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Screening of turmeric genotypes against shoot borer, *Conogethes punctiferalis*

Damini Karde, AK Sadawarte, VS Kale, SS Lande and Swati Sant

Abstract
The present investigation entitled "Screening of Turmeric genotypes against shoot borer, *Conogethes punctiferalis*" was carried out at Instructional farm, Department of Vegeteble Science, Dr. PDKV, Akola during 2020-21. A field experiment was carried out to find out the promising genotype against shoot borer i. e. *Conogethes punctiferalis*. A set of 24 genotypes used for experiment *viz*. PWTM-1, PWTM-3, PWTM-4, PWTM-5, PWTM-6, PWTM-8, PWTM-9, PWTM-10, PWTM-11, PWTM-14, PWTM-19, AKTL-3, AKTL-8, AKTL-10, AKTL-11, AKTL-12, AKTL-13, AKTL-16, AKTL-18, AKTL-19, PDKV Waigaon, PTS-10, Salem, Pragati were obtained from Department of Vegetable Science, Dr. PDKV, Akola during 2020-21. The results revealed that out of 24 genotypes evaluated the minimum per cent of infestation was noticed in three genotypes, i. e. PWTM-9 (0.9%), AKTL-12 (2.3%), AKTL-11 (3.2%). Overall mean per cent of shoot infestation recorded was varied from 0.9 per cent in PWTM-14 to 15.8 per cent in PWTM-9. Among the 24 genotypes Twenty-one genotypes registered 0.10- 12.50 per cent shoot infestation was graded as moderately resistant and remaining three genotypes showed 12.60- 17.10 per cent shoot infestation were placed under moderately susceptible category. None of the genotype were found highly resistant, susceptible and highly susceptible. In the correlation study of weather parameters with infestation of Turmeric shoot borer no significant correlation was observed with any weather parameters. Correlation study of mean infestation with morphological characters i.e. plant height, number of tillers and yield showed no significant correlation whereas leaf lamina showed negatively significant correlation.

Keywords: Turmeric, shoot borer, *Conogethes punctiferalis*, screening, genotype

Introduction
Turmeric (*Curcuma longa* L.) the golden spice of India is one of the most essential spices which is used as an important gradient culinary all over the world. It is multipurpose crop valued for its medical purposes, colouring, pigment and spicy flavour. It is also called as "yellow gold", "India saffron" and the "golden spice" of life. Turmeric is a member of the curcuma botanical group, which is a part of Ginger family of herbs, the "zingiberaceae". Its botanical name is *curcuma longa.* Turmeric is a rhizomatous herbaceous perennial plant, the root of which is used in cooking. India is known as "Home of spices" and "Spice bowl of the world". India is the largest producer, consumer and exporter of turmeric in the world and accounts for 80% of world's turmeric production and 60% of world export.

Maharashtra is one of the important states in turmeric production. In Maharashtra about 190.9 thousand hectares of cultivation area under turmeric crop and produce 96.60 thousand tons of turmeric. The district growing turmeric in Maharashtra are mainly Satara, Sangali, Kolhapur, Hingoli, Parbhani, Nanded and some part of Vidarbha region. The total area under turmeric is 720 ha in Akola district. The insect pest is one of the major causes of the low production of turmeric. Insect pests which attack turmeric are shoot borer (*Conogethes punctiferalis* L.), leaf roller (*Udaspes folus*), rhizome scale (*Aspidiella hartii*), lace wing bug (*Staphanitis typicus*), bihar hairy caterpillar (*Diacrisia abliqua*), rhizome fly (*Mimegralla coeruleifrons*). But the most common pest which attack turmeric is shoot borer i.e. *Conogethes punctiferalis.* Turmeric shoot borer is the most important serious pest of turmeric and it was first recorded by fletcher in 1914. Crop loss due to shoot borer is when 50% of the pseudostem in a clump was affected, there was a reduction of 38 g of yield per clump. (Fletcher 1914). The present investigation was carried out to evaluate different genotypes of turmeric that will help to find out promising genotype against the most important and serious pest i.e., shoot borer.

Material and Methods

Turmeric genotypes

The experiment was carried out at Instructional Farm, Department of Vegetable Science, Dr. P. D. K. V. Akola. The basic material for the study consisted of 24 genotypes of turmeric obtained from Department of Vegetable Science of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. A set of 24 genotypes of turmeric were sown in Randomized Block Design in plot size 2m x 1m on 10th June 2020 at Instructional Farm of Vegetable Science at 40cm x 25cm apart. All the agronomic practices were adopted for raising the good crop.

