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Estimation of crop loss caused by important insect-pests of mango

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Abstract
A field experiment was conducted at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) during 2009-10 to 2010-11. Application of recommended as well as need based insecticides in protected plots resulted in significantly lower hoppers (3.95 hoppers/twig or panicle), thrips (5.47 thrips/twig or panicle), damages of leaf gall midge (7.24% leaf damage), leaf webber (3.54 web/tree) and fruit fly (7.86% fruit infestation) as compared to the unprotected plots. Number of fruits set at stone (378.54/tree) and harvest stages (232.25/tree) were higher in protected trees giving significantly higher yield in protected (58.06 kg/tree) over untreated (21.82 kg/tree) trees followed by significant lower fruit dropping (38.51%) in the former over the latter (50.58%). The avoidable yield losses due to insect-pests was to the tune of 61.51% resulting into net profit of Rs. 69,780/ ha. in protected trees over control.

Keywords: Important insect-pests, Mango, hopper, thrips, leaf gall midge, leaf webber, fruit fly, yield loss, avoidable loss

Introduction
Mango (*Mangifera indica* Linnaeus) is national fruit of India and known as "King of fruits" due to its wide adaptability, excellent taste, exotic flavour, exemplary nutritive value, richness in variety, attractive colour, appearance and popularity among the masses. The major mango producing countries in the world are India, China, Pakistan, Mexico, Thailand, Indonesia, Brazil, Philippines, Nigeria and Viet Nam. India ranks first in production of mango in the world. Various insect-pests of mango *viz*., hoppers, mealybugs, leaf gall midges, shoot gall psylla, fruitfly, thrips, leag webber, stem borer. Among the insect pests, mango hoppers are major, serious and wide-spread throughout the year in south Gujarat mango ecosystem. Hoppers species *viz*., *Amritodus atkinsoni* (Lethierry), *Idioscopus clypealis* (Lethierry) and *Idioscopus nitidulus* (Walker) remains active and damage each crop stage of mango from emergence of new flush to flowering cum fruit setting stages [3, 18] and causes up to 100% losses. Both nymph and adult hoppers are observed sucking cell sap from young leaves, tender shoots, inflorescences or panicles and rachis of the young fruits which results in non-setting of flowers and dropping of immature fruits. Hoppers also excretes huge quantities of honey dew results in sooty mould formation, thus affects the photosynthesis of the plant. Other than hopper, thrips are major yield limiting factors in south Gujarat and elsewhere [1, 7, 19]. It is a polyphagous, cryptic mannered pest having short life cycle, high mobility towards development of insecticide resistance and infest a wide variety of host plants [11, 21]. In India, the greatest damage to mango crop is caused by these hoppers and at times they are responsible for total crop failure [28]. Not much work has been done on the quantification of losses caused by mango hoppers, although, 20 to 100% loss of inflorescences reported by [26]. The losses due to hopper to the tune of 25-60% [8, 10]. Similarly, [5] has recorded the losses up to 60%. Nymph and adult thrips suck cell sap from tender leaves, shoots, inflorescence and fruits of the mango which results in silvery shine with leaf edges, curling upwards, stunted growth, discoloration of buds and panicles, malformed, premature drops and bronzing of the fruit surface with feeding scars on fruits, thus adversely affects the quality of the marketable produce. Fruit flies, *Bactrocera dorsalis* (Hendel), *B. zonata* (Saunders) and *B. correcta* (Bezzi) are considered to be major bottleneck in economical mango production [2, 31]. It assumes great significance as a quarantine pest. During ripening stage of mango, female fruit fly lays eggs in the fruit skin with the help of ovipositor and after hatching, the maggots start feeding inside the fruit pulp and causes

internal discoloration, emits off flavours, pulp rotting and fruit drop and lastly, pupates in the soil. It causes up to 80% yield loss in mango [29] and total Rs 29, 460 million annual losses in mango, guava, citrus and sapota [22]. Fruit flies cause up to 40% yield loss in heavy rainfall zone of south Gujarat [25]. Other pests *viz*., shoot borer, leaf webber, stem borer, mealy bug, leaf gall midge, leaf damaging insect (ash grey beetle and leaf miner), scale insect, mite, red ants, hairy caterpillar, bark eating caterpillar, semi-looper and fruit borer are recorded as a minor or sporadic pest of mango [14, 25, 27, 29]. So the present investigation to estimate crop loss caused by important insect-pests of mango was carried out at the Regional Horticultural Research Station, Navsari Agricultural University, Navsari.

