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Differential damage of blossom midge, *Procontarinia mangiferae* (Felt) to mango cultivars and its impact on fruit retention and yield of variety Amrapali

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Abstract

The investigations on varietal (30) reaction and impact of inflorescence midge *Procontarinia mangiferae* (Felt) control practices on fruit retention and yield of mango variety Amrapali were carried out in the east coast region of India. Results revealed that the incidence of midge among the genotypes varied significantly ($P<0.00$). The lowest incidence was recorded on Neelgoa (16.15%), followed by Neeleshan (26.1%) and the highest in Alphanso (86.27%), Totapuri (86.42%), H-39(87.39%), Amrapali (88.69%), and Lalsundari (89.48%). Using the varying susceptibility of the genotypes to blossom damage as a basis, the genotypes were classified into distinct categories. Regardless of the extent of plant damage to floral buds, each variety exhibited fruit retention. With their wide-ranging genetic potential, there was no discernible correlation between fruit weight and fruit count. The impact studies of midge control measure in variety Amrapali revealed that the floral damage in untreated plants ranged between 73.69-91.37 percent and 61.47-75.47 percent in treated trees. The fruit number at the harvesting stage ranged between 2.80-4.00/ panicle and 3.1-4.20/ panicle, with a fruit weight ranging from 1.10-1.43kg and 1.23-1.50 kg/panicle, respectively. It was concluded that though the percent flower damage, fruit number, and yield per panicle differed significantly in treated and untreated trees, this statistical significance may not be of great economic importance at the maturity stage as 3-4 fruits per bunch in Amrapali gives standard yield.

Key words: Mango, blossom midge, cultivars, resistance

Introduction

Mango (*Mangifera indica* L.), a major fruit crop, suffers a huge loss regularly due to ravages of insect pests. Nearly 25 gall-inducing insect species have been reported on mango and the most prevalent is *Procontarinia* spp. (Raman *et al.,* 2009). The mango blossom gall midge, *Procontarinia mangiferae* (Felt) (Diptera: Cecidomyiidae), is reported to infest mango (Kolesik *et al.,* 2009) with an ability to feed on different parts of the mango tree, including inflorescences and young leaves (Raman, 2012). Another species of mango midge (*Erosomyia indica*) has gained much attention in the recent past as it has become a major pest in all mango-growing areas of the world by destroying mango flowers up to 70% (Waqar *et al.,* 2005).

P. mangiferae is a monophagous mango pest; the adult midge is an undamaging minute fly that is short-lived and dies within 24 hours of emergence after copulation and oviposition. Adults emerge from soil pupae and cause serious outbreaks during the mango flowering season (Vincenot and Normand, 2009). Female midges lay eggs on the flowers one by one before they open, and the eggs hatch in less than a week. Young maggots feed inside the flower, causing damage to the ovary and floral content. Infested flower buds turn reddish, black, and shrivel, whereas uninfested buds remain light green to yellow. They feed for about a week before the final instar maggots leave the flower, fall to the ground, and pupate in the soil. Under natural conditions, the life cycle lasts 14 to 25 days (Pezhman and Askari, 2004).

Mango gall midge populations have often been controlled in commercial farms with insecticides (Prasad, 1971; Abbas *et al.,* 1989), but most of them are ineffective against *P. mangiferae* (Barbosa *et al.,* 2002) or need to be spread regularly during the blooming season (Prasad, 1971). Sankaran (1988) reported that mango gall fly is not a serious economic problem in India to which they are indigenous, because parasitoids can control their numbers. However, due to excessive pesticides for other pests in mango, the midge population is flaring up, perhaps due to the loss of natural enemies. In recent years, the spread of this pest has increased and is now recorded in non-traditional areas like Odisha, where it was absent earlier and in South India (Kalleshwaraswamy *et al.,* 2016). Nowadays, its damage level is high enough to create panic among farmers for insecticide and regular spray. Looking at the increasing incidence of this pest, a study was conducted with two objectives i) to know the mango varieties/ hybrids relative susceptibility to blossom midge infestation and ii) to assess the impact of midge infestation on fruit retention and yield under both, chemical regimes and no control situation.

Materials and methods

The experiment was conducted in ICAR-Central Horticultural Experiment Station, Bhubaneswar, during 2014-2016 in a completely randomized block design with 30 varieties/hybrids (Table 1) in 3 replications. The varieties and hybrids of 15-yearold trees in the varietal evaluation block were selected to work out the pest's differential damage. Five panicles in each variety/cultivar were earmarked for each direction of the trees and, data on healthy and midge-infested florets was recorded and percentage damage worked out. The infested flowerets were easily identified as they remained unopened, bent on one side having reddish colour. The fruit number per panicle in each treatment was counted at the stone formation stage to determine fruit retention and fruit weight was taken. For this purpose, the fruits were harvested in the raw stage itself.