Observations

The infestation of shoot borer was recorded on ten randomly selected plants of each genotype at fortnightly intervals initiated from the first fortnight of August up to second fortnight of November. Observations on the number of healthy and damaged pseudo stems as characterized by the presence of bore- holes was recorded in each clump. The genotypes were screened against the turmeric shoot borer and categorized based on infestation level as per following table

Table 1: Categorization of turmeric genotypes against shoot borer

Sr. No.	Category of resistance	Range of shoot damage (%)
1	Highly resistant	0
2	Moderately resistant	0.10-12.50
3	Moderately susceptible	12.60-17.10
4	Susceptible	17.20-21.80
5	Highly susceptible	›21.80

The observation of morphological characters was recorded from five randomly selected plants from each plot in each replication for different morphological characters *viz*. plant height (cm), no. of tillers and leaf lamina (cm^2) at 160 DAP.

Statistical Analysis

Data on mean infestation and morphological characters of turmeric was correlated with meteorological parameters to establish correlation between shoot borer infestation and individual weather parameter, morphological characters. Similarly, the data recorded on mean infestation and morphological character were subjected to statistical analysis by following standard procedures of RBD experiment.

Results and Discussion

Infestation of shoot borer during first fortnight of August

The observation of infestation of shoot borer on each genotype at fortnightly interval was initiated from the first fortnight of August. In the first fortnight of August among the 24 genotypes percent shoot damage was maximum in 3 genotypes *viz*. AKTL-13 (4.61%), AKTL-18 (4.41) and AKTL-8 (4.0%). Nine genotypes had percent shoot damage is more than 2 er cent, namely PWTM-11 (3.66%), PWTM- 9 (3.27%), PWTM-5 (3.17%), PWTM-8 (3.03%), AKTL-10 (2.98%), PTS-10 (2.98%), AKTL-16 (2.70%), PWTM-3 (2.56%), Pragati (2.53%). Other 8 genotypes had minimum infestation more than 1 per cent *viz*. AKTL- 19 (1.72%), Salem (1.66%), PWTM- 10 (1.44%), PWTM- 1 (1.42%), PWTM- 6 (1.42%), AKTL-3 (1.40%), PWTM- 4 (1.38%) and PWTM-19 (1.33%). Remaining four genotypes had no infestation of shoot borer in first fortnight of August i.e. PWTM- 14, AKTL- 11, AKTL- 12 and PDKV Waigaon respectively.

Infestation of shoot borer during second fortnight of August

The infestation of shoot borer started increasing steadily in the second fortnight of August. Out of 24 genotypes shoot borer infestation was maximum in 5 genotypes *viz*. AKTL- 13 (9.30%), AKTL- 18 (8.33%), PWTM- 8 (8.00), PWTM- 11 (7.41%), PWTM- 9 (7.08%) in second fortnight of August. Eight genotypes had percent shoot damage more than 4 per cent, namely AKTL- 8 (6.64%), AKTL- 10 (6.41%), Pragati (5.26%), Salem (4.65%), PWTM- 1 (4.61%), PWTM- 5 (4.20%), PWTM- 10 (4.10%), PWTM- 3 (4.00%). Seven varieties had infestation in the range of 2.40- 3.89 per cent *viz*. PWTM- 19 (3.89%), PWTM- 6 (3.84%), AKTL- 3 (3.84%), AKTL-19 (3.65%), PTS- 10 (3.48%), AKTL- 16 (3.40%), PWTM- 4 (2.40%). Two varieties had less infestation i.e. PDKV Waigaon (1.17%), AKTL- 11 (0.87%). Remaining two genotypes had no infestation of shoot borer namely PWTM-14 and AKTL-11 in the second fortnight of August.

Infestation of shoot borer during first fortnight of September

Out of 24 genotypes evaluated only four genotypes had maximum infestation of shoot borer i.e. AKTL- 18 (16.66%), PWTM- 8 (14.66%), AKTL-13 (10.71%), PWTM 9 (10.45%). Ten genotypes had percent shoot damage more than 7 per cent and less than 10.45% namely Salem (9.09%), PWTM- 3 (8.92%), PWTM- 11 (8.64%), PWTM- 19 (8.27%), AKTL-19 (8.24%), AKTL- 3 (8.19%), AKTL- 16 (8.03%), AKTL- 8 (7.32%), PWTM- 1 (7.08%), PWTM -10 (7.08%). Seven genotypes had infestation in the range of 4.09- 6.81 per cent *viz*. AKTL- 10 (6.81%), Pragati (6.55%), PWTM- 5 (6.25%), PWTM- 6 (5.73%), PWTM- 4 (4.91%), PDKV Waigaon (4.23%), PTS-10 (4.09%). Only three genotypes had least infestation i.e. AKTL- 12 (2.54%), AKTL-11 (1.60%) and PWTM- 14 (0.16%).

