Seasonal correlation in prevalence of termite on wheat crops and weather parameters

Abstract

The field experiment were conducted at instructional farm, S.K.N. College of Agriculture, Jobner during *Rabi*, 2021-22 and 2022-23 to know the seasonal incidence of termite in wheat and their relation to weather parameters.The incidence of the termite in wheat field was observed throughout the crop season however, the maximum population of termite *i.e.* 88.20 and 98.68 per stickwas recorded in the second week of March and last week of February during *Rabi*, 2021-22 and 2022-23 respectively. The infestation of termite in wheat crop was recorded from seedling stage (50^{th} SMW) to till maturity stage (10^{th} SMW) which was ranged from 2.78 to 27.10 and 3.67 to 28.32 per cent plant damage during both the years of study. The termite population per stick and per cent plant damage by termite had significant positive correlation with maximum and minimum temperatures and evaporation during both the years while, with bright sunshine hours only during first year and non-significant correlation during second year. Whereas, with the morning and evening relative humidity it had significant negative correlation during both the years. The multiple linear regression (MLR) analysis explained that alone evaporation accounted about 84.60 and 92.70 per cent variation in termite population and 89.00 and 89.30 per cent variation in per cent plant damage by termite during both the years.

Keywords Termite, infestation, correlation, regression, wheat.

Introduction

Wheat [*Triticum aestivum* (L.) Em. Thell] belongs to family Gramineae, believed to have originated from South West Asia. It is second important staple food crop after rice. Its value in human diet, both as a source of carbohydrates and protein and its baking qualities make it comparatively more important crop other than cereal grains, which have provided daily nourishment for a large proportion of the world's population. Wheat grains provide characteristic substance "Gluten" which is very essential for bakers.It contains carbohydrate 78.10%, protein 14.70%, fat 2.10%, minerals 2.10% and considerable proportions of vitamins (thiamine and vitamin-B). It also provides 20 per cent of total calories for human (Kumar *et al*. 2011). In India it is cultivated in Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana, Bihar, Maharashtra and Gujarat. The area under wheat crop in India is 30.54 milion ha with the production of 106.41 million tonnes and productivity of 3484 kg per ha. Termites are most primitive social insects in the animal kingdom in order Isoptera and distributed in tropical and subtropical regions of the world. Termites damaged the seedlings by cutting either just below or above the soil surface. Patchy gaps are formed due to the death of seedlings resulting in poor or uneven plant stand. In mature plant, termites feed on root system and inside the stems, which directly kills the plant or indirectly lowers yield through decreased translocation of water and nutrients. Severely infested plants wilt, dry up and can be easily pulled up. At the earhead stage, the damage is characterized by chaffy earheads with little or no grain formation (Kumawat, 2001). The incidence of insect pests, nature and extent of damage to the crop are varied in different regions due to change in agro climatic condition. Weather parameters influence the life cycle, reproduction and outbreak of insects (Pedigo, 2004). Available scientific literature showed that not much information is available especially on seasonal incidence and influence of various weather parameters on the fluctuation of termite on wheat crop in semi-arid region of Rajasthan especially in *Rabi*,season. The study gives an idea about peak period of termite activity which may be helpful in developing management strategies and also find out the correlation matrix with weather parameters.

Material and Methods

For studying the effect of weather parameters on the incidence of termites the variety Raj-3077 was sown on 17th November, 2021 and 14th November, 2022 in the five separate plots. The size of the plot was kept of 3.0 m x 2.0 m with keeping row to row distance of 20 cm.

Method of observations

For recording observation on termites, 25 wooden sticks (about 5 cm diameter and 1 m length) were inserted in soil at the time of sowing at the depth of 15 cm in each plot. The termite was counted by observing each stick at weekly interval and again insert the sticks in soil (Gohil *et al*. 2018). The number of healthy and infested plants in each plot was also recorded at weekly interval from germination to maturity stage of the crop.The whole experimental plot was kept free from pesticide application. The percent damage plant was work out. The data on termite individuals and percent infested plant was correlated with meteorological parameters to know the role of abiotic factors on termite fluctuation.

Interpretation of data

To interpret the results of seasonal incidence of termite and percent infested plant were correlatedSimple correlation was computed between population of insect pests, percent infested plant and weather parameters (maximum and minimum temperatures, morning and evening relative humidity, evaporation and bright sunshine hours). The following formula was used for calculating correlation coefficient (Gupta, 1996).

