

Short communication

EFFECT OF INTERCROPPING OF MAIZE IN CITRUS ORCHARDS ON CITRUS LEAF MINER INFESTATION AND POPULATION OF ITS NATURAL ENEMIES

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An experiment was conducted to determine the effect of intercropping of maize fodder in months of monsoon (July to October), in Faisalabad, Pakistan, on infestation of citrus leaf miner (CLM) (*Phyllocnistis citrella* Stanton) and its predators. Lemon, Kinnow, Grapefruit and Musambi intercropped with and without maize were selected for recording data on these insects. Percent leaf miner infestation and number of predators were recorded from randomly selected branches of citrus trees. Results showed that intercropped plots of each variety had low infestation of citrus miner and high population of coccinellids and *Chrysoperla carnea* when compared with Tuckey's Test at $p < 0.05$. The mean CLM infestation on Kinnow and Musambi was 8.40 ± 0.144 and 12.72 ± 0.171 in intercropped and 9.12 ± 0.169 and 14.52 ± 0.200 in without intercropped plots, respectively. Interaction of population of *Chrysoperla carnea* and coccinellids was non-significant for months, varieties and intercropping but was significant within months, varieties and intercropping. The possibility of using maize fodder as intercrop in autumn in citrus is discussed.

Keywords: Intercropping, maize, citrus, leaf miner, natural enemies

INTRODUCTION

Intercropping of citrus with legume crops resulted in high nutrient availability (Lamberts, 1984; Yaseen and Ahmad, 2010). The use of intercropping in citrus groves has major viability in the presence of HLB (Huanglongbing), since it can reduce the risks of the activity and leads to higher income if well executed (Kilcher, 2005; Stuchi and Girardi, 2010). With regard to yield, pooled data analysis for intercropped versus monocropped citrus orchards showed superiority of monocultured ($68.5 \text{ kg tree}^{-1}$) over intercropped ($51.4 \text{ kg tree}^{-1}$) orchards. But, intercrop specific analysis revealed that citrus orchards with legumes as intercrop (soybean and chickpea), produced significantly ($p < 0.05$) higher fruit yield ($72.2 \text{ kg tree}^{-1}$) as compared to orchards without intercrops ($68.5 \text{ kg tree}^{-1}$) (Srivastava *et al.*, 2007). The citrus cultivation methods with the Egyptian clover gave the best results without significant differences between them regarding vegetative growth, yield and soil fertility (Abdel-Aziz *et al.*, 2008).

Recent reports from Vietnam indicate that infestations of *Diaphorina citri* and, consequently incidence of citrus greening disease in citrus, are negated to a large extent when citrus is interplanted with guava, *Psidium guajava* L. (Hall, 2008; Rouseff *et al.*, 2008). Effect of intercropping on the infestation of major insect pests of citrus and their natural enemies has not been evaluated in different situations. Intercropping *Ageratum conyzoides* L. (Billygoat-weed) in citrus orchards may increase the population of predatory

mite *Amblyseius newsami*, an effective natural enemy of citrus red mite *Panonychus citri*, which keep its population at low and no injurious levels (Kong *et al.*, 2005).

The present studies were conducted to determine effect of intercropping of maize fodder in the monsoon season in citrus orchards of different varieties and their effect on infestation of citrus leaf miner (*Phyllocnistis citrella* Stainton) and its predators in district Faisalabad.

MATERIAL AND METHODS

Three sites for orchards were selected for recording data regarding leaf miner and its natural enemies in Faisalabad. Lemon orchard at Meranwala Bangla, Citrus Research Area at Post-graduate Agricultural Research Station (PARS) and a citrus orchard at Dalowal Faisalabad were selected. The studies were carried out during the months of July to October, 2011. The maize fodder was used as intercrop in the orchards of same variety as well as no fodder as control. Orchards selected around Faisalabad were more than ten years old.

Ten trees of each citrus variety were tagged at each location and from each tree, 25cm long branches on the four sides of a tree were selected randomly. Percent citrus leaf miner (*Phyllocnistis citrella* Stainton) infestation and number of *Chrysoperla carnea* larvae and Coccinellids beetles were counted on the selected branches. Data were collected on these insects from locations with and without maize intercropping in orchards of respective citrus varieties.

The comparison of population of natural enemies and citrus leaf miner infestation was done with 3-way analysis of variance and means were compared with HSD Tukey's test at $p < 0.05$ (Minitab version 11).

RESULTS

The highest population of coccinellids was found on Musambi which had significant difference with other varieties; however, had significant difference among them. Coccinellids had statistical similar population in the months of July and August, being high in former month, thereafter, population gradually decreased (Table 1). The population of coccinellids was high in intercropped plots of each variety. Lemon and Kinnow had statistically similar population. The population of coccinellids was high in intercropped plots in various months comparatively in the plots without intercrop. The interaction of coccinellid population in different varieties and months with intercropped and without intercropped locations was non-significant.

