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Full Length Research Paper

Red palm weevil (*Rhynchophorus ferrugineus* Olivier) infestation and its chemical control in Sindh province of Pakistan

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The survey on various parameters showed that the degree of orchard infestation fluctuated by time period/seasons, so attack of red palm weevil varied on different months of the year during the study period. It was observed that this insect pest had significantly higher (16%) infestation in the months of June, July and August, during experimental period. The least attack (8%) of the weevil was in the months of January, September, October, November and December in both the years (2007 and 2008). Place of infestation of weevil on date palm stem revealed that the pest infestation was mostly concentrated at the base of trunk (up to 50 cm height) and 75 to 82% of total weevil infestations were located at the base of palm trunk. Spirotetramat insecticide was found most efficient treatment to control red palm weevil infestation/damage, which recovered (43%) damaged date palm trees, followed by Fipronil (33%), Chlorpyrifos (26%) and Methidathion (19%) during the year 2007 and 2008.

Key words: Red palm weevil, *Rhynchophorus ferrugineus,* chemical control, date palm.

INTRODUCTION

Date palm (*Phoenix dactylifera* L. family: Arecaceae) is the most important fruit tree of tropical and sub-tropical regions of the world, this tree is evergreen and can reach up to 30 meters tall (height). Date palm is widely grown for its fruit in Iraq, Iran, India, Mediterranean, North Africa Countries, Oman and Pakistan (Azam et al., 2001; Bozbuga and Hazir, 2008; Khushk, 2005). Date palm is also found in the countries like America, Argentina, Bangladesh, Brazil, Cyprus, Nagaland, North, Pakistan (Khushk, 2005) Peru and Spain. Pakistan stands at 4th position amongst date producing countries of the world. Regular cultivation of date palm in Pakistan is on 80935.61 ha, whereas in Sindh province/state on 33992.95 ha, which stands 40% area of cultivation in Pakistan.

The red palm weevil (*Rhynchophorus ferrugineus* Olivier) has become the serious insect pest to the palms in the world, where date palm or other palm trees are widely grown (Dembilio et al., 2010). This insect pest causes serious economic losses to the growers of date, coconut, oil and other palms. Most infestation of red palm weevil (RPW) was recorded up to 1 m height of the trunk of the tree (Azam et al., 2001). Azam et al. (2000) have applied twelve different insecticides to control RPW infestation and its recovery. They have applied insecticides through trunk injection and claimed higher recovery percentage of date trees by the damage of RPW. Ajlann et al. (2000) tested five organophosphorus insecticides against RPW and observed that pirimiphos-methyl at 0.2% or oxydemeton-methyl at 0.36% was enough to destroy the larvae and adults of RPW within three days period. Similarly, Khalifa et al. (2001) found that the insecticidal injection of carbosulfan, phenthoate+dimethoate, dimethoate+endosulfan and phostoxin tablets have significantly reduced the infestation of RPW in the field.

Keeping in view the economic significance of the damage caused by the red palm weevil, the present study

