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Screening of turmeric (*Curcuma longa* L.) genotypes against shoot borer (*Conogethes punctiferalis* Guen.) (Lepidoptera: Pyralidae), under hilly zone of Karnataka

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Abstract
Turmeric shoot borer (*Conogethes punctiferalis* Guen) is one of the notorious insect pest which causes severe damage at different stages of the turmeric crop resulting significant yield loss. The present investigations were carried out to screen out some promising turmeric genotype against shoot borer. Twenty two turmeric (*Curcuma longa* L.) genotypes including popular cultivars and high yielding varieties were screened in the field against the shoot borer at College of Horticulture, Sirsi, Karnataka during *kharif* 2015-16 and 2016-17. Out of twenty two turmeric genotypes screening against the shoot borer, three genotypes were highly resistant, two genotypes were moderately resistant, sixteen genotypes were moderately susceptible and one genotype was highly susceptible to the pest incidence.

Keywords: Turmeric, genotypes, Karnataka and shoot borer

Introduction
Turmeric (*Curcuma longa* L.) is an important sacred and ancient spice of India popularly known as Indian saffron. It is a tropical perennial rhizomatous spice belonging to the family zingiberaceae and native to South East Asia being grown in India since times immemorial. It is the golden spice of life, is one of the most essential spices which are used as an important gradient in culinary all over the world. It is a multipurpose crop valued for its medicinal properties, colouring pigment and spicy flavour. India is the major producer of turmeric, which occupies fourth place in area under spices and ranks third in production next to chillies and garlic. It occupies 20.14 per cent of spice production. In India it is being cultivated in more than 20 states in an area of 2,96,181 hectare with an annual production of 11,78,750 tonnes (dry) (Anon., 2019a) [1] and exporting 1,37,650 tonnes with earning a foreign exchange of Rs. 1,28,691 lakhs (Anon., 2019b) [2]. In Karnataka, turmeric is being cultivated in an area of 24,912 hectare with an annual production of 2,50,829 metric tonnes of fresh turmeric in Belgaum, Chamarajanagar, Uttar Kannada, Hassan, Shimoga and Chikmagalur are important districts growing turmeric (Anon., 2019c) [3]. Several constraints such as varieties, fertilizers, various insect-pests and diseases affect its productions. Among them, insect-pest shoot borer, *Conogethes punctiferalis* is one of them, which cause severe damage at different stages of the crop. Efforts to screen the reaction of turmeric germplasm for insect pests are very little or scarce barring a few scattered studies as been reported for shoot borer (Rao *et al*., 1994) [7]. Development of resistant varieties and their incorporation in IPM schedule is an eco-friendly alternate for management of shoot borer. Earlier attempts to screen the lines to shoot borer indicated that Dindigram Ca-2 (Sheila *et al*., 1980) and Mannuthy Local (Philip and Nair, 1981) were least susceptible to the pest. Velayudhan and Liji (2003) [10] identified 22 accessions that were more tolerant to the shoot borer. Hence this study was undertaken to evaluate few turmeric genotypes against shoot borer in the hilly zone of Karnataka.

Material and Methods
Investigations were carried out at College of Horticulture, Sirsi located at 605 meter above mean sea level at 14.61′ North latitude and 74.81′ East longitude receiving on an average rainfall of 2500 mm in the hill zone (Zone-9) of Karnataka during 2015-16 and 2016-17 *Kharif* season.

