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Shrikrushna G Gaikwad
Department of Entomology,
College of Agriculture,
Vasantrao Naik Marathwada
Krishi Vidyapeeth, Parbhani,
Maharashtra, India

Vijay K Bhamare
Department of Entomology,
College of Agriculture,
Vasantrao Naik Marathwada
Krishi Vidyapeeth, Parbhani,
Maharashtra, India

Corresponding Author:
Shrikrushna G Gaikwad
Department of Entomology,
College of Agriculture,
Vasantrao Naik Marathwada
Krishi Vidyapeeth, Parbhani,
Maharashtra, India

Effect of weather parameters on population dynamics of grasshoppers infesting Tuberose, *Agave amica* (Medikus) Thiede and Govaerts

Shrikrushna G Gaikwad and Vijay K Bhamare

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Abstract

Tuberose (*Agave amica* (Medikus) Thiede and Govaerts) is a perennial garden plant belonging to the asparagus family (Asparagaceae), widely cultivated for its fragrant flowers. It is a commercially significant cut flower crop in our country, often targeted by various insect pests. Among these, grasshoppers pose a major challenge by damaging young leaves and flower buds, especially during the rainy season. This damage reduces the aesthetic appeal and market value of the plants. In light of the importance of foliar pests, a study was conducted on the population dynamics of grasshoppers at the Research Farm of the Department of Entomology, College of Agriculture (VNMKV), Latur, during 2023-2024. Results indicated that the maximum population of grasshoppers (0.23 per plant) was observed during the 47th Standard Meteorological Week (SMW) of 2023. Correlation studies of grasshoppers with weather parameters revealed that minimum and maximum temperatures had a significant negative correlation with grasshopper populations. Afternoon relative humidity exhibited a significant positive correlation, while morning relative humidity showed a non-significant positive correlation. Rainfall, on the other hand, displayed a non-significant negative correlation with grasshopper populations. These results indicate that grasshopper populations tend to decrease with rising temperatures but are positively influenced by higher afternoon relative humidity. Conversely, rainfall and morning relative humidity show limited or negligible influence on their population dynamics. The grasshopper population variation was explained by 34.7% due to the influence of different weather parameters.

Keywords: Population dynamics, abiotic factors, tuberose, grasshoppers

Introduction

Tuberose (*Agave amica* (Medikus) Thiede and Govaerts), commonly known as the "Queen of Fragrance" or "Fragrance of the Night," is a night-blooming plant native to Mexico (Iftikhar *et al.*, 2023) [2]. It is a perennial species that belongs to the family Asparagaceae, exhibiting a monocotyledonous nature and a bulbous structure (Thiede and Govaerts, 2017) [14]. The plant's common name derives from the Latin word *tuberosa* and the French *tubéreuse*, referring to its swollen, tuberous root system (Singh *et al.*, 2015) [12]. Tuberose (*A. amica*) is cultivated commercially in tropical and subtropical regions for cut flower production, the floriculture trade, and as a source of oil (Sadhukhan *et al.*, 2022) [11].

Known locally as Rajnigandha or Nishigandha, tuberose is a versatile plant that thrives in pots, borders, and beds. It is highly valued for its wide range of uses. The flowers are prized for making artistic garlands, floral ornaments, bouquets, buttonholes, and gajras, as well as for the extraction of essential oils. Tuberose is also a popular cut flower, not only used in floral arrangements but also for its individual florets, which impart a powerful fragrance to bouquets and boutonnières. Additionally, the long flower spikes are excellent as cut flowers for table decorations, adding beauty and fragrance to any setting. The delightful fragrance of its flowers is one of the key reasons tuberose is so cherished in the floral industry. Tuberose is commercially cultivated in countries like India, China, Bangladesh, Mexico, and others. In India, it is grown in states such as West Bengal, Karnataka, Tamil Nadu, Maharashtra, Uttar Pradesh, and the northeastern region. The total area under tuberose cultivation in India is approximately 21.31 lakh hectares, with a production of around 197,000 tonnes in 2023-24. Of this, 96,510 tonnes were loose flowers, and 100,850 tonnes were cut flowers in the

2022-23 period (Agriwelfare, 2024).

