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Impact of Climate Change on Population dynamics of fruit fly in Mango Orchard and Control through Integrated Pest Management Practices in Agro-ecological Zone of Rahim Yar Khan Southern Punjab Pakistan

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Abstract

The mango fruit flies Bactrocera dorsalis (Hendel) and Bactrocera zonata (Saunder) are known as key pest of fruits in Pakistan. The objective of this study was to assess the effect of climate change, temperature, relative humidity and rain on the development and survival of fruit flies B. dorsalis or B.zonata (Diptera:Tephtritidae) and control through pest management practices in mango orchard. An experiment was carried out at Government Progeny Garden (Latitude; N 28°39'06.3036" & Longitude; E 70°41'57.3144") Khanpur Rahim Yar Khan South Punjab Pakistan during the period from March to September 2020. Environment friendly control through IPM practices were tested in reducing the undesirable fruit flies population responsible for decreasing the yield and the crop quality. The climate of agro-ecological zone of Rahim Yar Khan Southern Punjab, Pakistan is changing yearly rainfall, soil moisture, relative humidity, soil and air temperature and weeds within orchards effect the population of fruit flies. The population of fruit fly increased with the increase of temperature. Five management practices were studied which were simple, practical and low cost green chemical approach was developed that have a significant potential for crop protection, excellent efficiency and favorable safety profiles. Five treatments i.e biocontrol agent, bait application technique (BAT), male annihilation technique (MAT), field sanitation and control were tested. The experiment was laid out in randomized complete block design (RCBD) with three replications. All the treatments showed significant variations on all the parameters studied. The highest mature fruit set (400) per plant in sanitation management practices and lowest mature fruit set (79) per plant in control without management. The lowest percentage premature fruit drop (8) per plant in sanitation and highest percentage premature fruit drop (37) per plant in control without any management practice.

***Keywords**: Fruit fly, integrated pest management (IPM), Infestation, Mango*

Introduction:

Mango (*Mangifera indica L.*) is one of the most popular, valuable and commercially important fruit in Pakistan, either ripe or unripe are the rich source of minerals as well as vitamins (Paramanik, 1995). Mango contains soluble sugar, vitamin C and appreciable quantity of iron and carotene. Moreover, it provides a lot of energy (as much as 74kcal/100g edible portion) which is nearly equals the energy values of boiled rice of similar quantity by weight (Hossain, 1989).Fruit flies (Diptera : Tephtritidae) are recognized worldwide as the most important insect pests to fruits, especially mangos (Drew et al., 2005; Vayssieres et al., 2008; Ekesi et al., 2009). *Bactocera dorsalis* is widely recognized as either one of the most damaging horticultural pest where if occur or as a high level quarantine threat to food production of importing countries where it is absent but capable of invasion and establishment (white et al., 2005). Female fruit flies lay eggs under the skin of the fruit, which hatch into larvae that feed in the decaying flesh of the crop. Infested fruits quickly rot and become inedible or drop on the ground, thus causing direct loss to the farmer. Besides the direct damage to the fruits, indirect loss is associated with

quarantine restrictions that are imposed by fruits and vegetables importing countries. Among the pests, fruit flies by far the most significant ones, they are considered to be one of the most dangerous crop pests in the world (De Meyer, 1998). Most of the farmers of agro-ecological zone of Rahim Yar Khan indiscriminate and improper use of pesticides create major problems such as development of pest resistance to pesticides, outbreak of secondary pest, destruction of beneficial organisms, hazards to the human health and pollution of the environment. Unfortunately, chemical control is not effective in stopping the damage caused by flies, because fruit flies have a complex biology and chemical control has adverse effects on environment, producers and consumers (Pierre et al., 2015)**.**

Climate change also affects the rate of insect's invasions as well as the abundance, distribution and impacts of such invasions on global scale. Climate change especially with the increase of temperature is likely to increase fruit fly damage and control costs to commercial growers of agro-ecological zone of Rahim Yar Khan. The climate change may alter the distribution of suitable habitat for fruit flies, development and continuation of life cycle. Climate change in agro-ecological zone of Rahim Yar Khan increasing temperature, relative humidity and changing precipitation regimes simultaneously for improving the suitability of fruit flies.