The experimental material comprised of 22 genotypes collected from different sources namely Alleppey Supreme, Bidar Local, BSR-2, CO-1, CO-2, Cuddapah, Erode Local, Kanti, Kedaram, Krishna, Phule Swaroop, Prabha, Pratibha, Rajapuri, Salem, Shobha, Sona, Sudarshan, Suroma, Suvarna, Tekurpeta and Varna were obtained from KAU, Thrissur, KRCC Arabhavi. The rhizomes of turmeric varieties were planted during the month of June 2015 and 2016 by following all the agronomic practices, later which develops in to a clump containing several shoots. Two replications were maintained for each genotype. The incidence of shoot borer damage was recorded as per cent pest incidence by dividing number infested plants (dead hearts/shoots with bored hole) with total number of observed plants at 120 and 150 DAP in each genotype during the crop growth period. The mean percent shoot damage in each genotype was calculated using Microsoft Excel and SPSS. The mean and standard deviation of maximum percent shoot damage in each genotype was taken for calculating the pest susceptibility rating as per the method of Bhoomanvar *et al*., (1989) [4] and adopted the screening ginger germplasm against shoot borer (Devasahayam *et al*., 2010) and screening turmeric genotypes against shoot borer (Table 1), (Singh., 2018) [9].

Since the variation in per cent shoot damage between various germplasm was wide it was not possible to fix upper and lower limits of each group as constant values. Hence the mean and standard deviation for the year is used for calculating the various categories resistant or susceptibility. The categorization based on the extent of variation from mean (Positive or Negative) reduced the probability of inclusion the resistant/susceptibility germplasm (Bhoomanvar *et al*., 1989) [4].

Table 1: Pest susceptibility ratings

Sl. No.	Category of resistance	Criteria
1.	Highly resistant	No shoot damage
2.	Moderately resistant	Shoot damage less than (mean-2 SD)
3.	Moderately susceptible	Shoot damage in between (mean to mean-2 SD)
4.	Susceptible	Shoot damage between (mean to mean+2 SD)
5.	Highly susceptible	Shoot damage more than (mean + 2 SD)

Results and Discussion

As we discussed in the earlier chapter, the observations were recorded for shoot borer infestation for all 22 genotypes in two consecutive seasons at two intervals of 120 and 150 days after planting. The collected results are presented in table 2 and it reveals that, per cent shoot damage value ranges from (Sudarshan 2.31%) to (Bidar local 43.80%). It was recorded that, the infestation variation was found more in 120 days after planting data than compared to 150 days after planting.

Table 2: Per cent shoot borer *Conogethes punctiferalis* infestation in turmeric genotypes at different days after planting during 2015-16 and 2016-17

Sl. No.	Variety	Percent shot damage			
		2015-16		2016-17	
		120 DAP	150 DAP	120 DAP	150 DAP
1	Alleppy Supreme	20.37 (26.81)	22.75 (28.47)	21.29 (27.46)	23.69 (29.11)
2	Bidar Local	40.33 (39.40)	42.85 (40.87)	41.25 (39.93)	43.80 (41.42)
3	BSR-2	26.65 (31.06)	31.95 (34.40)	27.57 (31.65)	32.89 (34.98)
4	CO-1	18.52 (25.46)	20.00 (26.55)	19.44(26.13)	20.95 (27.22)
5	CO-2	23.16 (28.75)	26.67 (31.07)	24.08 (29.37)	27.61 (31.68)
6	Cudappa,	18.39 (25.37)	19.41 (26.12)	19.31 (26.05)	20.36 (26.80)
7	Erode Local	25.59 (30.36)	30.03 (33.21)	26.50 (30.96)	30.98 (33.80)
8	Kanti	25.29 (30.17)	32.25 (34.58)	26.20 (30.77)	33.20 (35.15)
9	Kedaram	26.62 (31.05)	27.50 (31.61)	27.54 (31.64)	28.45 (32.22)
10	Krishna	26.33 (30.85)	29.35 (32.79)	27.25 (31.45)	30.30 (33.38)
11	Phule Swaroop	2.57 (9.20)	2.54 (9.15)	3.49 (10.73)	3.48 (10.75)
12	Prabha	5.64 (13.69)	6.84 (15.15)	6.55(14.79)	7.79 (16.19)
13	Pratibha	10.88 (19.25)	11.12(19.15)	11.80(20.08)	12.06 (20.31)
14	Rajapuri	8.67 (17.11)	9.10 (17.54)	9.58 (18.02)	10.04 (18.46)
15	Salem,	22.33 (28.18)	24.09 (29.38)	23.25 (28.81)	25.04 (30.01)
16	Shobha	2.37 (8.80)	3.33 (10.49)	3.29 (10.40)	4.28 (11.92)
17	Sona	21.58 (27.66)	23.43(28.93)	22.50 (28.29)	24.38 (29.57)
18	Sudarshan	2.31 (8.71)	2.37(8.83)	3.22 (10.33)	3.32 (10.48)
19	Suroma	5.33 (13.31)	9.77(18.20)	6.25 (14.43)	10.72 (19.10)
20	Suvarna	24.63 (29.73)	27.51(31.61)	25.54 (30.34)	28.45 (32.22)
21	Tekurpeta	20.38 (26.80)	21.57(27.65)	21.30 (27.45)	22.51 (28.31)
22	Varna	17.50 (24.71)	21.09(27.32)	18.42 (25.40)	22.03 (27.98)
S.Em		0.48	0.22	0.472	0.215
C.D at 5%		1.32	0.64	1.351	0.616
CV (%)		3.49	1.52	3.301	1.411

