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Effect of an Insecticide, Chlorpyrifos on the Activity Density of Wolf Spiders (Araneae: Lycosidae) in Guava Orchard

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Abstract.- Effect of Chlorpyrifos (Lorsban) has been studied on the mean activity density and body measures (*i.e*., total body length, carapace length, carapace width and wet weight) of wolf spiders in the field. Significant difference was recorded in the mean activity density of wolf spiders in the treated and control field. Mean activity density of wolf spiders collected from different distances from field's margin of both fields (*i.e*., treated and control) also differed significantly. Chlorpyrifos did not show any negative effect on the growth of *Pardosa birmanica* Simon, 1884, while it affected the growth of carapace and wet weight in *Lycosa terrrestris* Butt *et al.,* 2006. It is concluded that application of chlorpyrifos in the fields may reduce the density of wolf spiders not only because of direct mortality but also due to disturbance and emigration, thus reducing the pest control potential of this important predatory group.

Keywords: wolf spiders, chlorpyrifos, natural predators, pest reduction.

INTRODUCTION

Spiders are ubiquitous (ever-present) in terrestrial ecosystem and abundant in both natural and agricultural habitats (Dondale, 1970; Turnbull, 1973; Nyffeler and Benz, 1987). They consume large number of prey without damaging the plants. Many studies demonstrated that spiders can significantly reduce prey densities in agricultural fields (Riechert, 1974; Riechert and Lockley, 1984; Riechert and Bishop, 1990; Greenstone, 1999; Symondson *et al*., 2002; Schmidt *et al*., 2004; Pearce and Zalucki, 2006; Tahir and Butt, 2009; Tahir *et al*., 2009). Their average annual activity density ranges from 50 to 150 individuals per square meter but can periodically reach maximal densities of more than 1000 individuals per square meter (Pearse, 1946; Nyffeler, 1982; Weidemann, 1990; Duffey, 1993).

The potential attributes like number of insects killed per unit time, good searching ability (especially hunting spiders), wide host range, adaptation under conditions of food limitations, low metabolic rate, energy conservation mechanism and polyphagous nature makes them a model predator (Riechert and Lockley, 1984). However, their small size, cryptic (hidden) habit and mode of feeding have made it difficult to determine whether this is so (Kiritani and Dempster, 1973; Stuart and Greenstone, 1990). Spider activity density is correlated with the specific vegetation characteristics, suggesting that availability of habitat is important for the spider colonization and establishment (Rypstra and Carter, 1995). A wide range of species can occur in arable fields, of which wolf spiders are the most abundant (Alford, 2003). Wolf spiders are well camouflaged in their surroundings and are often seen hunting during day time (Jogar *et al*., 2004). They do not build web to capture prey. Despite their almost unique predatory habits, they have received relatively little attention as natural enemies of insect pests.

Two major factors influencing the activity density of wolf spiders in agro-ecosystems could be the effect of pesticides and weed cover. The present study was designed to investigate the effect of insecticide (Chlorpyrifos) on the mean activity density and body measure *(i.e.,* total length, carapace width, carapace length and wet weight) of wolf spiders in the field. Wolf spiders constitute an important natural biological control group in agro-ecosystems of Punjab, Pakistan (Tahir and Butt, 2009). This study will help to understand the impact of Chlorpyrifos on the mean activity density and body measures of this important natural predator group in the study area.

MATERIALS AND METHODS

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Sampling area

The spiders were sampled from Guava orchard (two acre area) situated 5km north from Sagian Bridge, Lahore. The area of collection was divided into two sub areas, field I and field II (each of one acre). The ground surface of both sub areas was covered with a fodder crop (*Sorghum vulgare*) which is locally called as Charri. During trapping (June 2007 to December 2007), sub area I was treated with insecticide Lorsban (Chlorpyrifos) on 12th July and 18th September. Application rate of the insecticide was 450 ml per acre. Area II was not treated with any insecticide during the whole study period and was treated as control.