The results of population of *Chrysoperla carnea* in different

months and varieties was non-significant, however, number of *C. carnea* was high in intercropped plots as compared to without intercropping (Table 2).

Interaction of months x varieties showed that lowest infestation of citrus leaf miner was seen in month of October on Grapefruit (Table 2). Intercropped plots of lemon had the lowest infestation of citrus leaf miner (7.56), the highest being in Musambi (14.52) without intercrop. Infestation of citrus leaf miner was significantly low in intercropped plots than without intercropping (Table 3).

DISCUSSION

The results of present studies showed that intercropping of maize with citrus decreased citrus leaf miner infestation the population of Coccinellids and *Chrysoperla carnea* were high in intercropped plots of respective varieties. Intercropping of legume and many other crops including food and oil seed has been recommended to maximize land use and increasing fertility of soil by availability of nutrients (Lamberts, 1984; Yaseen and Ahmad, 2010). The yield of

Table 1. Coccinellids population on different citrus varieties in intercrop and without intercropped orchards

Variety	Intercropping		Mean
	With	Without	
Lemon	2.47±0.078	2.15±0.083	2.31±0.058b
Kinnow	2.56±0.080	2.11±0.101	2.34±0.066b
Musambi	2.98±0.098	2.49±0.088	2.73±0.067a
Grapefruit	2.13±0.073	1.91±0.073	2.02±0.052c
Mean	2.54±0.043a	2.16±0.044b	

Values are means±SE; Means sharing similar letter in a row or in a column are statistically non- significant ($P > 0.05$).

Table 2. C.carnea population on different citrus varieties intercrop and without inter cropped orchard.

Month	Variety				Mean
	Lemon	Kinnow	Musambi	Grapefruit	
July	7.94±0.18def	8.93±0.23cd	14.21±0.26a	8.83±0.17cde	9.98±0.181A
August	7.90±0.19efg	9.19±0.21c	14.14±0.28a	8.53±0.16cde	9.94±0.181A
September	8.11±0.22def	8.67±0.21cde	13.47±0.28ab	7.94±0.16d-g	9.55±0.174B
October	7.29±0.22fg	8.24±0.23c-f	12.65±0.28b	6.96±0.13g	8.78±0.175C
Mean	7.81±0.10C	8.76±0.11B	13.62±0.14A	8.07±0.08C	

Values are means±SE; Means sharing similar letter in a row or in a column are statistically non- significant ($P > 0.05$); Small letters represent comparison among interaction means and capital letters are used for overall mean.

Table 3. CLM infestation on different citrus varieties in intercrop and without intercropped orchards.

Variety	Intercropping		Mean
	With	Without	
Lemon	7.56±0.153e	8.06±0.141de	7.81±0.105C
Kinnow	8.40±0.144d	9.12±0.169c	8.76±0.113B
Musambi	12.72±0.171b	14.52±0.200a	13.62±0.142A
Grapefruit	7.84±0.123de	8.29±0.124d	8.07±0.088C
Mean	9.13±0.114B	10.00±0.136A	

Values are means±SE; Means sharing similar letter in a row or in a column are statistically non- significant ($P > 0.05$); Small letters represent comparison among interaction means and capital letters are used for overall mean.

intercropped citrus orchards was also improved as compared to monocropped orchards (Srivastava *et al.*, 2007; Abdel-Aziz *et al.*, 2008) however a few studies are presented to affect predatory fauna in citrus orchards (Kong *et al.*, 2005). The preference of citrus psylla (*D. citri*) was found to be changed in the presence of guava in citrus orchards and many repellent chemicals have been isolated to determine the reason of such an effect (Hall, 2008; Zaka *et al.*, 2009). We hypothesize here that maize being host of many predatory insects can have a significant effect on reduction of citrus leaf miner. Since effect was seen on each citrus variety, it is possible that a predator-prey relationship is positive and density of predators increased in the presence of maize in the citrus orchards. Maize may also serve as hiding places for predators.

Two approaches can be considered for intercropping in citriculture. In the first one, the cultivation of secondary crops in-between rows is recommended before citrus trees reach higher size (Stuchi and Girardi, 2010). In this case, maize would be an ideal crop to be used as intercrop for fodder. A second approach considers citrus as a temporary crop; in this case, its cultivation is an additional and anticipated income during the exploration of another species of interest. The second approach cannot be sought as focus is on citrus and intercrop is considered temporary. Further studies are suggested to explore the suitability of maize fodder as intercrop in the citrus which can reduce citrus leaf miner infestation as guava had shown for citrus psylla (Hall, 2008). To our knowledge, this is first report of the effect of maize intercrop on citrus leaf miner and its predators.

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