Based on the values of per cent shoot damage, further data was analysed to identify genotype category of resistance to the shoot borer according predefined five categories. The table 3 shows classification criteria for all five categories. Majority of the genotypes (>72%) were fall under the category of moderately susceptible. Only one genotype is highly susceptible and three genotypes highly resistant to shoot borer.

Table 3: Screening of turmeric genotypes against shoot borer under natural field condition

Category of resistance reaction	Range of shoot damage (%) criteria for classification	No. of genotypes	Percent of genotypes
Highly resistant	0-3.78	3	13.64
Moderately resistant	3.79-9.04	2	9.09
Moderately susceptible	9.05-30.11	16	72.73
Susceptible	30.11-35.36	Nil	-
Highly susceptible	>35.36	1	4.55

Among different turmeric genotypes (Sudarshan, Phule Swaroop and Shobha) have registered 0-3.78 per cent damage by shoot borer (*Conogethes punctiferalis*). Hence, these genotypes were grouped as highly resistant types as compared to other genotypes (Fig. 1).

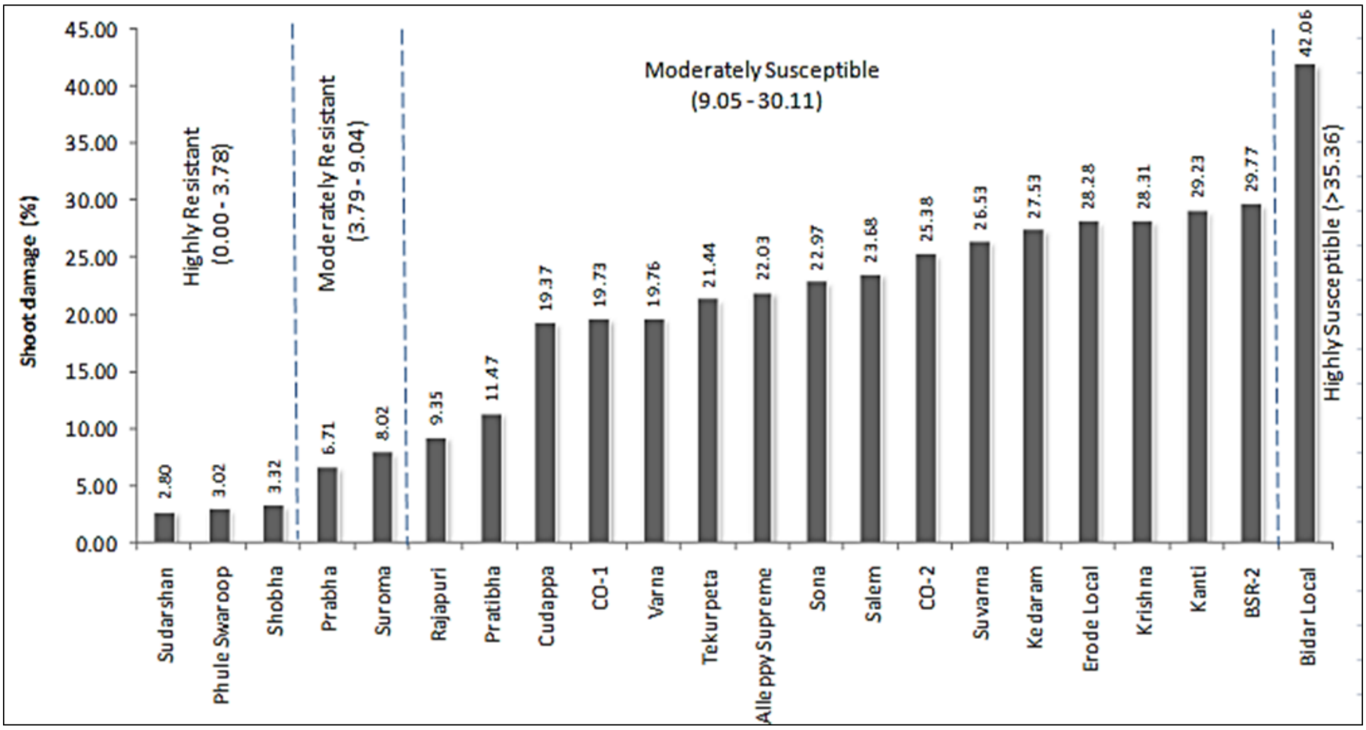

Fig 1: Genotypes distribution according to per cent shoot damage caused by *Conogethes punctiferalis*

The genotypes (Prabha and Suroma) were recorded 3.79-9.04 per cent damage by shoot borer. Hence, these genotypes were grouped under moderately resistant to shoot borer infestation. The genotypes (Rajapuri, Pratibha, Cuddapah, CO-1, Varna, Tekurpeta, Alleppey Supreme, Sona, Salem, CO-2, Suvarna, Kedaram, Erode Local, Krishna, Kanti and BSR-2) were recorded 9.05-30.11 per cent of damage by shoot borer, hence these were categorised as moderately susceptible type. While the highest >35.36 per cent of damage registered in genotype Bidar local, hence, this genotype was grouped under highly susceptible to shoot borer infestation during both the years of study as revealed by pooled analysis of response to shoot borer.