To assess the impact of insecticidal treatment, 24 trees of hybrid Amrapali were selected. Of these, two sets were made, each containing 12 trees. One was treated with Imidacloprid 17.8 SL (0.4 mL/L) at the panicle emergence stage and again just before the full bloom with Thiamethoxam 25 WG (0.4g/L), the common spray for hopper and midge. The second set was treated with Imidacloprid 17.8 SL (0.4ml/l) at the panicle emergence stage only and the second spray meant for midge was skipped. The data on midge incidence was recorded in each tree, as stated above. The fruit number and weight per panicle in each treatment were counted at the harvesting stage.

The data was subjected to the analysis of variance (ANOVA) and means values were compared by Tukey's honesty test of significance at 5 and 1%. Fruit number and yield data were subject to the paired t-test.

Results and discussion

First-hand observation on egg-laying and pest damage symptoms indicated the flies laid eggs singly on tender inflorescence axis as reported by Pena *et al.* (1998) and upon hatching, the minute maggots penetrated the florets and started feeding on them. Maggot feeding prevented flower opening and consequently, the floral bud bent aside, became reddish, and gradually dried up (Fig 1). A plastic sheet placed below the infested tree revealed a heavy fall of mature maggots on the ground for pupation into the soil.

The data on flower bud infestation presented in Table 1 reveals that the incidence of midge among the genotypes varied significantly ($F_{29, 58}$ = 25.88; P<0.00). The lowest incidence was recorded on Neel goa (16.15%), followed by Neeleshan (26.1%), whereas the highest was in Alphanso (86.27%), Totapuri (86.42%), H-39(87.39%), Amrapali (88.69%), and Lalsundari (89.48). Based on the relative incidence on the genotypes (percent damage

Table 1. Floral damage, fruit retention and per panicle yield of various mango varieties and hybrids as influenced by blossom midge

Genotype	Blossom midge infestation (%)	Fruit / panicle	Average fruit weight (g)/panicle
Amrapali	88.69[a]	3.07	364.92
Alphanso	86.27[abc]	2.80	305.39
Alfazli	58.49[ijk]	1.21	438.45
Arka Puneet	33.99[m]	1.92	304.92
Banganapalli	74.08[defg]	1.08	311.04
Bombay Green	69.28[fgh]	1.25	275.50
Dashehari	58.44[ijh]	1.88	242.91
H-1084	80.5[abcde]	1.17	335.64
H-1739	66.12[ghi]	2.29	329.44
H-18	76.54[cdef]	2.53	NR
Arunika	87.39[ab]	1.76	NR
H-949	55.55[kl]	2.17	378.05
Himsagar	63.28[hijk]	1.45	380.29
Mallika	80.28[abcde]	1.34	414.69
Manjeera	55.72[jkl]	1.07	316.76
Navneetham	65.68[ghij]	1.73	305.85
Neel Goa	16.15[n]	2.76	542.85
Neeleshan	26.1[mn]	1.63	379.55
Neeleswari	71.91[efgh]	1.83	321.571
Niranjan	75.36[defg]	1.81	172.04
PKM 1	46.94[l]	1.77	323.38
PKM 2	62.91[hijk]	2.00	261.20
Pravasankar	79.91[abcde]	1.16	180.18
Pusa Surya	77.36[bcdef]	1.67	355.20
Rajapuri	75.42[defg]	1.13	NR
Rumani	83.75[abcd]	1.37	NR
Sindhu	63.91[hijk]	1.07	178.94
Totapuri	86.42[abc]	1.14	413.79
Zardalu	72.63[efgh]	1.38	217.95
Lal sundari	89.48[a]	1.78	292.66
CD (0.01)	13.455		
CD (0.05)	10.115	-	-
CV (%)	9.152	-	-