Infestation of shoot borer during second fortnight of September

In the second fortnight the infestation was increased more rapidly. Among the 24 genotypes evaluated three genotypes had maximum infestation i.e. PWTM-9 (28.20%), PWTM- 8 (26.32%) and AKTL- 18 (25.28%). Seven genotypes had percent shoot damage in the range of 13.03 -18.20 per cent namely PWTM-1 (18.20%), AKTL-13 (17.24%), PWTM- 10 (16.66%), AKTL- 8 (15.99%), AKTL- 16 (14.66), AKTL- 10 (13.79%) and AKTL- 3 (13.03%). Seven genotypes had infestation in the range 10.24- 12.58 per cent *viz*. PWTM- 19 (12.58%), AKTL- 19 (12.34%), PWTM- 11 (12.32%), Salem (12.32%), PWTM- 3 (12.30%), PWTM- 5 (10.32%) and Pragati (10.24%). Four genotypes had infestation in the range of 8.34- 7.24 per cent i.e. PWTM- 4 (8.34%), PTS-10 (8.24%), PWTM- 4 (8.03%) and PDKV Waigaon (7.24%). Three genotypes had minimum infestation namely AKTL- 12 (3.82%), AKTL-11 (3.62%) and PWTM- 14 (1.20%).

Table 2: Evaluation of turmeric genotypes against shoot borer during kharif 2020

Sr. No.	Genotypes	Percent shoot damage								Mean
		1st fn of Aug	2nd fn of Aug	1st fn of Sept	2nd fn of Sept	1st fn of Oct	2nd fn of Oct	1st fn of Nov	2nd fn of Nov	
1	PWTM-1	1.42	4.61	7.08	18.20	16.23	10.20	7.36	6.90	9.0
2	PWTM-3	2.56	4.00	8.92	12.30	12.92	11.36	8.24	8.36	8.6
3	PWTM-4	1.38	2.40	4.91	8.34	7.52	6.36	4.36	2.20	4.7
4	PWTM-5	3.17	4.20	6.25	10.32	8.72	7.92	6.54	4.86	6.5
5	PWTM-6	1.42	3.84	5.73	8.03	12.36	9.57	8.28	5.36	6.8
6	PWTM-8	3.03	8.00	14.66	26.32	18.32	16.34	14.82	12.32	14.2
7	PWTM-9	3.27	7.08	10.45	28.20	22.42	20.34	18.26	16.42	15.8
8	PWTM-10	1.44	4.10	7.08	16.66	18.32	16.32	12.33	10.20	10.8
9	PWTM-11	3.66	7.41	8.64	12.32	11.24	9.36	8.56	5.36	8.2
10	PWTM-14	0.0	0.0	0.16	1.20	2.19	1.12	1.51	1.30	0.9
11	PWTM-19	1.33	3.89	8.27	12.58	10.42	9.36	7.24	6.52	7.5
12	AKTL-3	1.40	3.84	8.19	13.03	12.36	11.20	9.54	8.36	8.5
13	AKTL-8	4.00	6.64	7.32	15.99	11.11	10.56	8.32	6.36	8.8
14	AKTL-10	2.98	6.41	6.81	13.79	10.35	9.36	7.24	6.82	8.0
15	AKTL-11	0.0	0.0	1.60	3.62	6.45	5.80	4.82	3.44	3.2
16	AKTL-12	0.0	0.87	2.54	3.82	4.36	3.20	2.51	1.32	2.3
17	AKTL-13	4.61	9.30	10.71	17.24	15.32	12.15	10.24	8.36	11.0
18	AKTL-16	2.70	3.40	8.03	14.66	12.32	11.20	9.24	7.24	8.6
19	AKTL-18	4.41	8.33	16.66	25.28	21.36	18.35	15.36	12.05	15.2
20	AKTL-19	1.72	3.65	8.24	12.34	9.32	6.36	5.24	4.26	6.4
21	PDKV Waigaon	0.0	1.17	4.23	7.42	5.72	6.30	4.36	3.20	4.1
22	PTS-10	2.98	3.48	4.09	8.24	7.56	5.36	4.16	3.06	4.9
23	Salem	1.66	4.65	9.09	12.32	10.62	6.32	4.26	3.36	6.5
24	Pragati	2.53	5.26	6.55	10.24	8.92	6.32	5.32	2.32	5.9

Infestation of shoot borer during the first fortnight of October

Infestation of shoot borer in the first fortnight of October was less as compared to second fortnight of September. Out of 24 genotypes evaluated six genotypes had infestation in the range of 15.32- 22.42 per cent i.e. PWTM -9 (22.42%), AKTL- 18 (21.36%), PWTM-8(18.32%), PWTM- 10 (18.32%), PWTM-1 (16.23%), AKTL-13 (15.32%). Nine genotypes had percent shoot damage in the range of 10.35- 12.92 per cent namely PWTM- 3 (12.92%), PWTM- 6 (12.36%), AKTL- 3 (12.36%), AKTL- 16 (12.32%), PWTM- 11(11.24%), AKTL-8 (11.11%), Salem (10.62%), PWTM- 19 (10.42%) and AKTL- 10 (10.35%). Six genotypes had percent shoot damage in the range of 6.45- 9.32 per cent *viz*. AKTL- 19 (9.32%), Pragati (8.92%), PWTM- 5 (8.72%), PTS- 10 (7.56%), PWTM- 4 (7.52%), AKTL- 11 (6.45%). Three genotypes had least infestation PDKV Waigaon (5.72%), AKTL- 12 (4.36%) And PWTM- 14 (2.19%).