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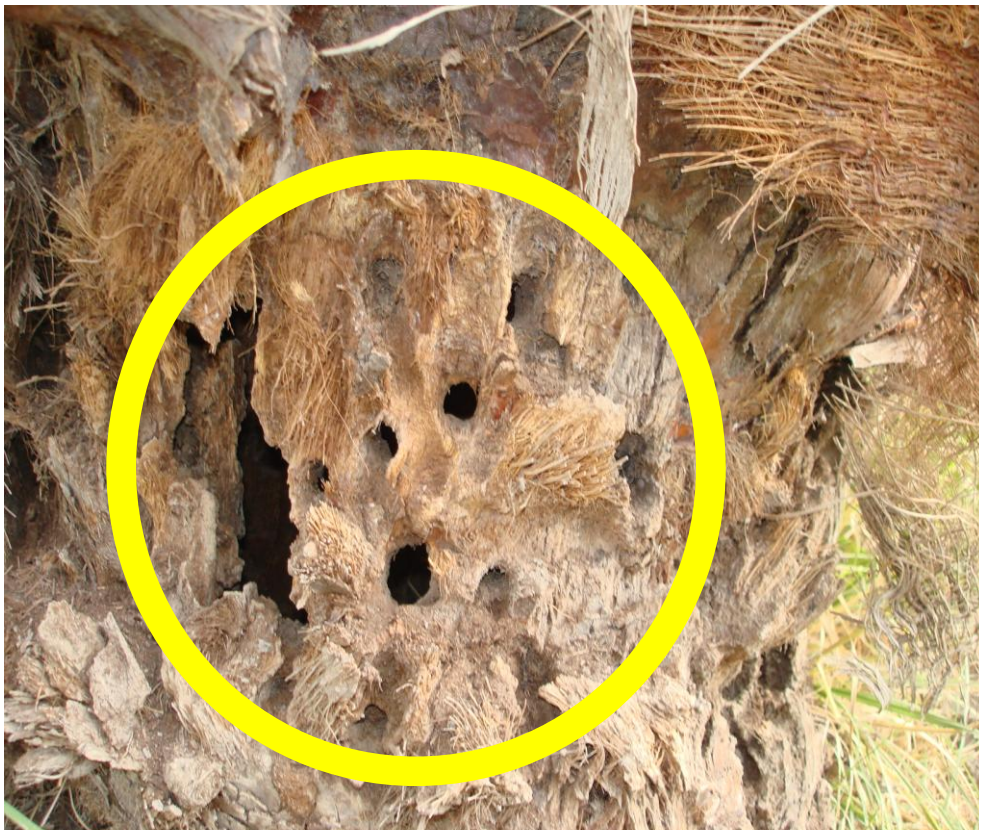

Figure 1. Symptoms of RPW infestation on the trunk of date palm trees.

was therefore carried out to determine the effective pesticides against this harmful pest as well as to study its nature of infestation to date palm plantation in Sindh, Pakistan.

MATERIALS AND METHODS

Degree of orchard infestation

In order to find out the peak period of (RPW) infestation, five gardens (five acres each) of Aseel variety were selected from experimental areas (Khairpur, Kingri, Kotdigi and Therhi). Age of the date trees were varied from 10 to 12 years. One hundred trees were selected and tagged in each orchard at above locations. Experiment was replicated four times and each replication consisted of 25 trees. Old and new infestations were recorded separately to ascertain variation in between months. Both healthy and infested trees were observed to record infestation percentage. Data were recorded at monthly intervals for two years (January 2007 to December 2008). Observations were taken on 1st of every month. Symptoms of infested plants were captured (Figure 1).

Place of infestation of RPW on date palm stem

The study was designed to assess the attack of RPW at different trunk heights categorized as C1=0 to 50 cm, C2= 51 to 100 cm C3=101 to 150 cm, C4=151 to 200 cm and C5=201 to 250 cm. One hundred trees were selected and tagged. The experiment was replicated four times; each replication consisted of 25 trees. Aseel variety from two locations of Therhi taluka at Karamabad and Palah villages of Sindh Province of Pakistan were studied. The RPW infestation (old and fresh) on date trees were observed and recorded on monthly basis (January 2007 to December 2008). The infested portion was measured with the help of measuring tape (Figure 2) and categorized in earlier mentioned five heights of the trunk of the tree.

Insecticidal control

The experiments were conducted for two years during 2007 and 2008 to test the efficacy of ten insecticides of district Khairpur intended to be used for control of RPW at village Pahore (Khairpur). From study area four acres area (400 trees) were selected to control through insecticides. Date palm orchards were visited thoroughly and all the trees which were being damaged by RPW were identified, marked and tagged. From infested palms a brown fluid was oozing out from the minute holes made by RPW. Forty infested/infested trees were selected for each insecticidal treatment. Three to four holes of 2.5 cm diameter and 10 cm deep were made with the help of drill machine above the insect attacking point on 1st February during 2007 and 2008 at same location. The holes were drilled at 45° angle downwards the infestation points (Figure 3).