Material and Methods

A field experiment was conducted at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) during 2009-10 to 2010-11 to estimate avoidable losses due to pest complex in mango cv. Kesar. Twenty four trees were selected with two treatments (treated and untreated). The pest incidence was recorded at weekly interval. Ten terminal twigs and ten panicles were selected randomly during vegetative and flowering stages from the lower canopy of the mango tree. The population of nymphs and adults of mango hopper and thrips were counted by visual count method. In case of leaf gall midge, numbers of healthy as well as damaged leaves were counted on each of the ten terminal twigs from the lower canopy of each tree. Observations of leaf webber were made on the basis of total number of webs on each selected trees, while those of fruit fly were made on the basis of total number of damaged fruits. Percent avoidable losses of fruit yield in different treatments were calculated by comparing the fruit yield of respective treatments with unprotected treatment by adopting following formula.

$$\text{Avoidable crop loss} = \frac{\text{Yield in treated plot (kg/ha)} - \text{Yield in control plot (kg/ha)}}{\text{Yield in treated plot (kg/ha)}} \times 100$$

$$\text{Avoidable economic loss} = \frac{\text{Income in treated plot (kg/ha)} - \text{Income in control plot (kg/ha)}}{\text{Income in treated plot (kg/ha)}} \times 100$$

The treatments were randomized and data on population of important pests of mango were recorded before as well as after each insecticide application. In each treatment except untreated control, need based applications of insecticides were given based on Economic Threshold Level of important pests of mango which is as under:

Sr. No.	Pests	ETL
1.	Hopper	5 nymph or adult or both/twigs at vegetative stage. 5 nymph or adult or both/panicle at flowering stage.
2.	Thrips	10% shoots or panicle damage or presence of thrips.
3.	Leaf gall midge	10% leaf damage
4.	Fruit fly	Presence of fruit fly
5.	Leaf webber	10 webs/tree.

For recording fruit setting per tree, total number of fruits per tree was counted at harvest stage (Physiologically mature fruit) which was later expressed as number of fruits or fruit bearing per tree. For recording yield, the total produce harvested from each selected tree was weighed and expressed as yield in kilograms per tree.

