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Evaluation of mango varieties against fruit borer, *Citripestis eutraphera* (Meyrick) under humid tropics in Gujarat, India

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ABSTRACT: Evaluation of 12 mango varieties/hybrids was carried out against the mango fruit borer, *Citripestis eutraphera* (Meyrick), (Lepidoptera: Pyralidae) at Agriculture Experimental Station, Navsari Agriculture University, Paria, Gujarat during two consecutive years (2022 and 2023). Pooled results showed that mango varieties Ratna, Totapuri Neelam, Vellaikolamban, Neeleshan and Vanraj were proved least preferred by the fruit borer recording lowest fruit borer infestation (2 to 5 % and 13 to 15% on standing tree and dropped fruits under tree, respectively) followed by Dashehari, Amrapali and Sonpari which recorded 4.65, 5.76, 5.39 per cent and 23.17, 24.28, 22.93 per cent fruit borer infestation in terms of standing tree and dropped fruits under tree, respectively. Whereas Alphonso and Kesar were most preferred varieties by fruit borer recording 9.28 and 7.08 per cent infestation on standing tree and 31.12 and 24.99 per cent dropped fruits infestation under tree, respectively. The overall highest damage intensity was found during first fortnight of May in most of the varieties.

Keywords: Mango, fruit borer, *Citripestis eutraphera*, varietal screening.

INTRODUCTION

Mango, *Mangifera indica* L. (Family: Anacardiaceae), is a tropical and subtropical fruit known as "King of Fruits". The states of Andhra Pradesh, Uttar Pradesh, Karnataka, Bihar, Gujarat and Maharashtra are major mango producers of the country. In Gujarat, Valsad, Navsari, Gir Somnath, Kutch and Surat are the major mango producing districts. Valsad and Navsari are major mango producing districts of South Gujarat having sub-tropical climate with moderately high humidity. In mango, about 492 species of insects, 17 species of mites and 26 species of nematodes have been reported from all over the world (Tandon and Verghese, 1985). Of these, 188 species have been reported from India (Butani, 1978; Tandon and Verghese, 1985) but only handfuls are of major importance which includes hopper, thrips, mealy bugs, stem borer, fruit flies and stone weevil. Some of the minor pests were also found to become major pests as a result of the changes in the environment. Prior to recent time, minor or secondary pests such as scales, thrips, mites, leaf webbers, stem borers, fruit borers, *etc*., are considered to be a threat (Jayanthi *et al.,* 2014). The mango fruit borer, *Citripestis eutraphera* (Meyrick), (Lepidoptera: Pyralidae) originally confined to the Andaman Islands, is a recent invasion in mainland India. Mango fruit borer, *C. eutraphera* which was originally described from Java, is a significant borer of mango fruits in South and South-East Asia and some parts of Australia (Anderson and Tran-Nguyen, 2012).

The most recent classical example of intra-national invasion of insect pests from the Andaman and Nicobar Islands to mainland India is the mango fruit borer, *C. eutraphera* and it was probably restricted to the Islands for almost two decades, till 2014, when it was reported by Jayanthi *et al.* (2014) from South India on mango. They first time reported the occurrence of *C. eutraphera* causing extensive damage to immature fruits of mango in Karnataka and Tamil Nadu. The infestation of *C. eutraphera* was recently reported for the first time in Gujarat, where it caused significant damage (Bana *et al.,* 2018). This species recently invaded and spread to mainland India and infested mango in Karnataka, Tamil Nadu, Kerala, Gujarat, parts of Maharashtra and Odisha (Krull and Basedow, 2006; Krull, 2004; Jayanthi *et al.,* 2014; Hiremath *et al.,* 2017; Singh and Kaur, 2014; Sunitha *et al.,* 2020) and recently in Punjab (Singh *et al.,* 2021). Mango-growing pockets in the South-Western parts of Gujarat, as well as parts of Kerala and Tamil Nadu will remain moderately to highly suitable for *C. eutraphera* distribution in 2050 and 2070 (Choudhary *et al.,* 2019).