The pest management practices throughout the world are increasingly leaning towards more environment friendly agriculture without disturbing the balance of the eco-system (Tillman et al., 2002) so, this study was conducted to overcome the problems of pesticide use, environmentally sound and safe method of integrated pest management practices was prime importance for domestic food security and prevalence, population dynamics in mango orchard with respect to climate change and guide the mango growers in the country for successful control measures against fruit fly.

Materials and methods:

This experiment was conducted at Government Progeny Garden Khanpur District Rahim Yar Khan during the period from March to September 2020 for monitoring of population of fruit flies 15 sex pheromone traps/hectare using male lure methyl eugenol (ME) were installed at an approximate height of 2 m, on Southern Part of the canopy, at a minimum distance of 20 m one from each other. *Bactrocera dorsalis* makes, like many other *bactrocera species*, are strongly attracted to methyl eugenol (ME), aphenylpropanoid compound naturally occurringly in many plants species (Shelly,2010) Sex attractants lure methyl eugenol (ME) and insecticide (spinosad) were renewed fortnightly bases in order to maintain their attractive and insecticide effects, for monitoring and recorded the population dynamics of fruit flies on daily basis with influence of climate change (Vayssieres et al., 2009, Mwatawala et al., 2009). Data of temperature, relative humidity and rain were taken from Government observatory khanpur. The experiment consists of 5 management practices i) T1= Control through biocontrol agents (parasitoids), ii) T2 = Bait application technique (BAT), iii) T3 = Male inhalation technique (MAT), iv) T4 = Sanitation (weeding and pruning), v) T5 =Control. In treatment biological control of pest population through their natural enemy (parasitoids), three types of parasitoids i- Larval pupal parasitoids (*Diachasmimorpha Longicaudeta* Ashm). ii- Larval pupal parasitoids *Trybliographa daci* weld iii- Pupal parasitoids (*Dhirhinus giffardi* Silv) were collected and released in mango orchard. In treatment bait application technique (BAT) female flies need protein for ovarian development and egg production. Therefore, protein baits containing 300 ml protein hydrolysate, 5ml insecticides spinosad and mixed with 9695 ml water, this prepared 10 litter of solution were sprayed in one hectare. Sprayed this solution in one meter square area on each alternate tree canopy for the control of female fruit flies. Flood jet nozzle giving droplet size 4-6 mm were used, four spray were done for one cropping season. In treatment male annihilation technique (MAT) prepared the solution mixed 300 ml of methyl eugenol (ME) as part of an environment friendly, lure and kill approach (Christenson, L.D 1963, Cunnigham. et.al; Steiner. et.al; 1955) and add 5 ml insecticide spinosad. Dip the wooden fiberboard squares (1 cm x 5 cm x 5 cm) for 48 hours and were installed on the stem of plant having height of 2 meter above the ground (Stonehouse et.al.,

2005) from April to August in mango orchard. Efficacy of these wooden blocks were remained for 15 days and after 15 days solution again applied on wooden fiberboard squares for the control of male fruit flies, five wooden fiber blocks were installed in one hectare. In treatment field sanitation technique destroyed all the developing larvae in the infested dropped fruits which were breeding sites of fruit flies, the larvae completed their feeding and pupate in the soil for next generation. Weeding, pruning of dead branches and collected the fallen fruits and dispose them by dumping, burying in 60 cm deep pits, ploughed the interspaces in the orchard to eliminate the pupation process of fruit flies. In treatment five no management practices were done. The experiment was conducted in randomized complete block design (RCBD) with 3 replications. The data were collected done base on following points- number of fruits set per plant, premature fruits drop per plant, % premature fruits drop per plant and mature fruits set per plant. The data were statically analyzed by using Fisher's anayalsis of variance technique and least significant difference (LSD) test @ 0.05 probability was applied to compare the significance of treatment means (Steel et al., 1997).