Infestation of shoot borer during second fortnight of October

Infestation got decreased from second fortnight of October it was comparatively less than first fortnight of October. From the 24 genotypes observed four genotypes had infested in the range of 16.32- 20.34 per cent i.e. PWTM- 9 (20.34%), AKTL- 18 (18.35%), PWTM- 8 (16.34%) and PWTM- 10 (16.32%). Six genotypes had percent shoot damage in the range of 10.20- 12.15 per cent namely AKTL-13 (12.15), PWTM- 3 (11.36%), AKTL- 3 (11.20%), AKTL- 16 (11.20%), AKTL- 8 (10.56%) and PWTM- 1 (10.20%). Ten genotypes had percent shoot damage in the range of 6.30-9.57 per cent *viz*. PWTM- 6 (9.57%), PWTM- 11 (9.36%), PWTM- 19 (9.36%), AKTL- 10 (9.36%), PWTM- 5 (7.92%), PWTM- 4 (6.36%), AKTL- 19 (6.36%), Salem (6.32%), Pragati (6.32%) and PDKV Waigaon (6.30%). Four genotypes had infestation in the range of 1.12- 5.80 per cent i.e. AKTL- 11 (5.80%), PTS- 10 (5.36%), AKTL- 12 (3.20%) and PWTM- 14 (1.12%).

Infestation of shoot borer during first fortnight of November

In the first fortnight of November the infestation got decreased as compared to second fortnight of October. Only five genotypes had infestation in the range of 10.24- 18.26 per cent i.e. PWTM- 9 (18.26%), AKTL-18 (15.36%), PWTM- 8 (14.82%), PWTM-10 (12.33%) and AKTL-13 (10.24%). Ten genotypes had percent shoot damage in the range of 6.54-9.54 per cent namely AKTL- 3 (9.54%), AKTL-16 (9.24%), PWTM- 11 (8.56%), AKTL- 8 (8.32%), PWTM- 6 (8.28%), PWTM- 3 (8.24%), PWTM-1 (7.36%), PWTM-19 (7.24%), AKTL- 10 (7.24%) and PWTM- 5 (6.54%). Seven genotypes had infestation in range of 4.16- 5.32 per cent Pragati (5.32%), AKTL-19 (5.24%), AKTL- 11 (4.82%), PWTM- 4 (4.36%), PDKV Waigaon (4.36%), Salem (4.26%) and PTS-10 (4.16%). Only two genotypes had very low infestation i.e. AKTL-12 (2.51%) and PWTM-14 (1.51%).

Infestation of shoot borer during second fortnight of November

In second fortnight of November the infestation was very less. From the 24 genotypes evaluated only three genotypes had maximum infestation i.e. PWTM-9 (16.42%), PWTM-8 (12.32%) and AKTL- 18 (12.05%). Nine genotypes got infested in the range of 6.36- 10.20 per cent *viz*. PWTM- 10 (10.20%), PWTM- 3 (8.36%), AKTL- 3 (8.36%), AKTL-13 (8.36%), AKTL-16 (7.24%), PWTM-1 (6.90%), AKTL-10 (6.82%), PWTM- 19 (6.52%) and AKTL- 8 (6.36%). Eight genotypes had percent shoot damage in the range of 3.06-5.36 per cent namely PWTM-6 (5.36%), PWTM- 11 (5.36%), PWTM- 5 (4.86%), AKTL- 19 (4.26), AKTL- 11 (3.44%), Salem (3.36%), PDKV Waigaon (3.20%) and PTS-10 (3.06%). Four genotypes had very less infestation i.e. Pragati (2.32%), PWTM- 4 (2.20%), AKTL- 12 (1.32%) and PWTM-14 (1.30%).