Resistant varieties play a vital role in integrated pest management (IPM) by reducing the insecticidal application against insect pests and improving the performance of natural enemies. The low level of resistance is also effective, which helps in reducing the insecticidal load on crops and ultimately the cost of cultivation (Srivastava, 1993). Insect-resistant varieties provide pest control at no cost to farmers (Prem Kishore, 2001). Therefore, it is important to identify the resistance genotypes or varieties. A study on resistance mechanisms in relation to crop phenological stages is essential for the crop improvement program in effective utilization of resistant sources. So, the use of resistant varieties is an environmentally safe and economically sound component of Integrated Pest Management (IPM). By considering this, evaluation of mango varieties against infestation of fruit borer,*C. eutraphera*was carried out to strengthen the IPM practices.

MATERIALS AND METHODS

The evaluation of mango varieties against fruit borer *C. eutraphera* was carried out under field conditions at Agriculture Experimental Station, NAU, Paria, Gujarat ($20^0$26'58.427"N $72^0$57'5.723"E) during 2022 and 2023. All the recommended agronomical practices of NAU, Navsari were followed. A total of 12 varieties *viz*., Alphonso, Amrapali, Ratna, Neeleshan, Kesar, Totapuri, Neelam, Vanraj, Dashehari, Sonpari, Karanjio and Vellaikolamban were screened in Randomized Block Design (RBD) with three replications. Three trees (one tree considered as one replication) from each of the selected varieties with 8m x 8m spacing were observed at weekly interval. The selected trees were kept free from insecticidal spray throughout the experimental period. The clearly visible 25 fruits/tree from the ground in all directions were observed for infestation of fruit borer starting from the fruit growth of marble size to the harvesting of fruits and per cent infestation was worked out. Total number of dropped fruits under tree were recorded from which fruit borer infested fruits were separated and per cent infestation was worked out.

RESULTS AND DISCUSSION

The newly emerged larvae of *C. eutraphera* scraped the fruit's skin on upper 1/3 portion of fruit and also the peduncle when single fruit was infested (Fig.1-b), whereas when multiple fruits (two or more) are infested, larvae scraped the fruit's skin at jointed portion (Fig.1-i). The late instars bore holes in the fruit to feed on the pulp to reach the soft seed/ kernel (Fig 3-e). In infested fruits, bored holes filled with frass (Fig. 1-h) and adjacent fruits of mango were often found blackened around the bored area (Fig. 1-i). During marble to egg stage, early instar larva also started feeding on the peduncle (Fig.1-b,c). resulted in premature dropping of fruits (Fig.1-l). The sap stain running from bore hole made by the larvae (Fig.1-g). The larva created irregular galleries in the kernel and completely devoured it. The infected kernel lost the germination. The exit hole allows ants, beetles, and occasionally microorganisms to enter the fruits. Furthermore, the damage caused longitudinal cracks in the fruits, which encouraged fruit flies to lay their eggs there (Fig.1-f).

The data on per cent fruit borer infestation on standing tree and per cent infestation in terms of dropped fruit under tree from marble stage to mature are presented in Table 1 and 2, respectively. Among all the varieties tested, Vellaikolamban is early variety; Alphonso, Kesar, Dashehari, Karanjio and Vanraj are the mid varieties; Sonpari is the mid-late variety; whereas Amrapali, Totapuri, Ratna, Neelam and Neeleshan are late varieties.

