2.50
1	Jan 03 - Jan 09	0.30	20.60	7.50	84.60	61.10	9.90
2	Jan 10 - Jan 16	0.20	17.70	5.30	91.90	80.60	67.50
3	Jan 17 - Jan 23	0.30	16.20	4.70	92.60	71.10	3.70
4	Jan 24 - Jan 30	0.20	16.60	5.30	91.60	67.90	33.90
5	Jan 31 – Feb 06	0.90	20.10	6.00	88.60	67.00	18.40
6	Feb 07 - Feb 13	1.20	20.50	7.30	85.90	64.10	4.50
7	Feb 14 - Feb 20	2.60	24.30	8.30	82.60	57.40	0.00
8	Feb 21 - Feb 27	2.80	25.90	9.90	82.70	50.30	0.70
9	Feb 28 – Mar 06	2.30	26.00	10.50	88.60	53.10	31.50
10	Mar 07 - Mar 13	3.30	30.30	13.40	76.00	43.00	0.00
11	Mar 14 - Mar 20	3.90	34.20	17.10	71.10	39.60	0.00
12	Mar 21 - Mar 27	4.20	37.50	20.10	67.40	34.30	0.00
13	Mar 28 - Apr 03	3.10	38.70	20.30	58.90	28.40	0.00
14	Apr 04 - Apr 10	1.90	39.80	21.70	52.10	24.70	0.00
15	Apr 11 - Apr 17	0.70	41.00	20.40	41.40	21.70	0.00

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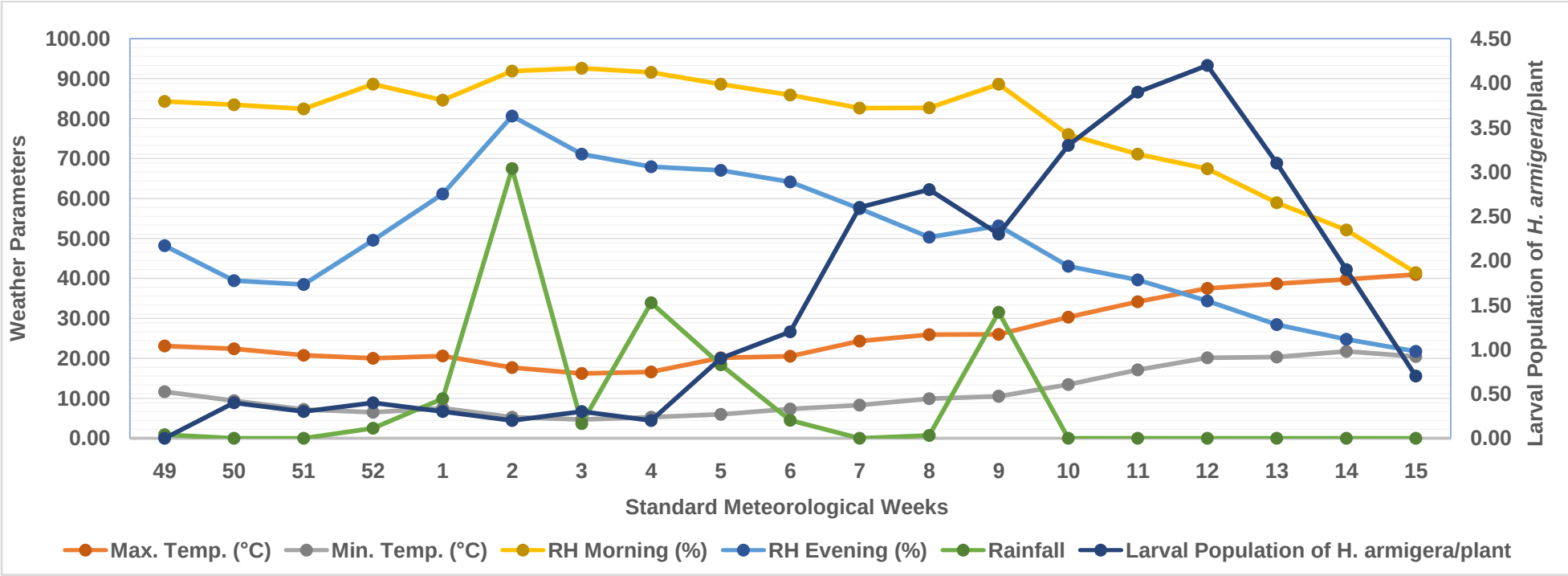

Fig 1: Seasonal population fluctuation of *H. armigera* larval population in relation to abiotic factors on Chickpea during *Rabi* season, 2021-22

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Table 2: **Seasonal population fluctuation of *H. armigera* larval population in relation to abiotic factors on Chickpea during *Rabi* season, 2022-23**