Sampling methods

In each area thirty-two wide mouth glass jars (6 cm diameter × 12 cm deep) were used as pit-fall traps. At each site, eight pitfall traps were placed at margin (0 m) of the field in a row with a distance of 8 m between each. The subsequent traps were set at 9 m, 18 m and 36 m from the margin of the field with similar distance (8 m). One hundred and fifty ml of 70% alcohol and one to two drops of 1% liquid detergent (to break surface tension) were used as trapping solution. In each field, the traps were operated consecutively for 72 hours after every one month from June through December, 2007 (on some occasions, the placement time had to be changed due to weather conditions).

Sampling and identification

Captured organisms were placed in small jars (5 cm height × 2.5 cm diameter) with 70% ethanol and transported to the laboratory for sorting and identification of spiders. Only sexually mature spiders were identified to the species level, with the help of available literature (Tahir and Butt, 2008). Juveniles, including penultimate stages, were identified only to genus level. Representative specimens of all identified species were deposited in the Biological Pest Control Laboratory, Department of Zoology, University of the Punjab, Lahore, Pakistan.

Measurements

The definitions of different measurements were as following:

Total body length: From clypeus to the posterior end of abdomen excluding spinnerets.

Length of cephalothorax: From anterior end of clypeus to the end of thoracic region.

Width of cephalothorax: Area of maximum width of cephalothorax.

Wet weight: Each spider specimen was taken from the preservative bottle and placed separately on the blotting paper for fifteen minutes. After fifteen minutes weight of each spider specimen was recorded.

Data analysis

To check the normality of the data, Kolmogorov-Smirnov test was used. Non-parametric tests were applied on the data which were not normal. Number of wolf spiders captured during different trapping sessions of each field was compared using Mann-Whitney test. Number of spiders sampled from the treated and untreated (control) fields were compared by student's t-test. Analysis of variance (SPSS version 10) followed by Tukey's test was used to assess the differences in mean activity density of wolf spiders at different distances (*i.e*., 9, 18 and 36 m) from the margin (0 m) of each field during different trapping sessions. Analysis of variance was also used to compare the body measures (*i.e*., total body length, carapace length, carapace width and wet weight) of wolf spiders collected from treated and control fields. Data are presented as means ± standard error. All means were considered significant at the $P = 0.05$ level.

RESULTS

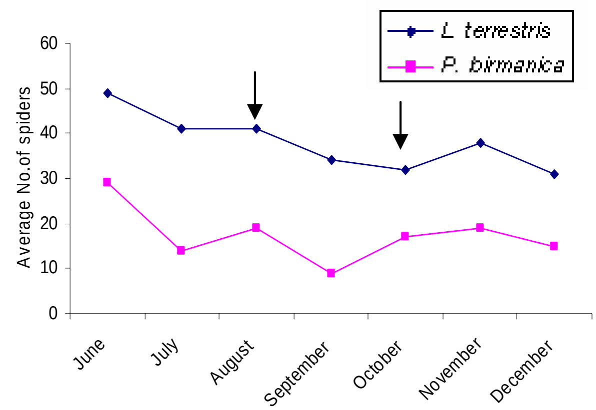
During the study, 601 individuals of wolf spiders, including 135 immature spiders (55 from treated field and 80 from untreated field) were collected. Of the total, 210 wolf spiders were collected from the area I (treated) while 391 from area II (control). The average number of wolf spiders per trap was 0.93 and 1.74 in treated and untreated fields, respectively. *Lycosa terrrestris*