Fig. 1. Damage symptom of inflorescence midge: A) Floral damage. B) Maggot inside the floret

to blossom), the genotypes were arranged in ascending order as Neel Goa >Neeleshan>Arka Puneet>PKM1>H-949>Manjeera> Dashehari>Alfazli>PKM-2>Himsagar>Sindhu>Navneetum>H-739>Bombay Green>Neeleswari>Zardalu>Banganpalli>Nira njan>Rajapuri>H-18>Pusa Surya >Prabhasankar>Mallika>H-1084>Rumani>Alphanso>Totapuri>Arunika>Amrapali>Lalsu ndari. Differential susceptibility of mango cultivars to gall fly infestation is a worldwide occurrence, as indicated by Githure *et al.* (1998), who classified 11 South African mango cultivars into different susceptibility categories to *P. matteiana*. This variation in the genotypes of the blossom midge incidence has been attributed to the cultivar's antixenosis properties, rendering it unsuitable for feeding, shelter, or oviposition by insects. Further, mango varieties evaluated in the present investigation have different bloom periods (Kishore *et al.,* 2015) and different levels of the midge adult population present in the field might have infested the flowers of different varieties and hybrids at different levels. This phenomenon has also been reported by Amouroux *et al.* (2013) as the female gall midges were able to colonize all trees of an orchard from external sources, but they were attracted differently by trees within the orchard concerning the abundance and the phenology of the susceptible parts.

The impact of floral infestation was assessed on fruit number and weight per panicle in different varieties (Table 1). Mango varieties have a particular fruit-bearing pattern and bear a certain number of fruits per panicle. In Langra, Alfazali, Mallika, Sundar Langra, and Totapuri, one fruit per panicle gives satisfactory yield as these varieties have solitary fruit-bearing patterns, whereas varieties like Amrapali bear fruit in the bunch. Based on this varietal character, it was seen that the level of infestation was not directly related to the desired number of fruits in different varieties; however, it seems that it impacted certain varieties like Amrapali, Arka Puneet, Dasheri 51, Rumani, and Pusa Surya as these varieties had less fruit number per panicle than they have under normal condition. It indicated that the varieties with big fruit size and genetically tuned to bear one fruit were less affected by the midge infestation whereas the bunch-bearing varieties were impacted in terms of fruit number. Further, there is a significant growth in mango fruits even after the stone stage in every variety (Lokesh *et al.,* 2017); hence, this significant variation in fruit number and weight recorded at the early stage may not manifest in the yield at the maturity stage.

In the second set of the experiment, the impact of the midge control measure was assessed on its incidence on flower, fruit retention, and yield of mango variety Amrapali. Fruit set in mango at 15th days ultimately determines the yield (Dangi *et al.,* 2017); however, in the present investigation, the fruit retention was recorded at the maturity stage to get the number of fruits reaching maturity as this pest is reported to infest early fruit s*et al*so. Data presented in Table 2 indicates that the floral damage in untreated plants ranged between 73.69-91.37 percent, whereas, in treated trees, it ranged between 61.47-75.47 percent. As such, there was very low (12.22-15.90 percent) flower protection due to additional insecticidal treatment, which confirms the report of Prasad (1971). Accordingly, the fruit number at the harvesting stage in the two treatments ranged between 2.80-4.00/ panicle and 3.1-4.20/ panicle, respectively, giving added fruit retention in a range of 0.20-0.30 fruits/panicle. The corresponding yield per panicle ranged from 1.10 -1.43kg and 1.23-1.50 kg/panicle, respectively. Though the percent flower damage, fruit number, and yield per panicle differed significantly in treated and untreated trees, this statistical significance in fruit number and yield may not be of great economic importance at the maturity stage as 3-4 fruits per bunch in Amrapali gives satisfactory yield.

Table 2. Paired Samples t-test for the impact of blossom midge damage on 'Amrapali' variety

Parameter	Treated Mean±SE	Untreated Mean±SE	t statistic	df	*P*
Percent flower damage (pf)	67.60± 1.24	84.97± 1.54	17.97	11.0	< 0.001
Fruit number (Fn)	3.57± 0.11	3.32± 0.12	-5.33	11.0	< 0.001
Yield (Yld)	1.32± 0.02	1.22± 0.02	8.74	11.0	<0 .001

In mango, fruit number is naturally reduced through fruit fall, which is often heavy (98%) (Sakhidin *et al.,*2004). Otherwise, removing fruits in certain numbers according to specified criteria while maintaining a few fruits is the basic principle of thinning, which reduces the number of unmarketable or below-standard fruits (Pescie and Strik, 2004). The cumulative fruit drop percentage in different mango varieties has been reported from 84.29 to 93.62%, precisely 86.66% in Amrapali up to 45 days of fruit set with a fruit retention level of 13.34% at harvest stage (Dangi *et al.,* 2017). The study indicates a high level of natural flower and fruit drop in mango, implying that flower loss to nearly 75- 80 percent by midge may not cause significant yield reduction.

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