Result and Discussion

Population of mango hopper was compared in protected (P) as well as unprotected (UP) plots (one tree was considered as unit replicate) before and after spraying. Subsequently, cumulative yield loss was compared in both the sets. Hopper population in protected trees (3.95) was significantly lower than in unprotected trees (8.82) (Table-1) whereas, thrips population in protected trees was significantly lower (5.47 thrips/twig or panicle) than unprotected trees (14.77). Moreover, leaf damage (%) in protected trees was significantly lower (7.24%) than in untreated trees (20.68). Protected trees indicated significantly lower webbing (3.54/tree) as compared to the unprotected trees (5.56). For fruit fly, fruit infestation was significantly lower (7.86%) in protected trees as compared to the unprotected trees (24.80). In protected plots, recommended pest management practices (Endosulfan 0.07% at bud initiation stage followed by need based application of imidacloprid 0.005% and thiamethoxam 0.0084%) were given as and when pests attained economic threshold level, whereas trees in unprotected plot were kept free from any insecticide application. Application of recommended insecticides followed by need based application significantly reduced hopper population in protected trees over unprotected trees. Imidacloprid at 0.2-0.6 ml/lit was found effective for a period of 21 days against hoppers complex of *Idioscopus nagpurensis* at 0.2 ml/lit against *I. niveosparsus* [30]. Similar observations were reported by [17] against mango hoppers, *I. clypealis* and *I. brevistylus* in Sri Lanka during February-March. Imidacloprid at 3-4 ml/10 lit of water equally and significantly effective for the control of mango hopper [12]. It also indicated highest reduction of hopper using imidacloprid in Andhra Pradesh [15]. However, higher efficacy of imidacloprid (0.005%) with 96.56% reduction over control reported by [6]. Two applications of thiamethoxam, once at the beginning of flowering and another at the full bloom stage at 50 and 100 g a.i checked mango hopper infestation [23]. In the present investigation, protected trees were applied endosulfan (0.07%) at bud initiation as recommended practice followed by application of imidacloprid (0.005%) and thiamethoxam (0.0084%) on need basis. Mango trees treated with imidacloprid 0.005% had significantly lower leaf damage (1.73%) during March [24]. The maximum fruit infestation coincided with harvesting period i.e. May to July in mango. Similar, observations were made by [16, 20] in Gujarat and [9] in Uttar Pradesh. Highest (34.66%) fruit infestation reported in second week of June by [4].

Fruit Yield

Number of fruits set at stone size fruit (378.54/tree) and harvest (232.25/tree) stages were significantly higher on protected trees than unprotected trees (179.71 and 87.29/tree at respective stages) which ultimately resulted in significantly higher yield in protected (58.06 kg/tree) as compared to the unprotected (21.82 kg/tree) trees. Significant lower fruit dropping was also observed from protected trees (38.51%) over the unprotected trees (50.58%) (Table 2).

Avoidable loss

Avoidable yield loss from important insect-pests of mango was worked out to the tune of be 61.51% which resulted in net profit worth of Rs. 69,780 per ha. By imposition of recommended and need based treatments in protected trees (Table 3). From the present findings, it may be interpreted that application of recommended insecticides (endosulfan 0.07% at bud initiation) followed by imidacloprid 0.005% and thiamethoxam 0.0084% on need basis showed avoidable loss of 60.79-63.39% from important insect-pests of mango in protected plots. 20-100% loss of inflorescences by hoppers reported by [30]. Losses due to hoppers to the extent of 25-60% reported by [8, 10]. Similarly, [5] has also recorded loss up to 60%. In a field experiment conducted in Maharashtra during 1998, 1999 and 2001, 46.30 and 41.09% increase in yield was also observed over control in second and third sprays, respectively [4].

Conclusion

Application of recommended as well as need based insecticides in protected plots resulted in significantly lower hoppers and thrips and damages of leaf gall midge, leaf webber and fruit fly as compared to the unprotected plots. Number of fruits set at stone and harvest stages were higher in protected trees giving significantly higher yield in protected (58.06 kg/tree) over untreated (21.82 kg/tree) trees followed by significant lower fruit dropping in the former over the latter. The avoidable yield losses due to insect-pests was to the tune of 61.51% leading to net profits over control of Rs. 69,780 per ha.in protected trees.

Table 1: Incidence of important insect-pests of mango in protected and unprotected plot in 2009-11

