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Population dynamics of linseed budfly (*Dasyneura lini* Barnes) in linseed (*Linum usitatissimum* Linn.)

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Abstract
The research trials were conducted at research cum instructional farm, College of Agriculture, IGKV, Raipur (C.G) for two consecutive *Rabi* seasons of 2020-21 and 2021-22. The major pest of the linseed crop in Chhattisgarh was linseed budfly, *Dasyneura lini*, observed during both cropping seasons. The peak activity of linseed budfly was observed during 10^{th} standard meteorological week of year 2020-21 and 2021-22, respectively. During this period, the correlation of maximum temperature was found positive significant and the correlation of relative humidity I and II was found negative significant whereas, all the other parameters showed the positive and negative non-significant correlation with the mean population of *D. Lini*.

Keywords: Linseed, budfly, standard meteorological week, maximum temperature, rainfall, relative humidity

Introduction

Population dynamics, an essential component within the field of population ecology, involves examining the factors that drive fluctuations in population sizes. Variations in seasonal weather patterns and ongoing changes in climate directly influence the adaptations and evolution of insect species. It is crucial for entomologists to comprehend how these factors interact to shape insect populations.

Insects, being poikilothermic creatures, show sensitivity to precipitation and exhibit fluctuations in response to environmental cues. These variations stem from their inherent traits, which are directly shaped by environmental conditions impacting their physiology and behaviors (Parmesan, 2007; Bale *et al.*, 2002) [2, 3]. The degree of impact from different environmental elements dictates the scale of fluctuations in insect population sizes.

A thorough understanding of insect population dynamics is vital for devising sustainable methods of crop protection and ensuring the well-being of agricultural ecosystems. Additionally, it plays a critical role in interpreting and predicting the reactions of various taxonomic groups to daily, seasonal, or long-term fluctuations in weather patterns, including those induced by global changes.

Linseed, scientifically referred to as *Linum usitatissimum*, belongs to the order Malpighiales, the family Linaceae, and the tribe Lineae. The genus name "*Linum*" originates from the Celtic term "lin," meaning thread, while the species "*usitatissimum*" was coined by Carl Linnaeus, signifying "most useful." Within the *Linum* genus, which encompasses approximately 230 species, cultivated linseed, commonly known as flax, stand out as the sole species of economic importance (Rowland *et al.*, 1995; Tadesse *et al.*, 2010) [4, 5]. This plant holds a venerable status as one of the earliest cultivated crops, valued for its versatile applications in both fiber and oil production. Linseed oil, extracted from its seeds, has served as a valuable drying oil for centuries, boasting an oil content ranging from 33 to 45% (Gill, 1987) [6]. In India, approximately 20% of the total linseed oil production provides to farmers' needs, while the remaining 80% is allocated too various industries for the manufacture of paints, varnishes, linoleum, printing ink, and other products. In India, linseed is grown mostly under rainfed (63%), utera (25%), irrigated (17%) and also in input starved conditions in major linseed-producing states, *i.e.*, Madhya Pradesh, Chhattisgarh, Maharashtra, Jharkhand, Uttar Pradesh and Odisha. It is currently grown in over 50 countries, mainly in the northern hemisphere (Srivastava, 2009) [7].

In India, Madhya Pradesh holds first rank in terms of area and production; however, in terms of productivity, Bihar ranks first. Linseed covered an area of over 0.23 lakh hectares in Uttar Pradesh and production was about 0.11 lakh tons, with the maximum productivity level being 4.75 q/ha (FAOSTAT, 2020) [8]. Linseed crop is attacked by a number of insect pests at various phases of its growth. Among which linseed budfly, *Dasyneura lini* Barnes is a major pest causing 88 per cent yield losses (Mukherji *et al*. 1999) [9]. Budfly lay their eggs in the calyx of flower buds. The maggots that come out of eggs feed the flower and as a result, the infested buds become hollow and unproductive.