Results and Discussions:

Effect of Management Practices:

Main effect of management practices on number of fruits set per plant.

Different management practices had significant influence on the number of fruits set per plant, sanitation practice resulted the highest fruit set per plant (435) followed by male inhalation technique (356), bait application technique (312), biocontrol agents (parasitoids) (230) and the lowest (125) was in control (in table-1). This showed that proper management practices might have influenced fruit set per plant.

Table-1: Effect of management practices on Number of Fruits set/plant, premature fruits drop per plant, % premature fruits drop/plant and Mature fruits per plant.

Treatments	No. of fruits set/plant	Premature Fruits drop/plant	% Premature fruits drop/plant	Mature fruits set/plant
Control through Biocontrol agents (parasitoids)	230d	23c	10bc	207c
Bait application technique (BAT)	312c	37ab	12b	275bc
Male inhalation technique (MAT)	356b	43a	12b	313b
Sanitation(weeding and pruning)	435a	35b	8c	400a
Control	125e	46a	37a	79d
LSD Value	44	5	2	40
Level of Significance	0.05	0.05	0.05	0.05

Main effect of management practices on premature fruits drop per plants.

The effect of management practices on average premature fruits drop was found to be statically significant. The lowest premature fruit drop was found under biocontrol agents (parasitoids) (23), management practices followed by sanitation (35), bait application technique (37), male inhalation technique (43) the highest (46) was on control (table-1). This variation might be occurred due to different management practices.

Main effect of management practices on percent pre-mature fruits drop per plant.

The effect of management practices on % premature fruit drop was found to be statically significant. The lowest (8%) pre-mature fruit drop was found under sanitation management practices and highest (37) premature fruits drop was found in control where no management practices were applied (table-1). Whereas premature fruits drop in bait application technique and male inhalation technique was at par (12%) in (table-1).

Main effect of management practices on mature fruits per plant.

The effect of management practices on mature fruits set per plant was found to be statically significant the highest number of mature fruits (400) was found under sanitation measurement practice followed by male inhalation technique (313) this showed that the application of semio chemicals has been an integral part of sustainable pest management programs for more than 40 years, being used in several times of controlling actions (Baker,2009).The mature fruits set in bait application technique were (275)followed by biological agents (parasitoids) (207) and the lowest (79) was in control (Table 1).This showed that proper management practices might have influenced fruit set per plant.

