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Evaluation of new chemistry insecticides for controlling invasive pest in citrus orchard

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Abstract

The field experiment was planned to evaluate the efficacy of different new chemistry insecticides viz. Thiamethoxam, Imidacloprid, bifenthrin and Spintoram for controlling Citrus Leafminer (CLM) at Chishtian during 2017. All the insecticides were effective however thiamethoxam gave better control after 24 and 48 hours so that Bifenthrin and Spintoram were efficiently controlled CLM after 72 and 96 hours of spraying. The R^2 value is greater (R^2=0.7279) after 24 hours of spraying than other treatments which indicated highly significant regression of CLM population with environmental conditions (Maximum & Minimum temperature (^oC), Morning and Evening Relative Humidity (%) however moderate trend line was developed after 48 (R^2=0.4346), 72 (R^2=0.6665) and 96 (R^2=0.5951) hours of treatment compared to control. The data was collected before spraying in a same sprayed plot showed moderate regression relation (R^2=0.5252; R^2=0.5454; R^2=0.4923; R^2=0.5475) compared to environmental conditions. At the end it was concluded that the farmers of this region are advised to use bifenthrin and spintoram for the best management of citrus leafminer with the consultation of Pest Warning and Quality Control of Pesticides, Chishtian.

Keywords: *Phyllocnistis citrella*; new chemistry insecticides, Control, Southern, Punjab-Pakistan

Introduction

Citrus leafminer (CLM), *Phyllocnistis citrella* Stainton belongs to family Gracillariidae and Order Lepidoptera distributed serious primary pest of citrus orchards (Heppner 1993). The species of citrus like Mandarins, Oranges and Grapefruit are important in the world along with Pakistan. Many different native and invasive insect pest attacks on the citrus plant however CLM is native to South Asia and China (French et al. 2001, Legaspi et al. 1999). The pest declines in winter however in spring its significant populations were recorded (Knapp 1995). Hence trees of three years old are less susceptible to leafminer attack. The CLM laid eggs singly beneath the fleshy leaves, hatch in few days and become larvae which immediately enter in the leaf sheath and start feeding. Larvae started to develop mines resulting curling and injured the leaves. Usually one mine is present per leaf, but in high attack may be 2 to 3. The young larvae having 4 instars, its development takes place from 5 to 20 days and it pupate in mine. The adults of

insect emerge out in dawn and active in morning, the other activities take place in dusk however females lay eggs at evening (Badawy 1967, Beattie et al. 1995, Heppner 1993). The feeding infestation is limited on the epidermal layer producing a transparent thin covering or silvery film over the mine which contains cuticle and cell wall (Belasque et al. 2005). After heavy infestation the curling of the leaves takes place which later become chlorotic resultantly necrotic. Hence infested leaves are frequently deformed resulting detach from the plant (Achor et al. 1997, Peña et al. 1996). The leaf injured after feeding also facilitates the transmission and source for the establishment of bacterium causing citrus canker (Ando et al. 1985, Cook 1988, Gottwald et al. 1997, Gottwald et al. 2001, Hill 1918, Rodrigues et al. 1998).

Insecticides play a vital role for suppressing insect-pest populations especially during high infestations. Haphazard use of chemical pesticides against this pest create resistance (Hoy 1996) however chemicals leave harmful effects on natural enemies and naturally grown populations (Huang and Li 1989). The adults of the insect prolong its period and overlap its emergence resulting multiple sprays recorded (Peña 1998). The practice of cultural and biological control occurred simultaneously on the Mediterranean coast of Europe, in the Middle East, and North Africa from 1993 to 1995 (Malausa , Uygun). The present study had been planned to evaluate the effectiveness of four pesticides for controlling leafminer in citrus orchard (CLM) Chishtian, Punjab-Pakistan.

Materials and Methods

Experimental outline

The field experiment was laid out to evaluate the efficacy of different new chemistry insecticides viz. Thiamethoxam 25WG @ 62gha^{-1}, Imidacloprid 20SL @ 187mlha^{-1}, bifenthrin 10EC @ 150mlha^{-1} and Spintoram 360SC @ 50mlha^{-1} for controlling leafminer in citrus orchard (CLM) compared to control and the data before spraying in same plot in moonsoon season at Chishtian. Randomized Complete Block Design (RCBD) with three replications (each replication having three rows in hectare) was considered at village Chak 211/F Tehsil Chishtian with latitude of 29.800 and longitude 72.867 during 2017. The insecticides were sprayed manually by knapsack hand sprayer with a spray volume of 250literha^{-1} through hollow cone nozzle. The numbers of citrus leafminor (CLM) populations before and 24, 48, 72, 96 hours along with control treatments were recorded with the help of magnifying lens. Mortality (%) was recorded by pest scouting taking hundred old, fresh and affected leaves randomly selected from three different locations from each plot by using equation (1).

$$M = \frac{\sum IB - \sum IA}{\sum IB} \times 100 \qquad (1)$$

Where M = mortality percentage; IB = Insect population before treatment; IA = Insect population after treatment (Iqbal 2015).