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

Where,

r = Simple correlation coefficient

x = Independent variables *i.e*. abiotic components

y = Dependent variables *i.e*. pests

N = Number of observations

Results and Discussion

The population of the termite in wheat field was observed throughout the crop season which was ranged from 14.56 to 88.20 and 20.60 to 98.68 termite individuals per stick during *Rabi,* 2021-22 and *Rabi,* 2022-23, respectively. The maximum population of termite (88.20 and 98.68 per stick) was recorded in the second week of March and last week of February during both year of study, respectively at maturity stage of the crop, when the prevailing maximum temperature of 31.60^{0}C and 32.10^{0}C and minimum temperature of 9.80^{0}C and 12.00^{0}C, morning relative humidity of 68.00 and 77.00 per cent, evening relative humidity of 31.00 and 28.00 per cent, evaporation of 4.30 and 4.50 mm and bright sunshine of 7.70 hrs and 8.80 hrs, respectively.

The infestation of termite in wheat crop was recorded from 50th SMW (third week of December) to till crop maturity stage *i.e.* 10th SMW (second week of March) which ranged from 2.78 to 27.10 and 3.67 to 28.32 per cent plant damage during both the years of study, respectively. The initial damage of termite in wheat crop cause mortality of seedling by cutting either just below or above the soil surface and substantially feed on stem and tunnelled the stem. The infestation of termite was reached to maximum in the

10^{th} SMW (27.10 and 28.32 % plant damage) at crop maturity stage when 31.60^{0}C and 30.70^{0}C maximum temperature, 9.80^{0}C and 11.30^{0}C minimum temperature, 68.00 and 77.00 per cent morning relative humidity, 31.00 and 28.00 per cent evening relative humidity, 4.30 and 4.50 mm/day evaporation and 7.70 and 6.90 hrs bright sunshine hours during both the years respectively.

These results are in conformity with those of Gadhiya (2012) reported that termite activity was found higher in the end of December (52^{nd} SMW) to 2^{nd} week of March (10^{th} SMW). Further Kumar *et al.* (2020)[a] and Meena (2023) revealed that infestation of termite was recorded from the 4^{th} week after sowing to 13^{th} week after sowing in all the wheat fields also corroborate the present investigation. Veer *et al*. (2021) recorded minimum damaged plants due to termite during 45^{th} to 50^{th} and 1^{st} SMW and maximum was in 48^{th} SMW in chickpea crop. Further Choudhary *et al*., (2023) recorded the maximum population of termites in the last week of November to the first week of December. The termite population had significant positive correlation with maximum temperature (r= 0.798 and 0.831), minimum temperature (r= 0.630 and 0.813) and evaporation (r= 0.846 and 0.927) during both the years while, with bright sunshine hours showed significant positive correlation (r= 0.580) during *Rabi*, 2021-22 and non-significant correlation during *Rabi*, 2022-23. Whereas, the morning relative humidity (r= -0.771 and -0.570) and evening relative humidity (r= -0.576 and -0.586) had significant negative correlation with termite population during both the years. Likewise, the per cent damaged plants by termite had significant positive correlation with maximum temperature (r= 0.829 and 0.831), minimum temperature (r= 0.765 and 0.813) and evaporation (r= 0.889 and 0.927) during both the years, but bright sunshine hours (r= 0.684) had significant positive correlation during first year and non-significant correlation during second year. Whereas, the morning relative humidity (r= -825 and -0.570) and evening relative humidity (r= -574 and -0.586) showed significant negative correlation during both the years.

The present findings are conformity with those of Gadhiya (2012) andChannabasava and Borad (2019) reported that the evaporation was highly significant positively correlated with termite populations, whereas morning relative humidity had highly significant negative association with termite population. The maximum, minimum and mean temperatures had significantly positive relationship with termite incidence. The mean relative humidity had significant negative correlation with termite population support the present findings. Avinash and Kumar (2019) also reported positive correlation of termite with minimum temperature corroborate the findings. Choudhary *et al*. (2023) reported that population of termites had a significant positive correlation with both maximum and minimum temperatures whereas; a significant negative correlation with morning and evening relative humidity also corroborates the present findings.