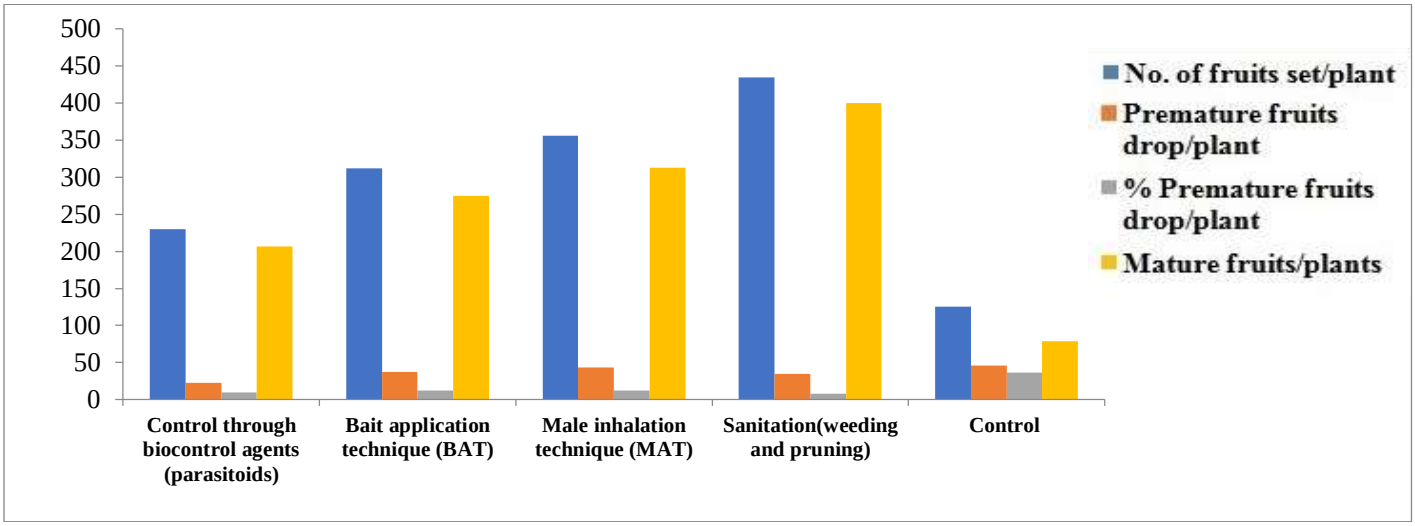

Fig.1 Effect of control measures in different management practices.

Effect of Temperature, Relative Humidity and Rain on Population Dynamics of Fruit Fly.

Fruit flies activity and population vary through the period and the metrological data showed that with the increase of temperature the population of fruit fly increased. Temperature is one of the most important factor affecting the developmental rate through the various life stages of fruit fly (Fletcher 1987). The maximum population were trapped in the month of June, when temperature was maximum. This showed that with the increase of fruit flies population, the attack of fruit flies on mango orchard was maximum in the month of June. It was evident that population of fruit flies start increasing from the month of march and was reached in maximum level in the month of June and then decreased with the decreased of temperature. Temperature is considering the main environmental factor that affect the survival and developmental rate through each immature stage of life history, also, hence the rate of survival from egg to adult emergence in fruit flies (Meats, 1984).Metrological data showed that in the month of April to August, fruit flies were most active because suitable host fruit was available. During this study it was noticed that fruit fly were active in the morning time started at dawn for searching of food and seemed to be regulatory element of the temperature of this behavior, so this was proved that temperature, humidity and rainfall were very strong factors that regulate development rates and other population process in fruit flies.

Table-2 Metrological Data (March to May 2020)

Maximum and Minimum Mean Temperature and Relative Humidity and Rain	March				April				May			
	Temp °C		RH %	Rain (mm)	Temp °C		RH %	Rain (mm)	Temp °C		RH%	Rain (mm)
	Max	Min			Max	Min			Max	Min		
	28.67	17.6	68.74	25.7	33.67	23.03	62.56	1.2	41.16	25.67	57.41	3.3
No of Fruit flies catch per day	91				146				189			

Table-3 Metrological Data (June to September 2020)

Maximum and Minimum Mean Temperature and Relative Humidity and Rain	June				July				August				September			
	Temp °C		RH %	Rain (mm)	Temp °C		RH %	Rain (mm)	Temp °C		RH %	Rain (mm)	Temp °C		RH %	Rain (mm)
	Max	Min			Max	Min			Max	Min			Max	Min		
	43.06	28.4	57.06	2.4	40.41	27.29	62.12	43.4	39.16	27.9	67	39.6	38.83	26.2	65.2	0
No of Fruit flies catch per day	316				279				185				169			

Conclusions:

As well as control measures for fruit flies a single method is not sufficient to effective control of fruit flies in ecological zone of Rahim Yar Khan southern Punjab. The best result were gained from different methods which were studied in the experiment. For example, BAT, MAT and good hygiene have been made combination in attempts to eradicate fruit flies, according to Verghese et al., (2004; 2006).The practice of IPM to control *B.dorsalis* can give very high reduction of infestation in mango fields, level of reduction between 75% and 100% are possible if sanitary measures such as removing of fallen fruits are applied. Fruit left on the ground serve as important breeding sources (liquido,1991).It is urgent need of time to trained the farmers of ecological zone of Rahim Yar Khan southern Punjab (Pakistan) in the use of sustainable control measures to approach integrated pest management practices.

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