Materials and Methods

The experiment was conducted during the *Rabi* season at the research cum instructional farm of the College of Agriculture, IGKV, Raipur (C.G), over two consecutive *Rabi* seasons: 2020-21 and 2021-22. The Neelum variety was planted in the last week of November during both experimental years, with a plot size of 1 acre. Weekly observations on the incidence of linseed budfly were recorded on 10 randomly selected plants. Infestation percentages were calculated by counting the number of infested buds against the total number of buds. The population dynamics of the budfly were analyzed based on standard meteorological data, which included maximum and minimum temperature, relative humidity I and II, and rainfall throughout the cropping season. These weather parameters were then correlated with the budfly population. The relationship between the linseed budfly and the weather parameters was examined using Microsoft Excel 2021 software for correlation calculations.

$$\text{Budfly Infestation (\%)} = \frac{\text{No. of infested buds}}{\text{Total no. of buds}} \times 100$$

Results and Discussion

Linseed budfly began appearing up during the bud formation stage and continued until it reached maturity. The linseed budfly is active during the duration of the crop. The mean population of *D. Lini* started in 2020-21 at 5.27% during the 2nd SMW, which corresponds to the second week of January with the peak population of 30.96% during the 10th SMW, which corresponds to the first week of March. The maximum temperature showed significant positive correlation (r=0.717*) with the mean population of *D.lini* and negative but significant correlation were found with relative humidity I (r=-0.788*) while, positive non-significant correlation were found with minimum temperature (r=0.411) and rainfall (r= 0.124) and negative non-significant correlation were found with relative humidity II (r=-0.398). The correlation of maximum temperature was found positive significant and the correlation of relative humidity I was found negative significant whereas, all the other parameters showed the positive and negative non-significant correlation with the mean population of *D. Lini*.

During 2021-22, the *D. Lini* population started at 4.65% during the 2nd SMW, *i.e.*, the second week of January and reached its peak 35.54% during the 10th SMW, *i.e.*, the first week of March. The seasonal mean of *Rabi* 2020-21 and 2021-22 were 14.82 and 20.11%. The maximum temperature showed significant positive correlation (r=0.868*), relative humidity I showed significant negative correlation (r=-0.876*) and relative humidity II showed significant negative correlation (r=-0.870*) with the mean population of *D.lini* population whereas, positive and non-significant correlation were shown with minimum temperature (r=0.073) whereas, negative and non-significant correlation were shown with rainfall (r=-0.559). The correlation of maximum temperature was found positive significant and the correlation of relative humidity I and II was found negative significant whereas, all the other parameters were found to be positive and negative non-significant correlation with the mean population of *D.lini*.

The average of both the years 2020-21 and 2021-22, indicated that the mean population of *D.lini* 4.96% during the 2nd SMW, *i.e.*, the second week of January and reached its peak 33.25% during the 10th SMW, *i.e.*, the first week of March. Throughout the cropping season, the mean budfly population were 17.47%. The maximum temperature showed significant positive correlation (r=0.793*) and relative humidity II showed significant negative correlation (r=-0.832*). whereas, rainfall (r=-0.218) and relative humidity II (r=-0.346) exhibited non-significant negative correlation, while minimum temperature (r = 0.242) exhibited non-significant positive correlation. The correlation of maximum temperature was found positive significant and correlation of relative humidity I and II was found negative significant whereas, the other weather parameters exhibited non-significant negative and positive correlation with the mean population of *D.lini*.

The findings of the current study corroborate those of Malik *et al*. (1998) Malik who reported that bud infestation commenced from the 3rd to 4th week of January during the years 1989-90 and 1990-91, with budfly infestation ranging from 0.74% to 1.71%. This infestation progressively increased to cumulative levels ranging from 16.07% to 50.28% at the harvesting stage. The peak bud infestation, reaching 11.82% and 10.22%, respectively, occurred during the last week of February to mid-March on the cultivar Neelum.

This result is found to be in close association with result obtained by Gupta and Katlam (2013) [11] who recorded that the linseed budfly appeared in the 2nd standard week with the 1.4% bud damage. The maximum cumulative damage by budfly was recorded in 10th standard week with bud damage of 34.16% in Neelum. These findings are also supported by Sahoo (2016 a) [14] who reported that the budfly infestation with the age of the crop which was maximum during 10th standard meteorological week.

Similar observations are also reported by Rizwan *et al.* (2018) [12] who evaluated the incidence of budfly was recorded as bud damage from second week of January and continued till last week of march. The maximum per cent damage was recorded in the third week of march in Neelum.