Data analysis

The final data were analyzed statistically by one-way ANOVA in conjunction with test (Steel et al. 1997). Mean differences were calculated by the Duncan's Multiple Range (DMR) test at ($P<0.05$) significant level. All analysis were carried out using SPSS 13.0 (Inc.) (Feng et al. 2009) however the graphical representations were adopted by using Sigma-Plot 10 software.

Coefficient of determination

The Coefficient of determination (R^2) value in a chart was used to test the models for validity that develop a trend or regression type between two variables (Hossain et al. 2017).

Results and Discussion

Figure-1 showed that maximum mortality was recorded by the application of bifenthrin (31.07%) and thiamethoxam (30.99%), these were statistically non significant ($P>0.05$) to each other but differed significantly ($P<0.05$) with other treatments 24 hours after spaying using one-way ANOVA. However after 48 hours significant mortality was recorded by spraying of thiamethoxam (54.01%). Bifenthrin recorded significantly high mortality (64.46%, 83.63%) after 72 and 96 hours however Spintoram after 96 hours produced (84.35%) compared to all other treatments. Our results are in line with researcher who reported that imidacloprid gave better efficacy on CLM because of systemic mode of action (Salas et al. 2006) however the growth of nurseries and newly planted trees of citrus were retarded due to its heavy infestation. The researcher recorded that Thiamethoxam was effective for controlling *P.citrella* used @ 10g a.i. ha^{-1} in water, however this concentration gave maximum mortality of CLM when

used in petroleum oil (Raga et al. 2001). Thiamethoxam 25WG (0.06 %) was the most significant treatment for controlling citrus leafminer (Jadhav 2015). *Phyllocnistis citrella* Stainton was controlled significantly with systemic insecticides i.e. Imidachloprid, Thiamethoxam (Saravanan and Savithri 2005). In soil application of imidacloprid, acetamiprid and thiamethoxam revealed that all these insecticides were effective for controlling CLM upto 20 days after application (Chadda et al. 2009).

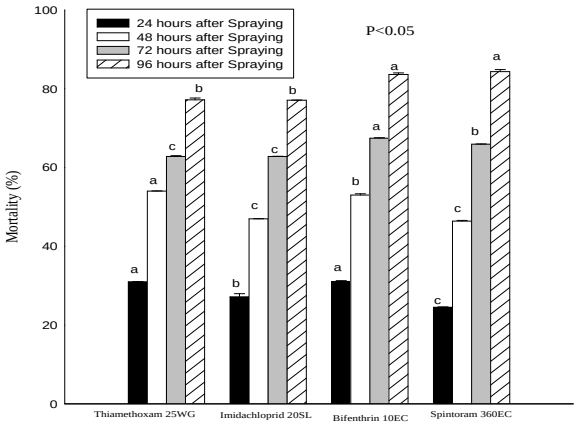

Figure-1 showing mortality (%) of CLM vs insecticidal treatments (where P<0.05)

The R^2 value is greater (R^2=0.7279) after 24 hours of spraying than other treatments which indicated highly significant trend or regression type of CLM population with environmental conditions (Maximum & Minimum temperature (^oC), Morning and Evening Relative Humidity (%) however moderate trend was developed after 48 (R^2=0.4346), 72 (R^2=0.6665) and 96 (R^2=0.5951) hours of treatment compared to control (Figure-2) in the studied area.

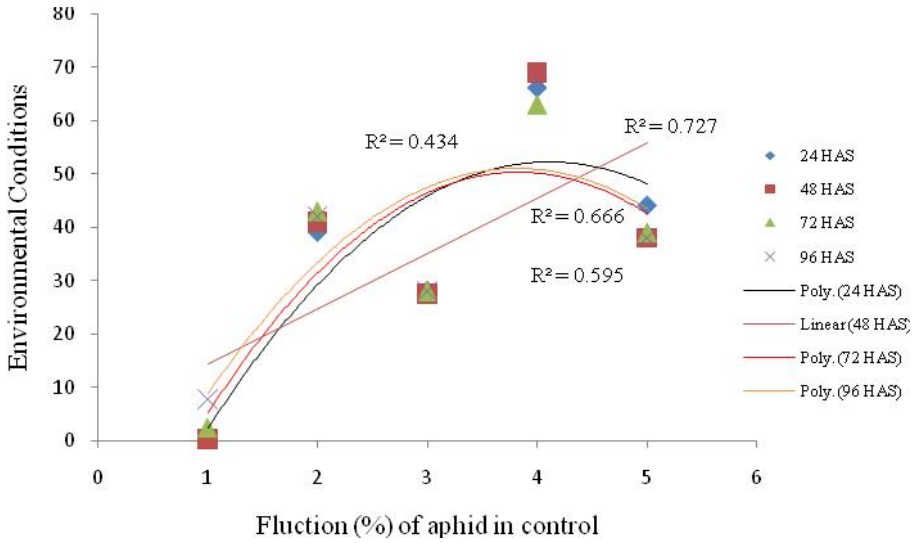

Figure-2 showing power relation of mortality (%) vs Environmental conditions (Maximum and Minimum temperature ^oC, Relative Humidity (%) morning and night. Whereas HAS (hours after spraying)