Renowned for its aromatic flowers, tuberose is a significant ornamental and commercial crop. However, it is highly susceptible to various pests that cause extensive damage. With the effects of climate change, the dynamics of pest populations have shifted, leading to the emergence of new pest threats and increased incidences (Pal and Chakravarthy, 2020) ^[9]. Understanding these changes is crucial for developing effective pest management strategies. Grasshoppers are particularly destructive to tuberose, targeting young leaves and flower buds (Mandal *et al.*, 2018) ^[6]. Their feeding activity results in both aesthetic and physical damage, reducing the commercial value of the plants. Damage is most pronounced during the rainy season, with affected plants losing their visual appeal and elegance (NHB, 2024) ^[8]. Given the importance of minimizing pest impact, this study was undertaken to examine the influence of weather parameters on the population dynamics of grasshoppers infesting tuberose. By understanding these relationships, the findings aim to support the development of sustainable pest management practices for tuberose cultivation.

Materials and Methods

The non-replicated field experiment comprising 72 quadrats each of 3 x 3 sq. m size was laid to investigate succession of major insect pests of Tuberose at the Research Farm of Department of Entomology, College of Agriculture (VNМКV), Latur (MS) during 2023-24. The popular tuberose variety, Phule Rajani was sown at the spacing of 100 x 30 cm in 72 quadrats July 8th, 2023, as per the package of practices recommended by the Directorate of Floriculture, Pune. The field experiment was conducted under pesticide-free conditions. The succession of grasshoppers on tuberose were determined by recording observations on all the plants from three quadrats, twice in each meteorological week. The population of grasshoppers was then calculated per plant. The statistical analysis of the data on population of grasshoppers on tuberose and weather parameters were carried out by simple correlation and multiple regression using WASP 2.0 software developed by ICAR Research Complex, Goa.

Results and Discussion

Population dynamics of grasshoppers

The population dynamics of grasshoppers on *A. amica* (tuberose) was studied during 2023-2024. During the course of the investigation, the weather parameters-rainfall, minimum temperature, maximum temperature, before noon relative humidity, and afternoon relative humidity-ranged from 0.00 to 179.5 mm, 11.78 °C to 20.22 °C, 23.22 °C to 29.86 °C, 70.28% to 97.57%, and 35.25% to 61%, respectively. The first incidence of grasshoppers on tuberose was observed in the 33rd SMW (Standard Meteorological Week) of 2023, with 0.11 grasshoppers per plant. The peak population occurred in the 47th SMW of 2023, with a

population level of 0.23 grasshoppers per plant. At the maximum population level of grasshoppers, the prevailing weather factors were as follows: rainfall 0.00 mm, minimum temperature 20.17 °C, maximum temperature 29.21 °C, before noon relative humidity 77.46%, and afternoon relative humidity 36.80% (Table 1 and Fig. 1).

The results of present investigation are in congruence with the findings of Kumar *et al.* (2023) ^[4] who revealed that the highest grasshopper incidence was recorded in the 40th SMW with 4.22 percent infestation in little millet. Khan *et al.* (2022) ^[3] exhibited that the maximum grasshopper population on maize was recorded in the 7th SMW (0.40 per plant). The seasonal average of the grasshopper population on maize was 0.17 per plant. Rawat *et al.* (2021) ^[10] showed that the highest grasshopper infestation (26.67 percent) in finger millet was recorded and the maximum infestation (33.33 percent) of grasshoppers in barnyard millet was recorded at Gaja Farm. Sreedhar *et al.* (2020) ^[13] evidenced that grasshoppers were associated with chrysanthemum crop right from the seedling stage to maturity stage. Kumar *et al.* (2020) ^[5] revealed that percentage damage of surface grasshoppers in maize appeared in the 10th SMW (1.26 percent) and reached its peak (3.21 percent) in the 22nd SMW. Manjunatha *et al.* (2019) ^[7] reported that the grasshopper's population was observed throughout the cropping period with a peak population (0.90 no. per plant) in the first fortnight of August as well as October.