The insecticides (Table 1) were diluted in distilled water at the ratio of 1:1 before application to the trees and 7 ml per tree of diluted insecticide were injected in the holes during the month of February, the holes were filled with cotton, and covered with plaster of Paris to prevent the tree from any new foreign infection. All the trees were observed at 15 days intervals for two months and

Figure 2. Measurement of infested portion of date palm trunk from ground level infested by RPW.

Figure 3. Insecticidal approach through injecting the insecticide into holes.

Table 1. Insecticides were used in experiments to control RPW damage (common name, brand name, company name and their formulations).

Serial number	Common name	Brand name	Company	Formulation
1	Spirotetramat	Movento ®	Bayer	150 OD
2	Flubendiamide	Belt ®	Bayer	480 SC
3	Imidacloprid	Confidor®	Bayer	200 SL
4	Fipronil	Regent®	Bayer	5% SC
5	Abamectin	Alarm plus®	Pak China Chemicals	3.5 EC
6	Chlorpyrifos	Lorsban®	Dow AgroSciences	40EC
7	Indoxacarb	Steward®	Du Pont Pakistan	150EC
8	Spinosad	Tracer®	Arysta Life Science	240SC
9	Profenophos	Curacron®	Syngenta	500EC
10	Methidathion	Supracide ®	Syngenta	40EC

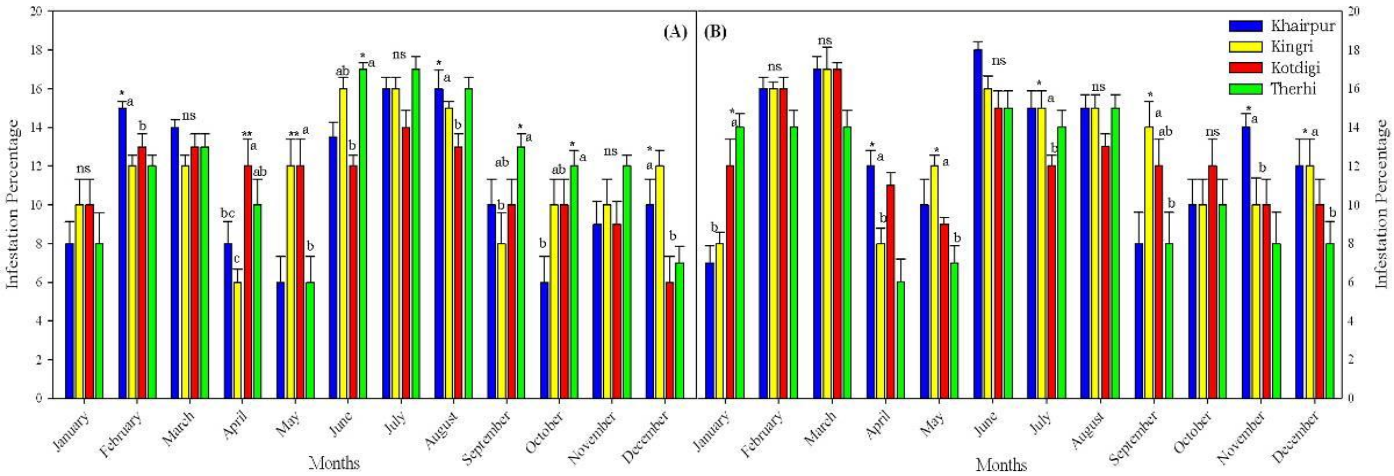

Figure 4. The infestation percentage of Red Palm Weevil (RPW) + SE (Standard Error) at four different locations/talukas that is; Khairpur, Kingri, Kotdiji and Therhi during 2007(A) and 2008 (B). Statistically significant differences (ANOVA at a *P* value of <0.05) are marked with an asterisk where, *, **, ***, equals *P*=0.05, *P*=0.01 and *P*=0.001; letters show significant differences (*P*<0.05) on selected month among different locations.

thoroughly checked that the oozing has stopped or still loosening. Trees in which oozing had stopped and there were no more symptoms of the RPW insect attack were considered as recovered from pest attack (healthy).