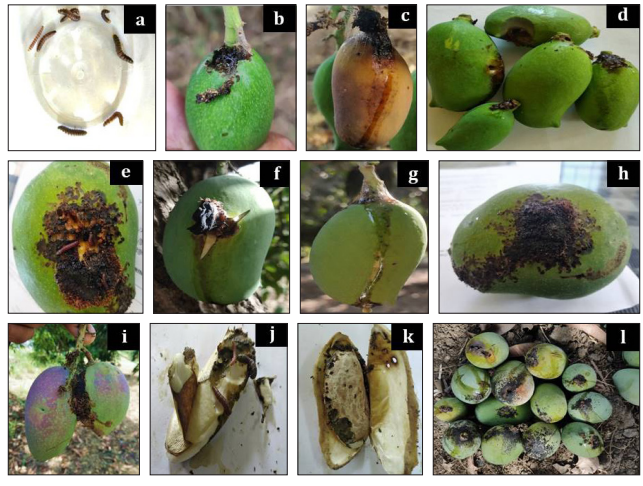

Fig.1: Damage by *C. eutraphera*: Larvae-a; Damage at marble stage-b (Fruit skin scraped by early instar larva); Rotting of fruit-c; Damage at egg size stage-d; Damage at mature stage-e; Cracking of fruits due to infstation-f; Sap stain running from bore hole-g; Entry hole plugged with excreta-h; Damage at jointed fruits-i: Larva feed on the soft kernal of mango-j & k; mature fruits dropped due to infestation-l.

Infestation on Standing Tree

Results revealed that all the varieties showed more or less fruit borer infestation during the season and it was commenced from first week of March (10^{th} SMW) coincided with the marble stage continued up to first week of June (22th SMW) coincided with the mature

Table 1: Screening of mango varieties against mango fruit borer in terms of per cent infested fruits on standing tree (Pooled of two years)

SN	Variety	Fruit borer infestation (%)													
		10thSMW	11thSMW	12thSMW	13thSMW	14thSMW	15thSMW	16thSMW	17thSMW	18thSMW	19thSMW	20thSMW	21stSMW	22ndSMW	Pooled
1	Alphonso	10.85 (3.57)	11.79 (4.21)	13.28 (5.31)	16.23 (7.82)	18.82 (10.42)	19.46 (11.11)	20.72 (12.54)	22.39 (14.56)	23.04 (15.40)	23.06 (12.45)	18.58 (10.18)	15.93 (7.61)	13.28 (5.41)	17.74 a (9.28)
2	Kesar	7.55 (1.73)	8.72 (2.32)	12.81 (4.94)	14.49 (6.27)	16.58 (8.15)	17.82 (9.41)	19.31 (10.96)	20.32 (12.13)	19.70 (11.39)	19.71 (9.02)	15.13 (6.85)	12.36 (4.71)	11.65 (4.11)	15.43 g (7.08)
3	Dashehari	4.97 (0.76)	6.45 (1.27)	10.28 (3.21)	10.38 (3.27)	12.68 (4.84)	14.31 (6.15)	15.29 (7.02)	15.75 (7.45)	16.16 (7.87)	16.26 (6.09)	12.29 (4.57)	12.62 (4.84)	10.09 (3.09)	12.45 e (4.65)
4	Amrapali	8.41 (2.15)	6.87 (1.46)	11.76 (4.19)	12.36 (4.60)	14.61 (6.37)	15.92 (7.54)	16.87 (8.46)	18.41 (10.09)	18.34 (9.93)	18.34 (7.85)	14.09 (6.08)	11.26 (3.93)	8.57 (2.23)	13.89 f (5.76)
5	Totapuri	0.00 (0.00)	0.00 (0.71)	6.87 (1.46)	8.62 (2.26)	8.81 (2.37)	10.60 (3.47)	11.11 (3.72)	12.86 (5.00)	13.31 (5.40)	13.27 (4.05)	9.83 (2.98)	8.03 (1.98)	4.83 (0.74)	9.33 a (2.63)
6	Sonpari	6.55 (1.31)	7.55 (1.74)	10.49 (3.35)	10.64 (3.44)	13.45 (5.44)	16.77 (8.36)	17.15 (8.73)	18.03 (9.64)	17.53 (9.10)	17.56 (7.82)	15.08 (5.87)	10.27 (3.19)	8.11 (2.08)	13.42 f (5.39)
7	Ratna	5.52 (0.94)	4.52 (0.66)	7.34 (1.65)	8.38 (2.13)	8.60 (2.25)	10.73 (3.59)	11.20 (3.78)	11.80 (4.36)	12.32 (4.65)	12.39 (3.02)	8.57 (2.63)	6.22 (1.19)	4.83 (0.74)	8.97 a (2.43)
8	Neelam	0.00 (0.00)	4.81 (0.73)	6.43 (1.26)	9.70 (2.88)	9.08 (2.52)	10.95 (3.68)	12.76 (4.90)	14.22 (6.12)	14.77 (6.52)	14.75 (4.14)	10.11 (3.18)	8.35 (2.11)	8.71 (2.31)	10.14 b (3.10)
9	Karanjio	5.10 (0.81)	8.92 (2.44)	10.64 (3.44)	13.87 (5.78)	15.25 (6.95)	17.00 (8.62)	18.17 (9.77)	19.10 (10.74)	18.32 (9.90)	18.28 (7.09)	13.59 (5.55)	10.05 (3.14)	7.38 (1.73)	13.98 f (5.84)
10	Neeleshan	0.00 (0.00)	3.85 (0.46)	7.68 (1.79)	9.60 (2.81)	10.55 (3.38)	12.17 (4.48)	14.40 (6.26)	16.22 (8.18)	17.04 (8.61)	17.00 (6.87)	13.01 (5.10)	9.91 (3.15)	9.33 (2.67)	11.74 d (4.14)
11	Vanraj	0.00 (0.00)	3.86 (0.47)	7.69 (1.80)	9.67 (2.86)	10.43 (3.31)	12.87 (5.01)	13.10 (5.26)	15.12 (6.98)	15.79 (7.51)	15.89 (8.33)	13.99 (5.94)	10.36 (3.26)	10.91 (3.61)	11.80 d (4.18)
12	Vellaikolamban	0.00 (0.00)	0.00 (0.00)	7.24 (1.61)	8.26 (2.07)	11.15 (3.75)	12.78 (4.91)	14.07 (6.02)	15.59 (7.36)	16.23 (7.94)	16.34 (6.21)	10.90 (3.69)	8.21 (2.04)	8.63 (2.27)	11.06 c (3.68)
	S.Em. ±	0.34	0.58	0.59	0.54	0.58	0.79	0.81	1.24	0.88	0.82	0.98	1.02	0.77	0.20
	CD (5 %)	0.99	1.70	1.75	1.60	1.73	2.32	2.38	3.65	2.58	2.42	2.91	3.01	2.28	0.57
	CV %	14.21	17.79	10.92	8.53	8.10	9.54	9.09	12.87	8.98	8.42	13.18	17.17	15.13	6.45