Correlation between incidence grasshoppers and weather parameters

The results in respect of simple correlations between population of grasshoppers infesting tuberose and weather parameters during 2023-24 are presented in Table 2. The data revealed that minimum temperature ($r = -0.570^*$) and maximum temperature ($r = -0.509^*$) had a significantly negative correlation with the population of grasshoppers. Meanwhile, afternoon relative humidity ($r = 0.529$) exhibited a significantly positive correlation with the population of grasshoppers, while before noon relative humidity ($r = 0.353$) showed a non-significant positive correlation. However, rainfall ($r = -0.072$) showed a non-significant negative correlation with the population of grasshoppers. More or less similar results were reported by Kumar *et al.* (2020) ^[5] who demonstrated that grasshoppers infesting *rabi* oat exhibited a highly significant positive correlation with maximum and minimum temperature ($r = 0.06^{**}$, $r = 0.73^{**}$) and sunshine (hrs.) ($r = 0.40^*$). While, highly significant negative correlation with morning relative humidity ($r = -0.58^{**}$) and non-significant positive correlation with rainfall ($r = 0.26$) and non-significant negative correlation with evening relative humidity ($r = -0.03$). Manjunatha *et al.* (2019) ^[7] indicated that grasshopper population infesting castor had positive significant relation with maximum temperature ($r = 0.701^*$) and wind speed ($r = 0.749^*$).

Table 4.1: Population dynamics of grasshoppers on tuberose in relation to weather parameters during 2023-24

Month	Standard Metrological Week	Rainfall (mm)	Temperature (°C)		Relative Humidity (%)		Mean no. of grasshoppers per plant per quadrat
			Min.	Max.	Before noon	Afternoon	
August 2023	33	0	20.22	29.86	77.43	36.36	0.11
	34	0	20.19	29.51	77.25	36.69	0.16
September 2023	35	0	20.16	29.22	77.18	36.96	0.13
	36	47.07	20.15	29.06	77.26	37.05	0.17
	37	0	20.16	29.06	77.55	36.87	0.12
	38	4.03	20.17	29.18	78.08	36.71	0.083
	39	179.5	20.17	29.22	77.27	36.73	0.15
October 2023	40	74	20.17	29.30	77.43	36.76	0.17
	41	0	20.16	29.22	77.43	36.82	0.161
	42	0	20.16	29.18	77.45	36.84	0.14
	43	0	20.16	29.17	77.49	36.82	0.15
November 2023	44	0	20.16	29.19	77.52	36.79	0.12
	45	4.01	20.16	29.20	77.52	36.78	0.07
	46	0	20.16	29.21	77.44	36.79	0.2
	47	0	20.16	29.21	77.46	36.80	0.23
December 2023	48	43.04	20.16	29.19	77.47	36.80	0.07
	49	3.01	20.16	29.29	77.47	36.80	0.11
	50	0	14.75	23.22	84.21	41.00	0.18
	51	0	14.67	26.00	70.28	42.00	0.20
	52	0	15.46	28.56	94.50	35.25	0.16
January 2024	1	0	12.77	26.28	91.00	57.00	0.22
	2	0	13.30	25.38	97.57	53.92	0.18
	3	0	11.95	25.31	85.78	52.35	0.19
	4	0	11.78	26.17	92.07	61.00	0.21