Similar results find with wide variations in pest susceptibility was also reported while screening ginger germplasm for resistant against shoot borer (*Conogethes punctiferalis*). (Ravi *et al*., 2018. Kotikal and Kulakarni 2001) [8, 5] reported that, among the different genotypes BSR-1, CO-1, Cuddapah and Salem emerged as tolerant against *Conogethes punctiferalis*. (Singh *et al*., 2018) [9] reported that, 11 genotype were rated as moderately resistant, three as moderately susceptible, five as susceptible and only one highly susceptible against the shoot borer. (Nandakumar *et al*., 2021) [6] reported that, among different turmeric genotypes screened against shoot borer (*Conogethes punctiferalis*), 27 genotypes have registered no damage by shoot borer and grouped as tolerant types. Five genotypes were grouped under moderately tolerant to shoot borer infestation. While, 16 genotypes were the highest damage and grouped into susceptible type.

Conclusion

The degree of variation occurred with respect to the response of genotypes to shoot borer was expected since, any tolerant or susceptibility of the genotypes to the insect pest is controlled by the genetic constitution of genotype. In this study, genotypes like Sudarshan, Phule Swaroop and Shobha found highly tolerant to shoot borer *Conogethes punctiferalis*. However, Bidar local genotype is highly susceptible to the pest. Hence, Sudarshan, Phule Swaroop and Shobha genotypes can be recommended to the farmers to reduce the productivity loss of the turmeric against major pest *Conogethes punctiferalis*.

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