Figures in parenthesis are original values and those outside are arcsine transformed values. Treatment means followed by the same latter(s) within a column are not significantly different by Duncan's New Multiple Range Test (DNMRT at 5% level of significance.

stage or harvesting stage. Moreover, peak infestation was recorded mostly during last week of April to first week of May (17th& 18th SMW) coinciding with egg size stage. The lower fruit borer infestation was noticed during early fruit development stages.

The data showed that, during early fruit development stage (10th SMW), infestation of *C. eutraphera* was not commenced simultaneously in all the varieties. The varieties *viz*., Vanraj, Vellaikolamban, Neeleshan, Neelam and Totapuri was found free from infestation. Pooled results showed that the difference in fruit borer infestation in all the varieties was found significant. Significantly lowest fruit borer infestation was recorded in Ratna (2.43 %) which was statistically at par with Totapuri (2.63 %) and Neelam (3. 10%).The next best varieties in term of lower fruit borer infestation were Vellaikolamban (3.68 %), Neeleshan (4.14 %), Vanraj (4.18 %) and Dashehari (4.65 %) which were not differ statistically from each other. Moderate infestation was noticed in Amrapali (5.76 %) and Sonpari (5.39 %). Significantly highest infestation was noted in Alphonso variety (9.28 %) followed by Kesar (7.08 %) (Table 1).The damage intensity was reached highest during first fortnight of May in Alphonso (7.87 %), Dashehari (15.40%), Totapuri (5.40%), Sonpari (9.10%), Ratna (4.65%), Neelam (6.22%), Neeleshan (8.61%), Vanraj (8.33%), Vellaikolamban (7.94%) and second fortnight of April in Kesar (12.13%), Amrapali (10.09%), and Karanjio (10.74%) (Table 1).

Infestation in terms of dropped fruits under tree

All the varieties showed more or less fruit borer infestation during the season and it was commenced from first week of March (10th SMW) continued up to first week of June (22th SMW). Moreover, peak infestation was recorded mostly during last week of April to first week of May (17th& 18th SMW) coinciding with egg stage. The lower fruit borer infestation was noticed during early fruit development stages.