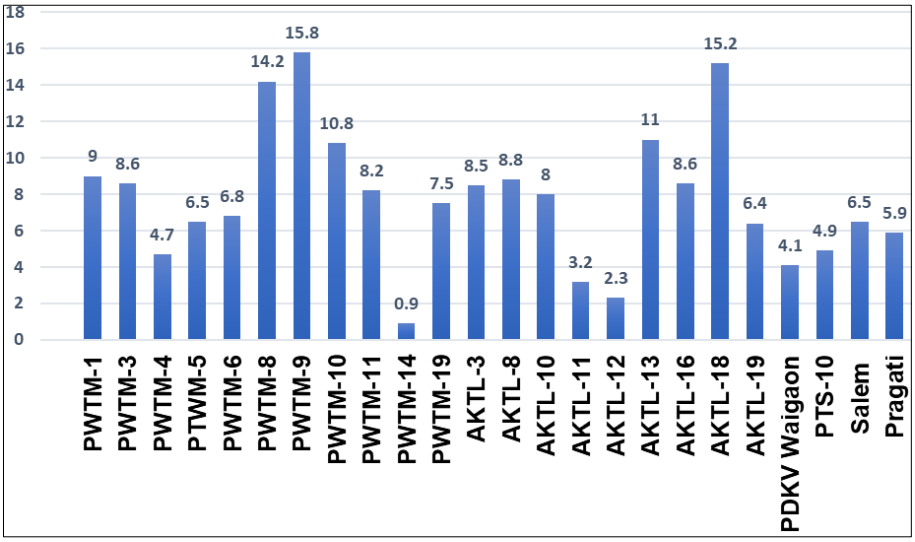

Fig 1: Mean in festationon shoot borer on each genotype

Mean per cent of Shoot borer infestation

Overall mean per cent of shoot infestation recorded during the experimental period of 24 genotypes evaluated from 1st fortnight of August to 2nd fortnight of November varied from 0.9 per cent to 15.8 per cent *viz*. PWTM-14 (0.9%), AKTL-12 (2.3%), AKTL-11 (3.2%), PDKV Waigaon (4.1%), PWTM-4 (4.7%), PTS-10 (4.9%), Pragati (5.9%), AKTL-19 (6.4%), PWTM-5 (6.5%), Salem (6.5%), PWTM-6 (6.8%), PWTM-19 (7.5%), AKTL-10 (8.0%), PWTM-11 (8.2%), AKTL-3 (8.5%), PWTM- 3 (8.6%), AKTL-16 (8.6%), AKTL-8 (8.8%), PWTM-1 (9.0%), PWTM-10 (10.8%), AKTL-13 (11.0%), PWTM-8 (14.2%), AKTL-18 (15.2%), PWTM-9 (15.8%). Out of 24 genotypes evaluated the minimum per cent of infestation was noticed in three genotypes, i.e. PWTM-9 (0.9%), AKTL-12 (2.3%), AKTL-11 (3.2%).

Identification of promising turmeric genotype against shoot borer

On the basis of per cent shoot infestation, 24 genotypes evaluated against the turmeric shoot borer were grouped into five categories (Table 1). Twenty-one genotypes registering 0.10- 12.50 per cent shoot infestation was graded as moderately resistant *viz*. PWTM-1, PWTM-3, PWTM-4, PWTM-5, PWTM-6, PWTM-10, PWTM-11, PWTM-14, PWTM-19, AKTL-3, AKTL-8, AKTL-10, AKTL-11, AKTL-12, AKTL-13, AKTL-16, AKTL-19, PDKV Waigaon, PTS-10, Salem, Pragati. Three genotypes showed 12.60- 17.10 per cent shoot infestation were placed under moderately resistant category *viz*. PWTM-8, PWTM-9, AKTL-18 None of the genotype were found highly resistant, susceptible and highly susceptible.

Table 3: Identification of promising turmeric genotype against shoot borer during kharif, 2020

Sr. No	Category of resistance	Range of shoot damage (%)	No. of genotype	Genotype identified
1	Highly resistant	0	0	0
2	Moderately resistant	0.10-12.50	21	PWTM-1, PWTM-3, PWTM-4, PWTM-5, PWTM-6, PWTM-10, PWTM-11, PWTM-14, PWTM-19, AKTL-3, AKTL-8, AKTL-10, AKTL-11, AKTL-12, AKTL-13, AKTL-16, AKTL-19, PDKV Waigaon, PTS-10, Salem, Pragati
3	Moderately susceptible	12.60-17.10	3	PWTM-8, PWTM-9, AKTL-18
4	Susceptible	17.20-21.80	0	0
5	Highly susceptible	> 21.80	0	0

The above results are in confirmation of with the studies of Kotikal and Kulkarni (1999) [7] who observed the reaction of eight selected turmeric genotypes to Shoot borer. From the eight genotypes four genotypes *viz*. BSR-1, CO-1, Cuddapah and Salem emerged as a tolerant and better yielder compared to other genotypes and were found superior over local variety under pesticide free conditions. However, none of the genotype was found to be resistant to the pests as they suffered more than 10 percent damage by pest.

Velayudhan and Liji (2003) [9] done the preliminary screening of 489 indigenous collections of turmeric against shoot borer. The lowest incidence of shoot borer (mean score 2) was observed in morphotype 2 followed by 2.6 in morphotype 14. Eighty accessions were susceptible to shoot borer. A total of 22 accessions were tolerant to shoot borer with <3 score.