Present result is also similar to past finding by Malik *et al.* (1998) [10] who recorded that the average temperature of 16-20 °C and relative humidity of 60-75% were most favourable for the multiplication of the *Dasyneura lini*.

These observations are in confirmation with Gupta (2012) [13] who investigated that there is a positive significant correlation with budfly infestation with maximum temperature of (r=0.865) and negative non-significant correlation with rainfall on Neelum.

This study aligns with Sahoo (2016) [14] research, which documented a notable positive correlation (r=0.731*) between maximum temperature and budfly infestation in linseed crops. Moreover, he noted that both maximum and minimum relative humidity levels exhibited a significant negative impact on the damage inflicted by the linseed budfly. Additionally, the study observed a progressive increase in budfly infestation with the crop's age, peaking during the 10th standard meteorological week (5th to 11th March). Present study agreed with the result of earlier finding reported by Malik *et al.* (2000) [15] who found that temperature 17-20 ̊C (Maximum 23-28 °C and minimum 9-12 °C) and relative humidity 60-70% (morning 65-75% and evening 57-65%) were congenial for budfly multiplication.

Table 1: Budfly infestation (%) on linseed during *rabi* 2020-21 and 2021-22

	Budfly Infestation (%)		
SMW	**2020-21**	**2021-22**	**Pooled mean**
52	0.00	0.00	0.00
1	0.00	0.00	0.00
2	5.27	4.65	4.96
3	8.06	13.31	10.69
4	11.84	21.72	16.78
5	14.43	24.48	19.46
6	18.46	27.47	22.97
7	21.36	29.11	25.24
8	24.88	31.32	28.10
9	27.82	33.71	30.77
10	30.96	35.54	33.25
Avg	14.82	20.11	17.47

Table 2: Correlation of budfly infestation (%) of linseed with abiotic parameters during *rabi* 2020-21 and 2021-22

Abiotic parameters	Budfly infestation (%)		
	2020-21	**2021-22**	**Pooled mean**
Maximum Temperature (°C)	0.717*	0.868*	0.793*
Minimum Temperature (°C)	0.411	0.073	0.242
Rainfall (mm)	0.124	-0.559	-0.218
Relative Humidity I (%)	-0.788*	-0.876*	-0.832*
Relative Humidity II (%)	-0.398	-0.870*	-0.346

* Significant at 5% level of significance (r=0.602) at 9 df

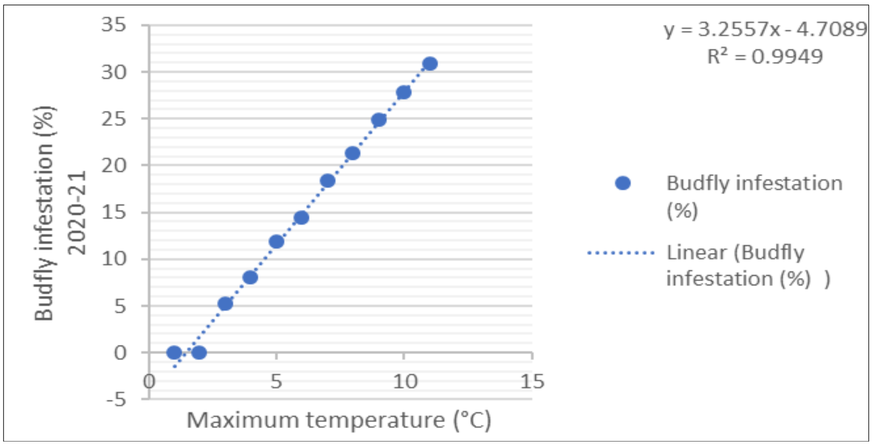

Fig 1: Regression line between budfly infestation (%) and maximum temperature (℃) during 2020-21