Figure-3 recorded that highly significant mortality was recorded by bifenthrin at 24 hours (29.16%); 48 hours (51.62%); 72 hours (67.16%) 96 hours (84.45%) after spraying, however spintoram (65.60%) and (85.06%) showed non-significant (P<0.05) with each other and recorded highly significant (P<0.05) mortality with rest of the treatments. In soil application roots absorbed imidacloprid translocated in the plant (Tattar et al. 1998). Maximum pest populations were build-up on new flush leaves however maximum mines are found in October to December, but can be seen throughout the year. Endosulfan 35EC proved to be the best insecticide after first application, followed by thiamethoxam 25WG, lufenuron 50EC, methiodethion 40EC for controlling CLM (Jadhav 2015). The foliar application of thiamethoxam remained effective against *P. citrella*. Our results are contradictory to the researcher who reported that imidacloprid was most effective against CLM (Lad et al. 2010). After 7th day of spraying imidacloprid recorded higher mortality (89.04%) this was at par with fenvalerate.

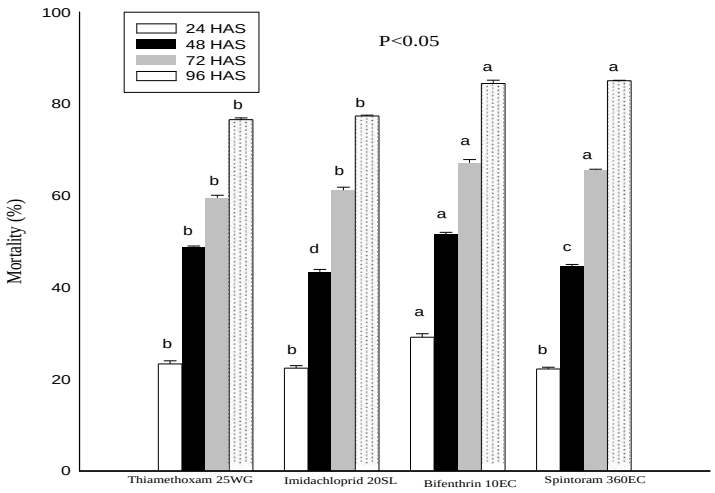

Figure-3 showing mortality (%) vs insecticides (where P<0.05)

Figure-4 showed moderate trend line or regression type (R^2=0.5252; R^2=0.5454; R^2=0.4923; R^2=0.5475) with the data collected before spraying in a same sprayed plot compared to varying level of environmental conditions (Maximum and minimum temperature (°C), Relative Humidity (%) at morning and evening time).

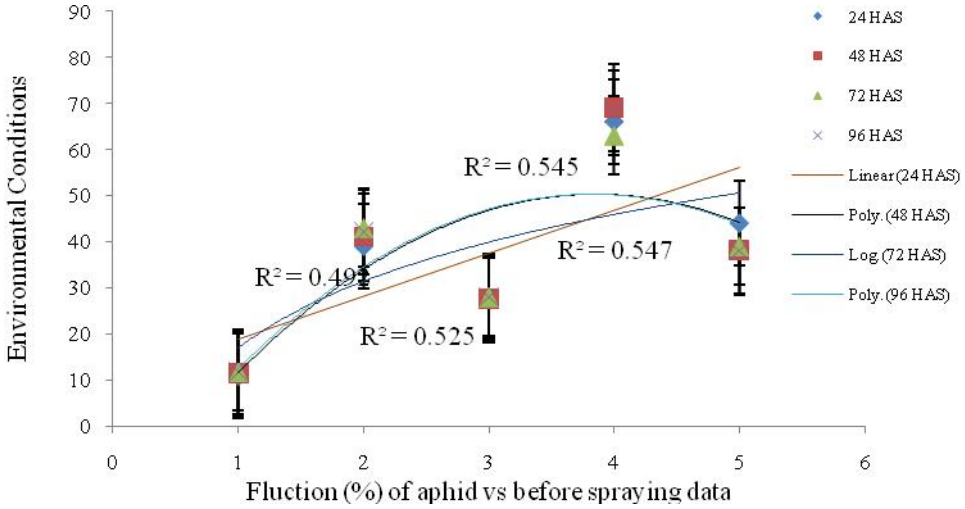

Figure-4 showing power relation of mortality (%) vs Environmental conditions (Maximum and Minimum temperature °C, Relative Humidity (%) of morning & night

Conclusion

At the end it was concluded that thiamethoxam gave better control after 24 and 48 hours of spraying. Bifenthrin is effective 24, 72 and 96 hours however Spintoram gave better mortality 72, 96 hours after spraying of insecticides. The farmers of this region are advised to use bifenthrin and spintoram for the best management of citrus leaf miner with the consultation and coordination of Pest Warning and Quality Control of Pesticides, Chishtian.

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