(64.2%) was the most dominant species followed by *Pardosa birmanica* (29.4%) in both fields. Collectively, both species constituted 93.6% of the total wolf spiders. A statistical analysis (Mann-Whitney test) of the results indicated that there was significant difference in the mean activity density of wolf spiders among trapping sessions of both treated and untreated areas (Mann–Whitney U test; P = 0.04 for treated field and P = 0.02 for untreated field). Mean activity density of spiders collected from different distances of both treated and untreated fields also differed significantly (df = 3, 27; F = 36.69; P < 0.001 for treated field and df = 3, 27; F = 23.90; P < 0.001 for untreated field). Results of Tukey's test showed that in treated field there was no significant difference in the mean activity density of spiders collected from 9, 18 and 36 m distances. However, the number of wolf spiders caught at these distances (9, 18 and 36 m distances from field,s margin) was significantly lower than at the field's margin (Table I). In the treated field, the trapping session that immediately followed by insecticide spray showed less numbers of *P. birmanica* compared to control. Slight difference of *L. terrestris* in treated and untreated fields was also observed (Fig. 1). The number of wolf spiders was significantly higher in the untreated field as compared to the treated one (t = 3.33; P = 0.02). Figure 2 is showing the difference in the mean activity density of wolf spiders during different trapping sessions in treated and untreated fields. Mean activity density of wolf spiders was the same in the month of June in both fields. Number of wolf spiders suddenly dropped during July (first round of insecticide spray) in treated field and increased next month. However, after the second round of insecticide treatment it remained low compared to control field till last trapping month (December). When dominant wolf spiders (*i.e.*, *L. terrestris* and *P. birmanica*) collected from the treated fields were compared for body measures (*i.e.*, total length, carapace length, carapace width, wet weight) with spider specimens captured from control field, non-significant difference was recorded for *P. birmanica*, however significant difference was recorded only for carapace and wet weight width in *L. terrestris* (Table II).

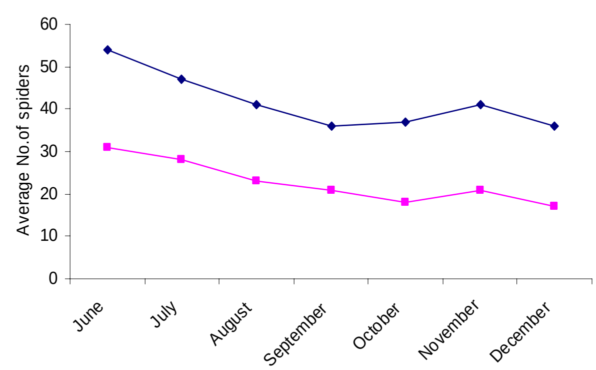
Table I.- Results of Tukey's test showing differences in mean activity density of wolf spiders among different distances from the field's margin.

Distance from field's margin	Control field	Treated field
0 m	36.28 ^{c}	32.37 ^{b}
9 m	21.71 ^{b}	17.02 ^{a}
18 m	15.14 ^{ab}	12.85 ^{a}
36 m	12.71 ^{a}	9.21 ^{a}

Note: Values in columns having no common superscripts are significantly different from each other.



Treated



Untreated

Fig. 1. Seasonal dynamics of wolf spiders in treated and untreated fields. Arrows in the figure indicates the insecticide treatment time.

DISCUSSION

In the present study the average number of wolf spiders per trap was low in treated field compared to control. Several studies have also reported decline in the density of wolf spiders in

Table II.- **Comparison of body measures of dominant males and females wolf spiders in treated and untreated fields (M±SE).**

Body measures	*Lycosa terrestris*		*Pardosa birmanica*	
	Treated field	Untreated field	Treated field	Untreated field
Males				
Total length	5.43 ± 0.35 ns	6.90 ± 0.23	5.40 ± 0.78 ns	5.23 ± 1.09
Carapace width	2.37 ± 0.75*	2.92 ± 46.0	2.23 ± 0.34 ns	2.37 ± 0.24
Carapace length	2.88 ± 0.26 ns	3.56 ± 0.17	2.88 ± 0.38 ns	2.77 ± 0.29
Wet weight	21.0 ± 73.0 ns	20.0 ± 97.0	24.0 ± 84.0 ns	22.0 ± 93.0
Females				
Total length	6.70 ± 0.44 ns	6.90 ± 0.23	5.46 ± 0.99 ns	5.50 ± 1.22
Carapace width	2.61 ± 0.30*	2.92 ± 46	2.30 ± 0.70 ns	2.42 ± 0.51
Carapace length	3.28 ± 0.90 ns	3.56 ± 0.17	2.90 ± 0.12 ns	3.10 ± 0.23
Wet weight	19.0 ± 83*	25.0 ± 79	28.0 ± 11.0 ns	25.0 ± 85.0

ns, non significant;*, significant.