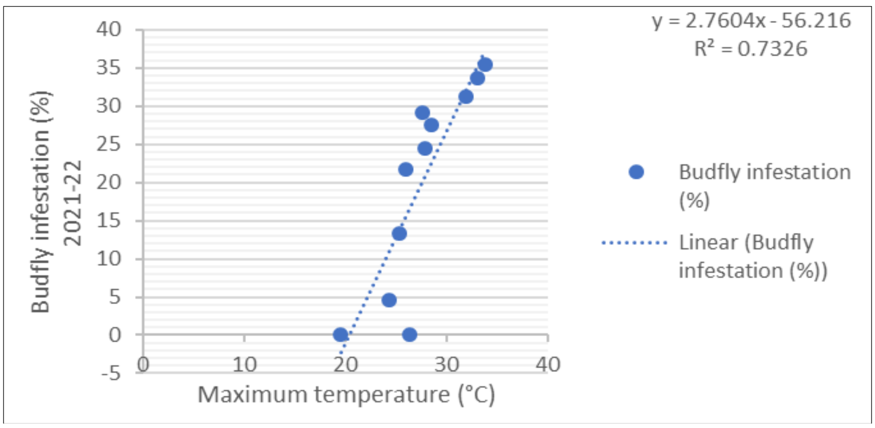

Fig 2: Regression line between budfly infestation (%) and maximum temperature (℃) during 2021-22.

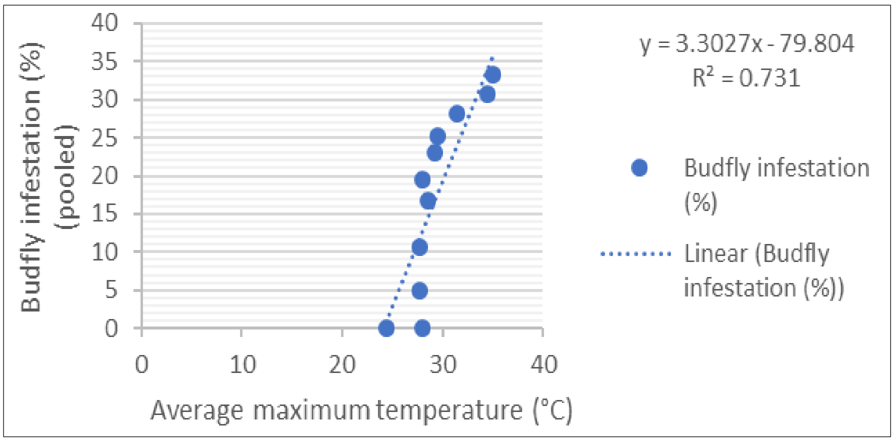

Fig 3: Regression line between budfly infestation (%) and average maximum temperature (°C) (Pooled)

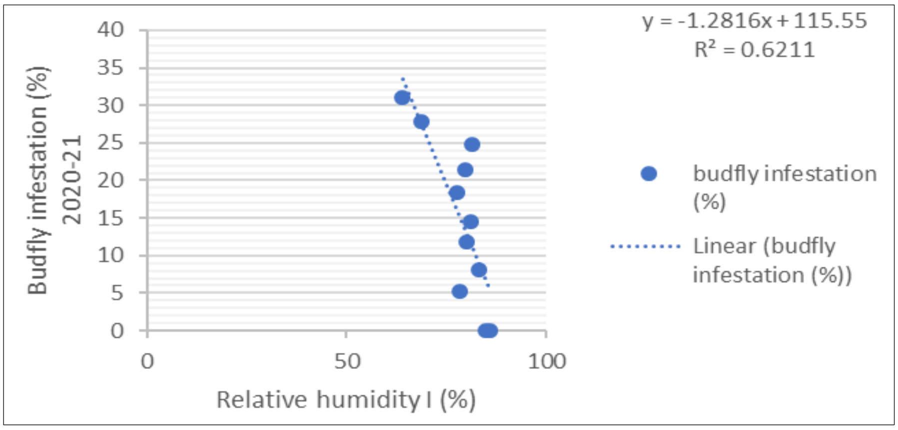

Fig 4: Regression line between budfly infestation (%) and relative humidity I (%) during 2020-21.