The multiple linear regression (MLR) analysis explained 88.00 and 93.90 per cent variation in termite population due to combined contribution of all-weather parameters. While, alone evaporation accounted about 84.60 and 92.70 per cent variation in termite population which was found to have highest contribution in influencing the termite population among the other weather parameters during first and second year, respectively. The multiple linear regression (MLR) analysis explained 96.60 and 96.50 per cent variation in per cent plant damage due to combined contribution of all-weather parameters. While, alone evaporation accounted about 89.00 and 89.30 per cent variation in per cent plant damage which was found to have highest contribution in influencing the termite infestation among the other weather parameters during first and second year, respectively.

Conclusion

The important conclusions drawn from present investigation made on seasonal incidence of termite in wheat and their relation to weather parameters.The maximum population of termite (88.20 and 98.68 per stick) was recorded in the second week of March and last week of February during *Rabi*, 2021-22 and 2022-23, respectively. The incidence of termite in wheat crop was recorded throughout the crop season during both the years of study. The termite population per stick and percent plant damage by termite had significant positive correlation with maximum and minimum temperatures and evaporation during both the years while, with bright sunshine hours only during first year. Whereas, with the morning and evening relative humidity it had significant negative correlation during both the years. The multiple linear regression (MLR) analysis explained that alone evaporation accounted about 84.60 and 92.70 per cent variation in termite population and 89.00 and 89.30 per cent variation in per cent plant damage during both the years, respectively.

Table 1 Seasonal incidence of termite in wheat crop and their relation with weather parameters during *Rabi,* 2021-22

Standard Meteorological Weeks (SMW)	Date of Observations	Number of termites/ stick	Termite damaged plants (%)	Temperature (^{0}C)		Relative Humidity (%)		Evaporation (mm)	Bright sunshine (hrs)
				Maximum	Minimum	Morning	Evening		
50	15-12-2021	14.56	2.78	22.90	3.60	78	42	2.30	6.70
51	22-12-2021	28.12	4.60	22.40	-0.30	82	29	2.40	7.50
52	29-12-2021	38.20	6.87	22.70	6.00	85	46	2.30	3.80
1	05-01-2022	16.40	7.64	20.30	6.10	87	60	2.00	4.10
2	12-01-2022	13.16	8.10	17.30	4.50	85	52	2.00	5.00

3	19-01-2022	32.80	9.17	18.90	3.90	80	50	2.30	6.00
4	26-01-2022	47.24	11.08	18.90	3.40	80	52	2.30	6.30
5	02-02-2022	50.16	12.60	23.50	4.10	74	48	3.90	8.60
6	09-02-2022	46.32	15.49	23.50	5.10	74	42	2.90	8.90
7	16-02-2022	48.20	18.43	26.30	4.70	66	35	3.80	9.70
8	23-02-2022	56.16	21.34	29.00	7.40	73	30	4.00	9.00
9	02-03-2022	60.24	24.12	30.10	8.00	69	29	4.30	9.30
10	09-03-2022	88.20	27.10	31.60	9.80	68	31	4.30	7.70

Table 2Seasonal incidence of termite in wheat crop and their relation with weather parameters during *Rabi*, 2022-23

Standard Meteorological Weeks (SMW)	Date of Observations	Number of termites/ stick	Termite damaged plants (%)	Temperature (^{0}C)		Relative Humidity (%)		Evaporation (mm)	Bright sunshine (hrs)
				Maximum	Minimum	Morning	Evening		
50	12-12-2022	20.60	3.67	26.50	4.60	75	33	2.20	8.90
51	19-12-2022	42.16	5.43	25.50	4.60	79	37	2.40	8.10
52	26-12-2022	53.28	7.80	23.30	2.20	79	30	2.20	7.90

1	02-01-2023	25.08	8.92	20.70	-1.00	82	40	2.00	7.50
2	09-01-2023	36.20	11.08	24.50	4.90	75	35	2.70	7.30
3	16-01-2023	32.80	12.78	20.10	-0.50	77	33	2.60	8.30
4	23-01-2023	40.12	15.79	21.30	3.60	80	42	2.80	4.10
5	30-01-2023	44.24	16.78	22.00	5.20	83	54	3.10	7.30
6	06-02-2023	53.16	18.55	26.90	6.90	82	31	4.10	9.00
7	13-02-2023	78.20	20.70	28.40	5.80	76	26	5.20	9.40
8	20-02-2023	92.36	23.67	31.90	9.80	73	25	5.40	8.60
9	27-02-2023	98.68	25.62	32.10	12.00	70	28	5.30	8.80
10	06-03-2023	75.60	28.32	30.70	11.30	77	28	4.50	6.90