Pair No.	Avg. No of Hoppers/twigs or panicle		Avg. No of thrips/twigs or panicle		Leaf Damage (%)		No. of web/tree		% fruit infestation	
	P	UP	P	UP	P	UP	P	UP	P	UP
1.	3.47	8.72	4.75	16.34	6.39	20.68	4.00	4.75	7.84	18.14
2.	3.76	8.21	5.34	15.59	6.90	20.19	3.75	5.25	8.99	22.41
3.	4.14	9.07	6.32	16.59	6.81	19.43	4.00	5.75	8.32	27.24
4.	4.09	8.51	5.05	14.92	7.52	19.89	2.75	4.75	6.16	27.15
5.	4.03	8.24	5.65	14.05	7.62	20.94	3.50	6.00	5.84	28.80
6.	3.84	8.89	5.92	14.83	6.82	20.41	3.50	6.00	6.88	27.51
7.	3.54	8.98	5.57	13.38	8.11	22.38	3.50	5.25	10.28	25.61
8.	3.57	8.19	5.61	13.90	7.60	21.43	4.25	5.00	6.88	21.84
9.	3.79	8.28	6.50	13.98	7.59	20.95	2.50	5.75	9.35	21.76
10.	4.19	9.31	4.74	14.19	7.21	20.79	3.50	7.50	7.14	31.56
11.	4.48	9.44	5.00	14.19	7.24	20.30	3.75	5.50	9.17	25.32
12.	4.48	10.06	5.26	15.31	7.04	20.78	3.50	5.25	7.53	20.26
Mean	3.95	8.82	5.47	14.77	7.24	20.68	3.54	5.56	7.86	24.80
SD	0.345	0.584	0.566	1.012	0.47	0.753	0.491	0.741	1.37	3.936
Variance	0.11	0.346	0.323	1.026	0.227	0.56	0.241	0.552	1.898	15.46
T value	38.654**		27.108**		80.297**		7.465**		12.888**	
*Significant at 5% Table t value (0.05): 2.201			**Significant at 1% Table t value (0.01): 3.106							

Where, P=Protected, UP=Unprotected.

Table 2: Yield attributes as influenced by crop loss in 2009-11

Pair No	No. of fruits/tree				Fruit Drop%		Yield (kg/tree)	
	Marble/ stone size fruit		Harvest stage					
	P	UP	P	UP	P	UP	P	UP
1.	391.00	204.50	250.50	85.00	35.28	58.18	62.63	21.25
2.	409.00	168.50	233.00	84.00	43.32	50.79	58.25	21.00
3.	300.50	243.00	183.00	102.00	39.01	58.00	45.75	25.50
4.	370.00	166.00	256.00	83.50	29.34	50.88	64.00	20.88
5.	336.50	230.50	183.50	94.00	45.54	57.88	45.88	23.50
6.	474.50	178.00	287.00	92.50	38.02	50.37	71.75	23.13
7.	430.50	161.00	281.00	84.00	33.74	46.37	70.25	21.00
8.	429.50	161.00	255.50	85.00	40.45	46.92	63.88	21.25
9.	331.00	157.00	214.00	79.50	35.98	48.54	53.50	19.88
10.	372.50	155.50	201.00	91.00	48.14	41.39	50.25	22.75
11.	374.50	174.00	243.00	85.00	35.13	51.13	60.75	21.25
12.	323.00	157.50	199.50	82.00	38.15	46.53	49.88	20.50
Mean	378.54	179.71	232.25	87.29	38.51	50.58	58.06	21.82
SD	51.273	29.913	35.81	6.341	5.267	5.24	8.95	1.585
Variance	2628.741	894.929	1282.938	40.241	27.7	27.526	80.171	2.51
T value	10.022**		12.995**		5.275**		12.993**	
*Significant at 5% Table t value (0.05): 2.201					**Significant at 1% Table t value (0.01): 3.106			

Where, P= Protected, UP= Unprotected

Table 3: Economics of avoidable loss

Treatment	2009-10		2010-11		2009-11 (Pooled)	
	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected
Total spray	3	-	3	-	3	-
Yield (kg/ha)	6417	2463	5196	1902	5806.50	2182.50

Yield loss (kg/ha)	-	3954	-	3294	-	3624.00
Gross Return (Rs/ha)@ Rs 20/kg of mango	128340	49260	103920	38040	116130.00	43650.00
Pesticides cost	1500	-	1500	-	1500	-
Spraying charges (Rs.)	1200	-	1200	-	1200	-
Net Return	125640	49260	101220	38040	113430	43650
Net profit over control	76380	-	63180	-	69780	-
Avoidable loss (%)	60.79	-	63.39	-	61.51	-

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