The data showed that, during early fruit development stage (10th SMW), infestation of *C. eutraphera* was

Table 2. Screening of mango varieties against mango fruit borer in terms of per cent infested dropped fruits under tree (Pooled of two years)

S.N	Variety	Fruit borer infestation (%)													
		10thSMW	11thSMW	12thSMW	13thSMW	14thSMW	15thSMW	16thSMW	17thSMW	18thSMW	19thSMW	20thSMW	21stSMW	22ndSMW	Pooled
1	Alphonso	4.25 (19.81)	4.86 (23.17)	4.99 (25.24)	5.16 (26.59)	4.90 (24.01)	5.26 (27.48)	5.50 (30.70)	5.81 (33.32)	5.92 (34.62)	6.15 (37.45)	6.45 (41.41)	6.67 (44.02)	6.05 (36.68)	5.62 e (31.12)
2	Kesar	2.60 (8.10)	3.86 (14.95)	4.61 (20.91)	4.62 (21.04)	4.46 (19.48)	4.58 (20.54)	4.93 (24.09)	5.66 (31.89)	5.63 (31.31)	5.72 (32.28)	5.67 (31.72)	6.01 (36.09)	5.74 (32.48)	5.04 d (24.99)
3	Dashehari	1.67 (4.17)	3.88 (15.00)	4.04 (16.04)	4.86 (23.28)	4.35 (18.65)	4.37 (19.10)	4.89 (24.02)	5.51 (30.06)	5.47 (29.62)	5.52 (30.91)	5.45 (29.37)	5.55 (30.42)	5.54 (30.55)	4.86 d (23.17)
4	Amrapali	0.71 (0.00)	4.07 (16.34)	4.55 (20.50)	4.96 (24.11)	4.59 (20.59)	4.40 (19.40)	5.00 (24.65)	5.33 (28.11)	5.39 (28.98)	5.67 (32.12)	5.89 (34.93)	6.07 (36.98)	5.42 (28.94)	4.96 d (24.28)
5	Totapuri	0.71 (0.00)	2.43 (6.94)	2.81 (7.43)	3.83 (15.12)	3.61 (13.18)	3.96 (15.35)	3.96 (15.60)	4.33 (18.28)	4.63 (21.18)	4.53 (20.16)	4.69 (21.60)	5.19 (26.65)	4.95 (24.72)	4.04 bc (15.86)
6	Sonpari	1.85 (5.56)	3.60 (12.59)	4.10 (16.80)	4.34 (18.49)	4.48 (19.90)	4.22 (18.14)	4.71 (22.56)	5.43 (29.32)	5.50 (29.83)	5.68 (31.83)	5.80 (33.27)	5.67 (32.26)	5.26 (27.60)	4.84 d (22.93)
7	Ratna	0.71 (0.00)	2.52 (7.50)	2.95 (8.52)	2.61 (6.54)	2.67 (7.15)	3.21 (9.91)	2.98 (8.47)	3.68 (13.29)	3.98 (15.42)	3.91 (14.95)	4.03 (15.77)	4.01 (17.09)	3.78 (14.35)	3.34 a (10.69)
8	Neelam	0.71 (0.00)	1.98 (6.67)	3.26 (10.56)	3.33 (10.97)	3.40 (11.71)	3.32 (11.07)	3.16 (9.81)	4.04 (16.39)	4.30 (18.20)	4.42 (19.31)	4.35 (18.64)	4.79 (23.03)	3.90 (15.20)	3.70 ab (13.20)
9	Karanjio	0.71 (0.00)	2.52 (7.50)	3.45 (11.85)	3.94 (15.31)	3.74 (13.65)	3.74 (13.78)	4.87 (23.46)	4.99 (24.51)	5.49 (29.99)	5.59 (31.52)	5.64 (31.99)	5.70 (32.61)	5.40 (29.94)	4.56 cd (20.47)
10	Neeleshan	0.71 (0.00)	2.52 (7.50)	3.36 (10.87)	3.79 (13.87)	3.63 (12.81)	3.53 (11.98)	3.44 (11.98)	3.95 (15.10)	4.43 (20.10)	4.45 (20.15)	4.89 (23.70)	5.01 (25.15)	4.23 (17.63)	3.88 b (14.68)
11	Vanraj	0.71 (0.00)	2.40 (6.67)	2.85 (7.70)	2.94 (8.37)	2.79 (7.46)	3.39 (11.18)	2.87 (8.20)	4.44 (19.31)	4.59 (20.82)	4.88 (23.32)	4.81 (22.68)	4.27 (17.98)	3.72 (13.89)	3.66 ab (12.89)
12	Vellaikolamban	1.61 (3.70)	2.22 (5.59)	2.81 (7.43)	3.24 (10.37)	2.98 (8.68)	3.28 (10.55)	3.01 (8.71)	4.16 (16.89)	4.47 (20.11)	4.75 (22.76)	4.91 (23.89)	4.55 (21.00)	4.25 (17.72)	3.75 ab (13.65)
	S.Em. ±	0.65	0.76	0.37	0.38	0.40	0.40	0.46	0.31	0.38	0.43	0.35	0.51	0.47	0.18
	CD (5 %)	1.91	NS	1.09	1.10	1.17	1.17	1.35	0.90	1.10	1.27	1.03	1.50	1.38	0.52
	CV %	80.16	42.70	17.70	16.41	18.26	17.59	19.50	11.15	13.10	14.73	11.74	16.80	16.90	7.04