Similarly, Devasahayam *et.al* (2011) [3] conducted screening of nine hundred and fifteen turmeric germplasm for resistant to shoot borer. Rating of germplasm in relation to the level of pest infestation indicated that none of the accessions was rated as resistant, whereas, 34, 412, 456 and 13 accessions were rated as moderately resistant, moderately susceptible, susceptible and highly susceptible, respectively, to the pest. conducted screening of turmeric genotypes against shoot borer. Out of twenty genotypes on turmeric screening against the shoot borer none was found resistant. Eleven genotypes were rated as moderately resistant, three as moderately susceptible, five as susceptible and only one as highly susceptible.

Effect of some weather parameter on incidence of shoot borer in turmeric genotypes

The meteorological data as regard to temperature (maximum

and minimum), relative humidity (morning and evening) and rainfall were obtained from Meteorological observatory of Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

The mean shoot borer infestation of present fortnight is corelated with previous fortnight weather parameters of 24 genotypes and is presented in Table 2. The data revealed that in the first fortnight of august 2.15% infestation was observed, when the maximum and minimum temperature were 31.8 and 23.5 ^{0}C, respectively and the relative humidity was 87 per cent in morning and 65 per cent in evening with rainfall 55.3 mm. However, the infestation started increasing from 2nd fortnight of August, when the maximum temperature was 31.2 and minimum temperature was 23.4 ^{0}C. The relative humidity during this period was 86 per cent in the morning and 69 per cent in the evening with rainfall 23.7 mm. Further when the population attained peak during 1st fortnight of September, maximum temperature was 28.9 and minimum temperature was 22.2 ^{0}C, the relative humidity during this period was 88 per cent and 75 per cent in the morning and evening, respectively. The rainfall recorded during this fortnight 56.6 mm.

Table 4: Effect of some weather parameter on incidence of shoot borer in turmeric genotypes

Fortnightly Interval	Mean Infestation (%)	Temperature		Relative Humidity		Rainfall (mm)
		Maximum	Minimum	RH I	RH II	
1st fn of August	2.15	31.8	23.5	87	65	55.3
2nd fn of August	4.43	31.2	23.4	86	69	23.7
1st fn of September	7.34	28.9	22.2	88	75	56.6
2nd fn of September	13.01	33.4	22.5	88	56	21.5
1st fn of October	11.51	32.4	21.5	88	61	47.6
2nd fn of October	9.61	33.1	21.3	86	53	14.2
1st fn of November	6.66	33.1	19.3	87	47	17.8
2nd fn of November	6.24	32.4	10.7	82	28	0

The infestation was increased rapidly in the 2nd fortnight of September, when maximum temperature was 33.4 and minimum temperature was 22.5 ^{0}C. The relative humidity was 88 per cent in the morning and 57 per cent in the evening with rainfall 21.5 mm.

However, the infestation started declining from 1st fortnight of October, when the maximum and minimum temperature was 32.4 and 21.5 ^{0}C respectively. The relative humidity in this period was 88 per cent in the morning and 61 per cent in the evening with rainfall 47.6 mm. The trend of declining infestation was continued up to 2nd fortnight of November when the maximum and minimum temperature was 32.4 and 10.7^{0}C. The relative humidity during this period was 82 per cent in the morning and 28 per cent in the evening with no rainfall. It can be concluded that the borers population was observed in all 24 genotypes during the entire experimental period.

Correlation co-efficient between borers and abiotic factors (weather parameters)

The result of simple correlation co-efficient (r) worked out between mean infestation and abiotic factors are presented in Table 5. Statistical analysis of the data showed that maximum and minimum temperature were positively correlated with borer infestation but statistically non- significant (r=0.384, 0.0452). Relationship between morning humidity and percent shoot damage were positively correlated but statistically non-significant (r=0.338). The relationship of evening humidity and rainfall with percent shoot infestation were negatively correlated and statistically non- significant (r= -0.095, -0.154).

Table 5: Correlation between weather parameter and shoot borer infestation of turmeric genotypes

	Temperature		Relative Humidity		Rainfall (mm)
	Maximum	Minimum	RH I	RH II	
Mean Infestation (%)	0.38424	0.045274	0.338394	-0.09517	-0.154021

Table r Value= 0.707

The correlation co-efficient between shoot borer infestation and abiotic factors showed that none of the weather parameters namely temperature (maximum and minimum), relative humidity (morning and evening) and rainfall was found significantly correlated with shoot borer infestation.

The references on correlation of weather parameters with shoot borer incidences on turmeric crop are not available hances references on other crops were discussed here. The above results are differing with results of others it may be due to differences in crops, weather situation in different geographical area and also due to only one season results. Basavaraj *et al.* (2013) [2] studied the effect of weather parameters on incidence of caster shoot and capsule borer. Caster shoot and capsule borer population was significantly negatively correlated (-0.80*) only with maximum temperature of same fortnight. Whereas correlation of larval population with weather parameters of one fortnight before was significantly positively correlated with morning relative humidity (0.60*) and evening relative humidity (0.75*). But correlation of larval population with any weather parameters of two fortnights before was non-significant.