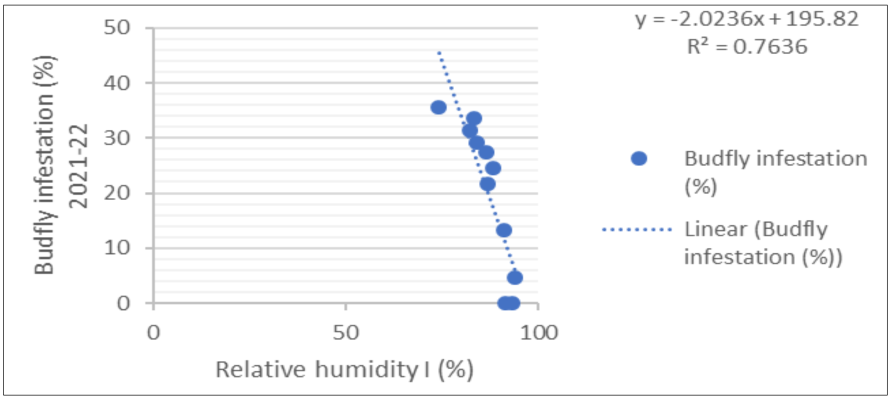

Fig 5: Regression line between budfly infestation (%) and relative humidity I (%) during 2021-22

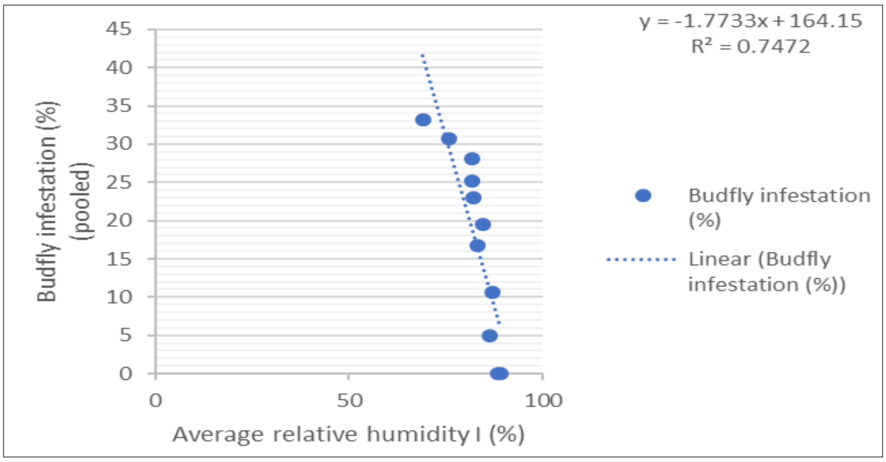

Fig 6: Regression line between budfly infestation (%) and average relative humidity I (%) (Pooled).

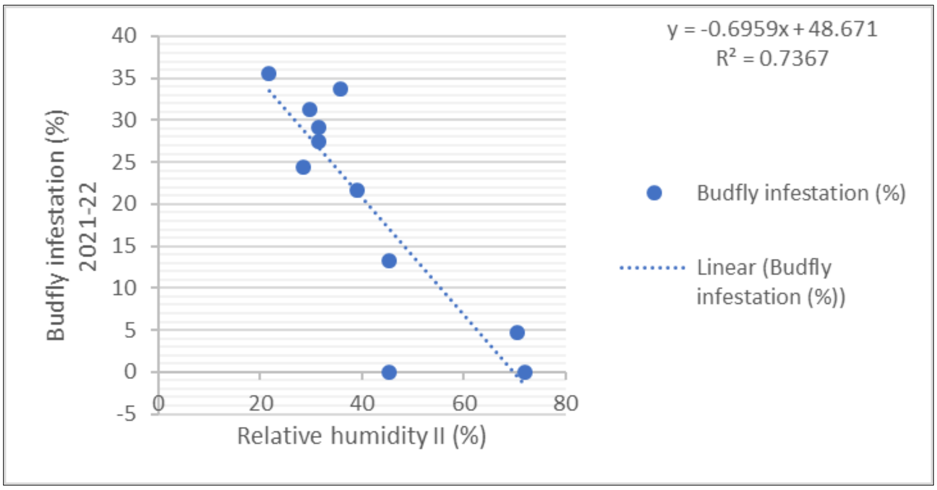

Fig 7: Regression line between budfly infestation (%) and relative humidity II (%) during 2021-22.

Conclusion

The first week of March was found to be the most favourable period for the multiplication of the budfly. The correlation study unveiled significant values, indicating a significantly positive correlation with maximum temperature and a negative correlation with relative humidity I and II. From this, it can be inferred that the combined effect of all-weather parameters did not exert a significant influence on budfly population dynamics, except for maximum temperature and relative humidity I and II. None of the individual weather factors alone demonstrated a substantial impact on the budfly population.

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