Figures in parenthesis are original values and those outside are arcsine transformed values. Treatment means followed by the same latter(s) within a column are not significantly different by Duncan's New Multiple Range Test (DNMRT) at 5% level of significance.

commenced in almost all the commercial varieties *viz*., Vanraj, Vellaikolamban, Neeleshan, Neelam, Ratna, Karanjio and Amrapali was found free from infestation. Pooled results showed that the difference in fruit borer infestation in all the varieties was found significant. Significantly lowest fruit borer infestation was recorded in Ratna (10.69%) which was statistically at par with Vanraj (12.89%), Neelam (13.20%) and Vellaikolamban (24.28%). The next best varieties in term of lower fruit borer infestation dropped under tree were Neeleshan (14.68%) and Totapuri (15.86%) which were not differ statistically from each other. Significantly highest infestation was noted in Alphonso variety (31.12%) which was not differing statistically from Kesar (24.99%), Amrapali (24.28%), Dashehari (23.17%) and Sonpari (22.93%).

It was also noticed that, the varieties with bunch bearing character were found most susceptible to fruit borer infestation. Dashehari and Amrapali were the bunch bearing mango varieties hence found susceptible. From the results it also can be conclude that most of the mid varieties were susceptible to fruit borer infestation however, early and late varieties were least susceptible. Even though Amrapali were late variety, but due to bunch bearing character it was found susceptible to *C. eutraphera*.

Perusal of literature revealed that, very few and scanty reports are available so far pertaining to the screening of mango varieties against *C. eutraphera*. Bhattacharyya (2014) tested susceptibility of fifteen commercially grown mango cultivars against *C. eutraphera* and concluded that Himsagar, Arka Anmol, Prabha Sankhar and Amrapali were the most susceptible varieties. In present study, Amrapali was also found susceptible to *C. eutraphera*. Thus confirms the present finding. According to Dulai *et al*. (2015) average infestations of fruit borer in commercial varieties are always higher than the infestations in folk varieties. Alphonso, Kesar, Dashehari and Amrapali are the commercial varieties tested during present study and found susceptible. Thus, present findings are in line with earlier workers.

Besides mango, it also infested seedlings and grafts of cashew, *A. occidentale* in Kerala (Jacob *et al.,* 2004; Hiremath *et al.,* 2017; Kori Nagaraj *et al.,* 2020, Kori Nagaraj *et al.,* 2022). Reddy *et al.* (2022) screened fifty-two released cashew varieties against *C. eutraphera* and concluded that none of the released cashew varieties showed either tolerance /resistance to attack of *C. eutraphera*, indicating no varietal preference for infestation.

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