Similarly, observed the influence of weather parameters on the incidence of shoot and capsule borer on Cardamom. The results indicated that there was a significant positive correlation with relative humidity and rainfall with per cent shoot damage in M-1 and M-2 varieties of cardamom.

Mean performance of turmeric genotypes based on morphological characters:

Among the 24 genotypes evaluated the range of plant height recorded at 160 DAP was 93.2- 111.03 cm. The maximum plant height was recorded in two genotypes i.e. AKTL-11(111.3) and PDKV Waigaon (110.1). Twelve genotypes had plant height in the range 109.6-100.03 *viz.* AKTL-12

(100.03), PTS-10 (100.13), AKTL-10 (101.23), PWTM-3 (101.2), AKTL-18 (102.8), AKTL-19 (103), PWTM-1 (103.2), AKTL- 16 (104.27), PWTM-14 (104.33), Salem (105.27), AKTL-13 (105.4), Pragati (109.6). Ten genotypes had plant height in the range 99.2- 93.2 namely PWTM-11 (99.2), PWTM- 9 (97.33), PWTM-10 (97.13), PWTM-5 (97.07), PWTM-4 (96.87), PWTM-8 (96.6), AKTL-8 (96.4), PWTM- 6 (96.07), AKTL-3 (95.13) and PWTM-19 (93.2).

For the character number of tillers at 160 DAP the range recorded was 1.47- 2.73. The maximum number of tillers was found in six genotypes i.e. PWTM-6 (2.73), AKTL-19 (2.73), PWTM-5 (2.67), AKTL-11 (2.6), Salem (2.6) and PWTM-4 (2.53). Thirteen genotypes had number of tillers in the range 2-2.47 namely AKTL-18 (2.47), PWTM-3 (2.33), PWTM-10 (2.33), AKTL-16 (2.27), PTS-10 (2.27), PWTM-1 (2.2), PWTM-8 (2.2), PWTM-9 (2.2), PWTM-14 (2.07), AKTL-3 (2.27), AKTL-12 (2.07), PWTM-19 (2) and PDKV Waigaon (2). Other five genotypes had number of tillers in the range 1.47- 1.93 *viz*. AKTL-10 (1.93), AKTL-8 (1.8), AKTL- 13 (1.8), Pragati (1.8) and PWTM-11 (1.47).

Table 6: Mean performance of turmeric genotypes based on morphological characters

Genotypes	Plant height (cm) at 160 DAP	No. of tillers at 160 DAP	Leaf lamina (cm^2) at 160 DAP	Yield (Qtls/ha)
PWTM-1	103.20	2.20	53.00	5.12
PWTM-3	101.20	2.33	48.53	2.99
PWTM-4	96.87	2.53	53.33	5.37
PWTM-5	97.07	2.67	49.47	4.83
PWTM-6	96.07	2.73	49.13	4.02
PWTM-8	96.60	2.20	52.33	6.23
PWTM-9	97.33	2.20	53.50	5.22
PWTM-10	97.13	2.33	55.73	4.72
PWTM-11	99.20	1.47	52.00	5.56
PWTM-14	104.33	2.07	57.87	5.60
PWTM-19	93.20	2.00	55.73	4.75
AKTL-3	95.13	2.07	53.83	4.82
AKTL-8	96.40	1.80	52.53	5.29
AKTL-10	101.23	1.93	53.80	5.65
AKTL-11	111.03	2.60	57.53	5.14
AKTL-12	100.03	2.07	56.07	5.58
AKTL-13	105.40	1.80	51.80	5.55
AKTL-16	104.27	2.27	54.67	5.20
AKTL-18	102.80	2.47	50.33	4.82
AKTL-19	103.00	2.73	52.20	5.34
PDKV Waigaon	110.10	2.00	52.80	2.59
PTS-10	100.13	2.27	53.87	5.70
Salem	105.27	2.60	54.87	5.48
Pragati	109.60	1.80	56.60	4.94
Range	93.2- 111.03	1.47- 2.73	48.53- 57.87	6.23- 2.60
Mean	101.11	2.21	53.40	5.02
SE(m)±	2.39	0.16	1.29	0.48
CD at 5%	6.63	0.44	3.57	1.34
CV%	4.10	12.52	4.18	16.71

The range of leaf lamina of 24 genotypes evaluated was 48.53- 57.87. Six genotypes had highest leaf lamina in the range 55.73- 57.87 *viz*. PWTM-14 (57.87), AKTL-11 (57.53), Pragati (56.6), AKTL-12 (56.06), PWTM-10 (55.73) and PWTM-19 (55.73). Fifteen genotypes had leaf lamina in the range 50.33-54.87 *viz*. Salem (54.87), AKTL-16 (54.67), PTS-10 (53.87), AKTL-3 (53.83), AKTL-10 (53.8), PWTM-9 (53.5), PWTM-4 (53.33), PWTM-1 (53), PDKV Waigaon (52.8), AKTL-8 (52.53), PWTM-8 (52.33), AKTL-19 (52.2), PWTM-11 (52), AKTL-13 (51.8) and AKTL-18 (50.33). Three genotypes had leaf lamina lowest leaf lamina namely PWTM-5 (49.46), PWTM-6 (49.13) and PWTM-3 (48.53).