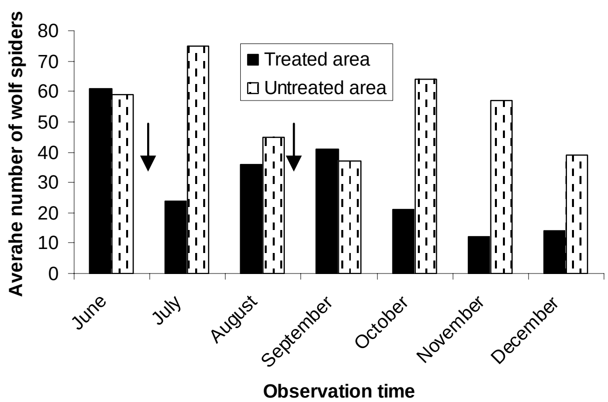


Fig. 2. Mean activity density of wolf spiders in treated and untreated fields during the observed period in 2007. Arrows in the figure represent the insecticide treatment time.

insecticide treated fields as compared to untreated fields (Mansour, 1987; Fountain *et al*., 2007). Although different spider taxa respond differently when exposed to pesticides, some species of wolf spider appear to be more sensitive to chemical treatment than web builders (Marc *et al*., 1999; Amalin *et al*., 2001; Shaw *et al*., 2006). In the present study, *P. birmanica* appeared to be more sensitive to chlorpyrifos than *L. terrestris*. Other workers also reported that effects of pesticides are species specific (Shaw *et al*., 2004; Pekár and Beneš, 2008). Beside direct spiders mortality due to insecticide, other possible reason of low spider's density in the treated fields may be the reduction of pest (in the treated fields) which might in turn has caused the emigration of wolf spiders to the surrounding fields for prey capture.

Mean activity density of wolf spiders, both in treated and untreated fields, decreased as the distance from the field's margins increased. Similar results have also been reported by many other researchers in agro-ecosystems (Alderweireldt, 1989; Holland *et al*., 1999; Tahir and Butt, 2009). Higher mean activity density of wolf spiders at field's margins was expected as permanent grassy strips or weedy borders at field's margins are source of food, shelter and over-wintering sites for wolf spiders in the fields which are frequently disturbed by field managements and insecticide application (Huusela-Veistola, 1998; Clough *et al*., 2005; Öberg, 2007). Mean activity density of wolf spiders, especially *P. birmanica*, was reduced following pesticide applications in treated field. It appears that insecticide application may had a direct effect on population of wolf spiders. Treatment of insecticides also disturbs the spatial distribution of wolf spiders in the fields (Holland *et al*., 2000).

Significant difference was observed in the carapace width of *L. terrestris* collected from the treated and untreated fields. This result suggested that chlorpyrifos may not have direct effect on the density of *L. terrestris*, however it does have negative effect on growth of body (ie., carapace width and wet weight) might be due to less availabity of food for wolf spiders in the insecticide treated fields. Our result is also in contrast with the findings of Deng *et al*. (2008) who reported in their study that insecticides have no negative effects on the development and growth of wolf spiders. Results of the present study showed that use of chlorpyrifos in the fields not only reduces the density of wolf spiders but also have negative effect on the growth of carapace and wet weight at least in one of the dominant wolf spiders. It is recommended that only those compounds should be used in the fields that are pest specific and have least effects on the population of natural predators.

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