Standard Week	Date	Larval Population of *H. armigeral* Plant	Meteorological Parameters				
			Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)
			Maximum	Minimum	Morning	Evening	
49	Dec 05 - Dec 11	0.00	24.90	8.80	79.70	64.00	0
50	Dec 12 - Dec 18	0.00	23.40	8.60	88.50	69.20	0
51	Dec 19 - Dec 25	0.30	21.80	7.00	95.10	75.00	0
52	Dec 26 – Jan 01	0.40	18.90	6.10	95.70	77.70	0
1	Jan 02 - Jan 08	0.60	15.36	4.57	97.86	82.86	0.0
2	Jan 09 - Jan 15	0.90	15.59	5.50	94.71	79.71	0.0
3	Jan 16 - Jan 22	1.20	17.37	5.07	92.00	71.86	0.0
4	Jan 23 – Jan 29	1.30	20.56	6.64	88.14	60.00	0.2
5	Feb 30 - Feb 05	1.50	21.07	6.00	90.86	59.29	11.0
6	Feb 06 - Feb 12	1.90	25.14	9.50	83.43	51.14	0.0
7	Feb 13 - Feb 19	2.60	26.99	11.17	84.43	48.00	0.0
8	Feb 20 - Feb 26	2.80	29.87	13.00	74.71	44.43	0.0
9	Feb 27 - Mar 05	3.00	31.21	14.21	73.00	45.79	1.0
10	Mar 06 - Mar 12	3.20	32.06	14.93	68.57	43.43	0.0
11	Mar 13 - Mar 19	3.80	33.04	15.60	61.43	46.00	2.0
12	Mar 20 - Mar 26	1.10	23.99	12.61	85.71	68.29	106.2
13	Mar 27 – Apr 02	1.40	29.33	16.63	75.86	45.57	37.5
14	Apr 03 - Apr 09	1.70	29.63	16.77	69.57	48.43	2.8
15	Apr 10 - Apr 16	0.80	34.93	17.80	45.14	26.86	0.0

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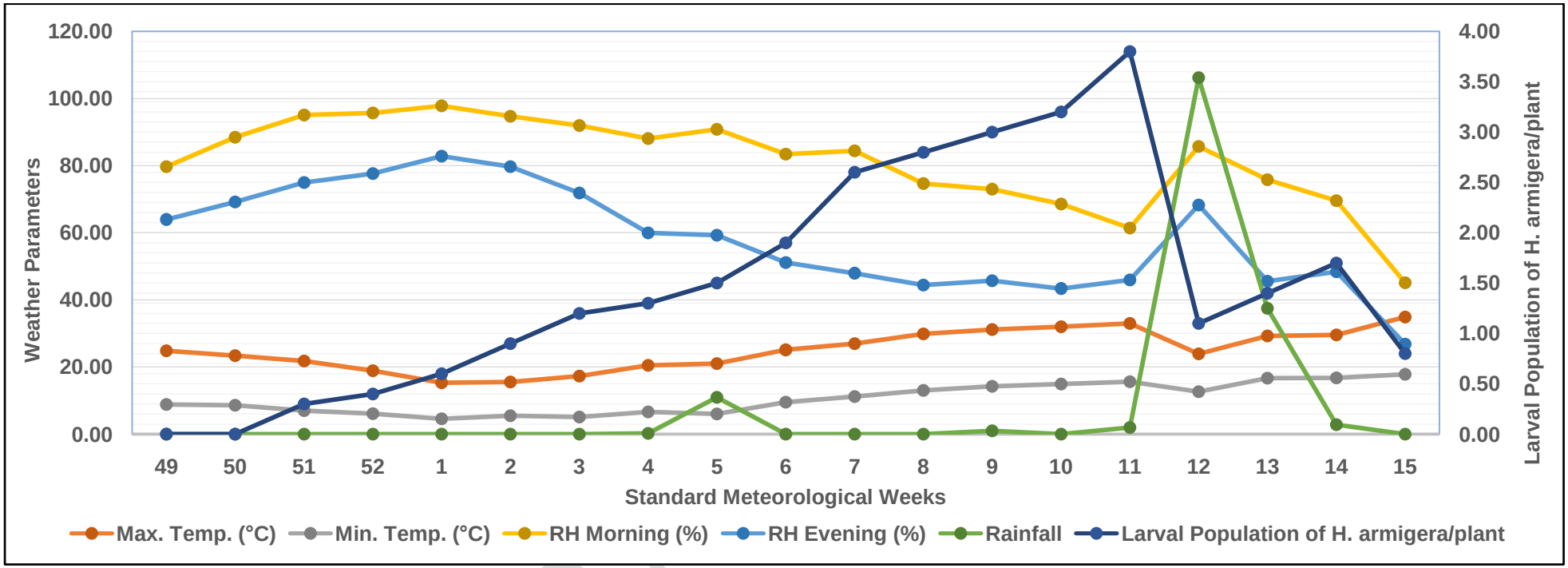

Fig 2: Seasonal population fluctuation of *H. armigera* larval population in relation to abiotic factors on Chickpea during *Rabi* season, 2022-23

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Table 3: Correlation between larval population of *H. armigera* with Meteorological Parameters during *Rabi*, 2021-22 and 2022-23

Season	Meteorological Parameters	***H. armigera* Correlation coefficient (r) 2021-22**	***H. armigera* Correlation coefficient (r) 2022-23**
Rabi, 2021-22 and 2022-23	Maximum Temperature (^{0}C)	0.656**	0.603**
	Minimum Temperature (^{0}C)	0.613**	0.531*
	Relative humidity morning (%)	-0.393 NS	-0.475*
	Relative humidity evening (%)	-0.422 NS	-0.619**
	Rainfall (mm)	-0.319 NS	-0.078 NS

*Significant at 5% level (P = 0.05), ** Significant at 1% level (P = 0.01); NS- Non significant

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nice table for the discussion. but it will be better if some of theses table can be illustrated by graph, to depict as the insects peaked and declined.

I have made changes in the no of authors in the manuscript please consider the recent names added only.

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