Table 3 Multiple regression models developed for termite during *Rabi*,2021-22

	Regression equation (Y=a+bX)	R^2 Value
Termite population	$Y=184.16^a+(-1.18)T_{max}+(0.90)T_{min}+(-1.51)RH_{mor}+(-0.46)RH_{eve}+(19.13)E+(-5.69)Bs$	0.880
	$Y=-47.52^a+(3.77)T_{max}$	0.798
	$Y=14.37^a+(5.32)T_{min}$	0.630
	$Y=223.23^a+(-2.36)RH_{mor}$	0.772
	$Y=90.76^a+(-1.17)RH_{eve}$	0.576
	$Y=-16.40^a+(19.41)E$	0.846
	$Y=-2.29^a+(6.15)Bs$	0.580
Percent plant damage	$Y=37.98^a+(-1.31)T_{max}+(2.47)T_{min}+(-1.52)RH_{mor}+(-0.32)RH_{eve}+(4.12)E+(0.881)Bs$	0.966
	$Y=-20.73^a+(1.43)T_{max}$	0.829
	$Y=0.10^a+(2.36)T_{min}$	0.765
	$Y=83.90^a+(-0.92)RH_{mor}$	0.825
	$Y=30.93^a+(-0.43)RH_{eve}$	0.574
	$Y=-9.20^a+(7.45)E$	0.890
	$Y=-494^a+(-2.52)Bs$	0.652

Table 4. Multiple regression models developed for termite during *Rabi*, 2022-23

	Regression equation (Y=a+bX)	R^2 Value
Termite population	$Y=43.00^a+(0.16)T_{max}+(0.76)T_{min}+(-1.32)RH_{mor}+(-0.34)RH_{eve}+(14.62)E+(-1.47)Bs$	0.939
	$Y=-75.54^a+(5.02)T_{max}$	0.831
	$Y=25.77^a+(5.15)T_{min}$	0.813
	$Y=347.34^a+(-3.79)RH_{mor}$	0.570
	$Y=116.83^a+(-1.87)RH_{eve}$	0.587
	$Y=-8.89^a+(18.16)E$	0.927
	$Y=-11.97^a+(5.26)Bs$	0.283
Percent plant	$Y=31.38^a+(-1.73)T_{max}+(1.50)T_{min}+(0.19)RH_{mor}+(-0.24)RH_{eve}+(6.13)E_v+(-0.87)Bs$	0.965
	$Y=-15.89^a+(1.22)T_{max}$	0.647

damage	$Y=7.30^{a}+ (1.50)\ T_{min}$	0.762
	$Y=68.84^{a}+ (-0.69)\ RH_{mor}$	0.334
	$Y=27.17^{a}+ (-0.35)\ RH_{eve}$	0.351
	$Y=-3.31^{a}+ (5.44)\ E$	0.893
	$Y=14.78^{a}+ (0.07)\ Bs$	0.012

S. No.	**Weather parameters**	***Rabi*, 2021-22**		***Rabi*, 2022-23**	
		Termite population	**Plant damage (%)**	**Termite population**	**Plant damage (%)**
1.	Maximum Temperature ^{0}C	0.798**	0.829**	0.831**	0.647*
2.	Minimum Temperature ^{0}C	0.630*	0.765**	0.813**	0.761**
3.	Morning Relative Humidity(%)	-0.772**	-0.825**	-0.570*	-0.333
4.	Evening Relative Humidity(%)	-0.576*	-0.574*	-0.586*	-0.351
5.	Evaporation(mm)	0.846**	0.890**	0.927**	0.893**
6.	Bright Sunshine Hours (hrs)	0.580*	0.652*	-	0.012

** Correlation is significant at the 0.01 level
 * Correlation is significant at the 0.05 level

Table 5 Correlation coefficient between termite population and weather parameters in wheat crop during *Rabi,* 2021-22 and 2022-23

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