Statistical analysis

All statistical analyses were undertaken in Minitab 14.0 (Minitab Inc., USA), SigmaPlot 10.0.0.54 (Systat Software Inc., Germany).

RESULTS

Degree of orchard infestation

In the year 2007, the degree of orchard infestation by RPW was significantly ($P < 0.05$) higher on date palm trees at Khairpur in the month of February as compared to Kingri, Kotdigi and Therhi areas (Figure 4a). Infestation was significantly ($P < 0.01$ and $P < 0.05$) higher on date trees at Kotdigi and Therhi as compared to Khairpur and Kingri in the month of April. In the month of May, date trees were significantly ($P < 0.01$) infested at Kingri and Kotdigi compared to Khairpur and Therhi. Red Palm Weevil infestation was significantly ($P < 0.05$) higher on trees at Therhi as compared to Kotdigi and Khairpur in the month of June. In the month of August infestation of RPW was significantly ($P < 0.01$) higher on date trees at Khiarpur and Therhi as compared to Kotdigi, however Therhi had significantly ($P < 0.05$) higher infestation as compared to Kotdigi and Khairpur in the month of September and October. In the month of December, date palm trees at Kingri were significantly ($P < 0.05$) higher infested by RPW as compared to Kotdigi and Khairpur, while Kingri was not significantly different than Khairpur (Figure 4a).

During the year 2008, infestation of RPW was

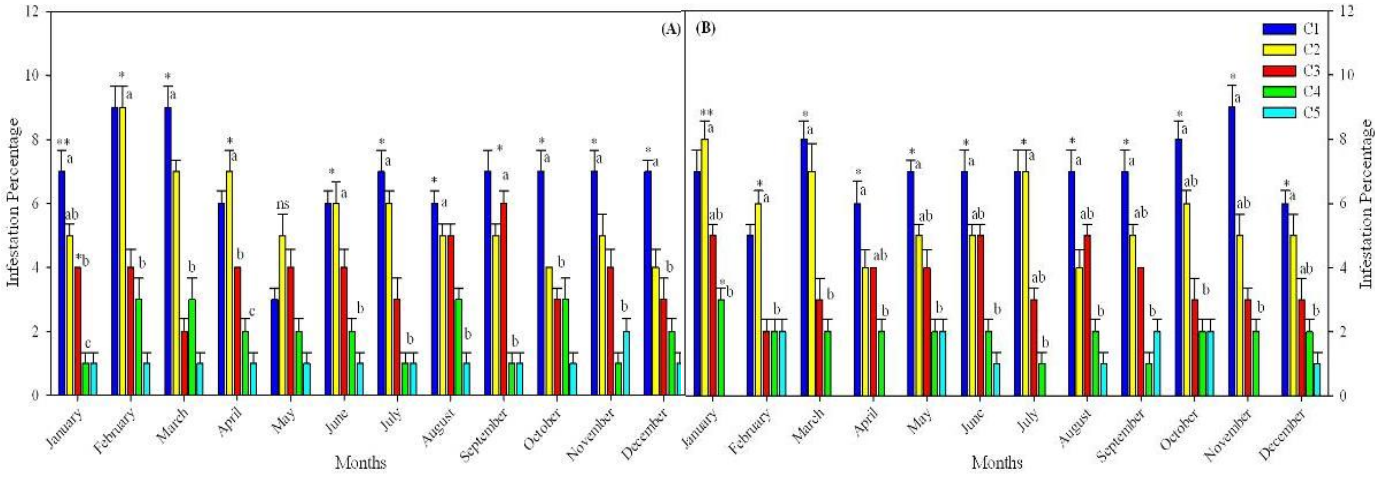

Figure 5. The infestation percentage of Red Palm Weevil (RPW) + SE (Standard Error) of five different heights categorized as C1=50cm, C2=51-100cm, C3=101-150cm, C4=151-200cm, and C5=201-250cm (n=25) during 2007 (A) and 2008 (B) at Karamabad (Therhi) Sindh, Pakistan. Statistically significant differences (ANOVA at a P value of <0.05) are marked with an asterisk where, *, ** equals P=0.05 and P=0.01; letters show significant differences (P<0.05) on selected month among different heights of date.