Total yield of rhizome of 24 genotypes evaluated was recorded in the range 6.23- 2.60 q/ha. Fifteen genotypes had yield more than five q/ha namely PWTM-8 (6.23 q/ha), PTS-10 (5.71 q/ha), AKTL-10 (5.65 q/ha), PWTM- 14 (5.61 q/ha), AKTL-12 (5.58 q/ha), PWTM- 11 (5.57 q/ha), AKTL-13 (5.55 q/ha), Salem (5.48 q/ha), PWTM-4 (5.37 q/ha), AKTL-19 (5.34 q/ha), AKTL-8 (5.30 q/ha), PWTM-9 (5.22 q/ha), AKTL-16 (5.21 q/ha), AKTL-11 (5.14 q/ha) and PWTM-1 (5.12 q/ha). Yield of seven genotypes were recorded more than 4 q/ha *viz*., Pragati (4.94 q/ha), PWTM-5 (4.83 q/ha), AKTL-3 (4.82 q/ha), AKTL-18 (4.82 q/ha), PWTM-10 (4.72 q/ha), PWTM-19 (4.57 q/ha) and PWTM- 6 (4.02 q/ha). Remaining two genotypes produced minimum yield i.e. PWTM- 3 (2.99 q/ha) and PDKV Waigaon (2.60 q/ha).

Correlation between morphological characters of turmeric and infestation of shoot borer

The result of simple correlation co-efficient (r) worked out between mean infestation of shoot borer and morphological characters of turmeric are presented in Table 7. Statistical analysis of the data showed that plant height and number of tillers were negatively correlated and yield was positively correlated with mean infestation but statistically non-significant (r= -0.33031, -0.06383, 0.0918). Relationship between leaf lamina and mean infestation were negatively correlated and statistically significant i.e. when the leaf lamina increases infestation of shoot borer decreases (r= -0.42613).

Table 7: Correlation between morphological characters of turmeric and infestation of shoot borer

	Plant Height	No. of tillers	Leaf Lamina	Yield
Mean infestation	-0.3303	-0.0638	-0.4261	0.0918

r= 0.404

Few previous studies have been found related to correlation between morphological characters of turmeric and infestation of shoot borer. The plant height number of tillers and yield has no significant correlation with infestation of shoot borer as observed in our results correspond who had conducted morphological and molecular screening of turmeric (*Curcuma longa* L.) cultivars for resistance against parasitic nematode, *Meloidogyne incognita*. Morphological characteristics of 23 cultivars of *C.longa* and reaction of turmeric cultivars to *M. Incognita* was studied. Plant height, No. of tillers, leaves per tillers, leaf length, leaf width and yield was correlated with root knot index but no significant correlation was observed.

Similarly, Arun and Chezhiyan (2005) [1] studied the morphogenetic and biochemical basis for stem borer (*Conogethes punctiferalis*) resistance in turmeric (*Curcuma longa* L.) genotypes. The results revealed genotypes with lower incidence of pest recorded higher yield the other morphological parameters observed no correlation whereas the genotypes with higher tolerance limit showed higher peroxidase, PPO, catalase and phenol content. In present study leaf lamina shows negative significant correlation ship which may be due to as the leaf lamina increase the width and stiffness of pseudo stem also increase and due to this it is difficult to shoot borer larvae to bore the pseudo stem of turmeric. More confirmation study is needed in this case.

Conclusion

The infestation of turmeric shoot borer was observed from the first fortnight of August to second fortnight of November. The infestation was in the range of 0.0 per cent to 28.20 per cent. The peak infestation of turmeric shoot borer *(Conogethes punctiferalis)* was observed in the month of September. Out of 24 Turmeric genotypes evaluated the minimum infestation of shoot borer were observed in PWTM-14 (0.9%), AKTL-12 (2.3%) and AKTL- 11 (3.2%). In the correlation study of weather parameters with infestation of Turmeric shoot borer no significant correlation was observed with any weather parameters. Correlation study of mean infestation with morphological characters i.e. plant height, number of tillers and yield showed no significant correlation whereas leaf lamina showed negatively significant correlation. These genotypes can be further explore for the development of new turmeric varieties.

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