*Average of 30 plants per quadrat

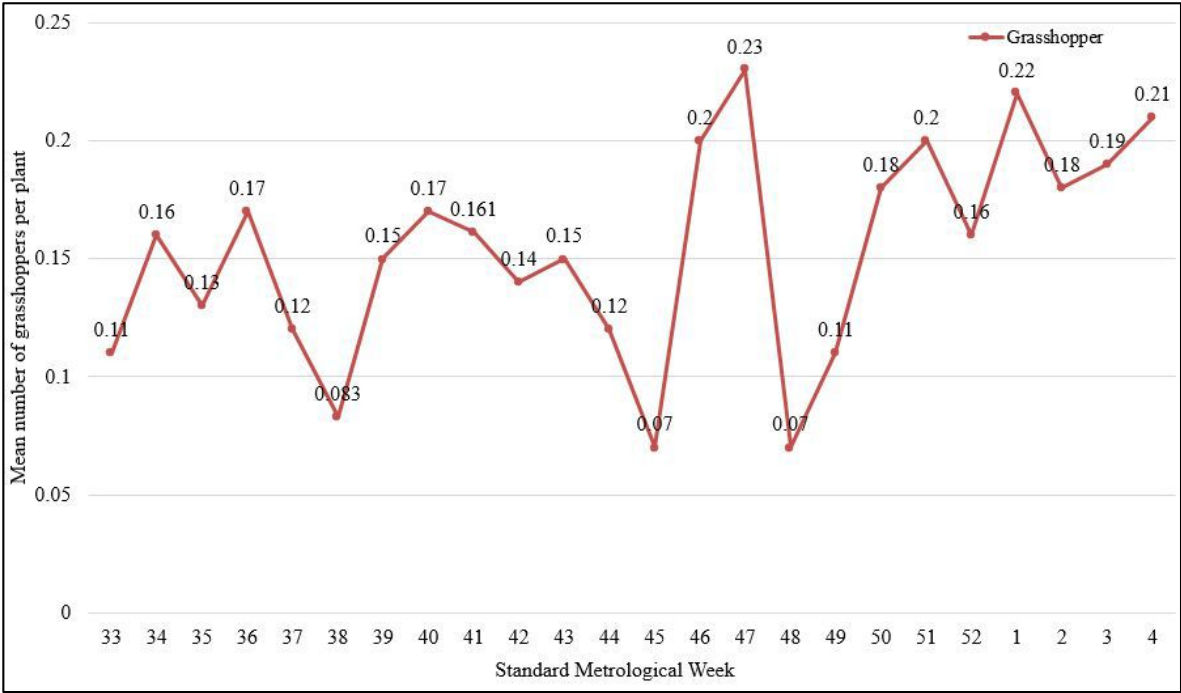


Fig 1: Population dynamics of grasshoppers on tuberose in relation to weather parameters during 2023-24

Table 2: Simple correlation of weather parameters with grasshoppers infesting tuberose

Weather parameter	Correlation coefficient ('r' values) grasshoppers
Rainfall (mm)	-0.072
Minimum temperature (°C)	-0.570*
Maximum temperature (°C)	-0.509*
Before noon relative humidity (percent)	0.353
Afternoon relative humidity (percent)	0.529*

N=24

*Significant at 5 percent

Regression studies

Weather based multiple linear regression model was developed in respect of incidence of grasshoppers (Y) as a

dependent variable and weather parameters (B1 to B5) as independent variables and presented in Table 3.

Table 3: Multiple regressions of weather parameters with grasshoppers on tuberose

Weather parameter	Regression coefficients (b)	SE (b)	T test	T table (0.05)
Rainfall (mm) (B1)	0.000	0.000	0.316	2.101
Minimum temperature (°C) (B2)	-0.009	0.010	-0.881	2.101
Maximum temperature (°C) (B3)	0.000	0.011	0.031	2.101
Before noon RH (percent) (B4)	-0.001	0.002	-0.607	2.101
Afternoon RH (percent) (B5)	0.001	0.003	0.368	2.101
Intercept (a) = 0.361 Coefficient of determination (R Square) = 0.347 Multiple Correlation Coefficient (R) = 0.589 Standard Error = 0.041				

The regression equation worked out is as follow.

$$Y = 0.361 + (0.000) \times B1 + (-0.009) \times B2 + (0.000) \times B3 + (-0.001) \times B4 + (0.001) \times B5 + 0.041$$

The regression equation revealed that various weather parameters had profound influence on the incidence of grasshoppers on tuberose. The coefficient of determination (R²) was 0.347, which designated that different weather parameters accounted 34.7 percent variability in the population of grasshoppers.

Conclusion

In conclusion, the study on the population dynamics of grasshoppers infesting tuberose revealed that grasshopper populations are most abundant during the 47th Standard Meteorological Week of 2023. The weather parameters significantly affect their population, with higher afternoon relative humidity promoting grasshopper populations, while increasing temperatures (both minimum and maximum) lead to a decrease in their numbers. Morning relative humidity and rainfall had limited or negligible effects on the grasshopper population. These findings highlight the importance of weather factors in grasshopper population dynamics and provide valuable insights for the development of effective pest management strategies in tuberose cultivation.

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