significantly (P < 0.05) higher in Therhi and Kotdigi as compared to Khairpur and Kotdigi in the month of January (Figure 4b). Khairpur and Kotdigi had significantly (P < 0.05) higher infestation as compared to Kingri and Therhi in the month of April. In the month of May and July, Khairpur and Kotdigi had significantly (P < 0.05) higher infestation as compared to Therhi and Kotdiji. Kotdigi had significantly (P < 0.05) higher infestation as compared to Khairpur and Therhi in the month of September. While, Khairpur had significantly (P < 0.05) higher infestation as compare to rest of the locations in the month of November. In the month of December, Therhi had significantly (P < 0.05) lower infestation as compared to Khairpur and Kingri which had significantly higher infestation of RPW (Figure 4b).

Place of infestation of RPW on date palm stem at Karamabad (Therhi) Sindh, Pakistan

During the 2007 year RPW had significantly (P<0.01 and P<0.05) higher infested on C_1 and C_2 heights (C_1= 50 cm and C_2= 51 to 100 cm heights of the trees) in the months of January, February, March, April, June, July, August, September, October, November and December as compared to C_3, C_4 and C_5 (C_3=101 to 150 cm, C_4=151 to 200 cm and C_5=201 to 250 cm heights of the trees) at Karamabad, (Therhi) Sindh, Pakistan (Figure 5a). The attack of RPW was significantly (P<0.05) higher on C_3 height as compared to C_4 and C_5 heights in the months of August, September and November at village Karamabad, Therhi (Figure 5a). In the year 2008, most significantly (P<0.01 and P<0.05) infestation was also observed on C_1 and C_2 heights of date trees as compared C_3, C_4 and C_5 heights (Figure 5b) at village Karamabad, Therhi.

However, infestation of RPW was significantly (P<0.05) lower in C_4 and C_5 heights as compared to C_1 and C_2 heights of date palm trees at Karamabad, (Therhi) Sindh, Pakistan (Figure 5b).

Place of infestation at village Palah (Therhi) Sindh, Pakistan

In the month of January 2007, RPW had significantly (P < 0.01) higher infestation on C_1 height, followed by C_2 and C_3 (P<0.05) height as compared to C_4 and C_5 heights at Palah (Therhi) Sindh, Pakistan (Figure 6a). C_1 and C_2 heights had significantly (P < 0.05) higher infestation of RPW, followed by C_3 and C_4 (P<0.05) heights as compared to C_5 heights in the month of February. Red Palm Weevil had significantly (P<0.001) higher infestation on C_1, followed by (P<0.01) on C_2 height as compared to C_3, C_4 and C_5 heights on date trees in the month of March. In the month of April, May and June, the attack of RPW was significantly (P < 0.05) higher on C_1 and C_2 heights as compared to C_4 and C_5 heights. Red Palm Weevil had significantly (P<0.01 and P<0.05) higher infestation on C_1 and C_2 heights of date trees as compared to C_3, C_4 and C_5 heights, while C_3 had also significantly (P < 0.05) higher infestation as compared to C_5 height in the month of July. In August, C_1 height was significantly (P < 0.001) higher infested by RPW followed by C_2, C_3 and C_4 heights as compared to C_5 height. In the months of September, October and November, RPW had significantly (P<0.001) greater infestation on C_1 height followed by C_2 and C_3 heights (P<0.05) as compared to C_5 height. Red Palm Weevil had significantly (P<0.01) higher infestation on C_1 height followed by C_2 (P<0.05) as compared to C_3, C_4 and C_5 heights of the date palm trunk

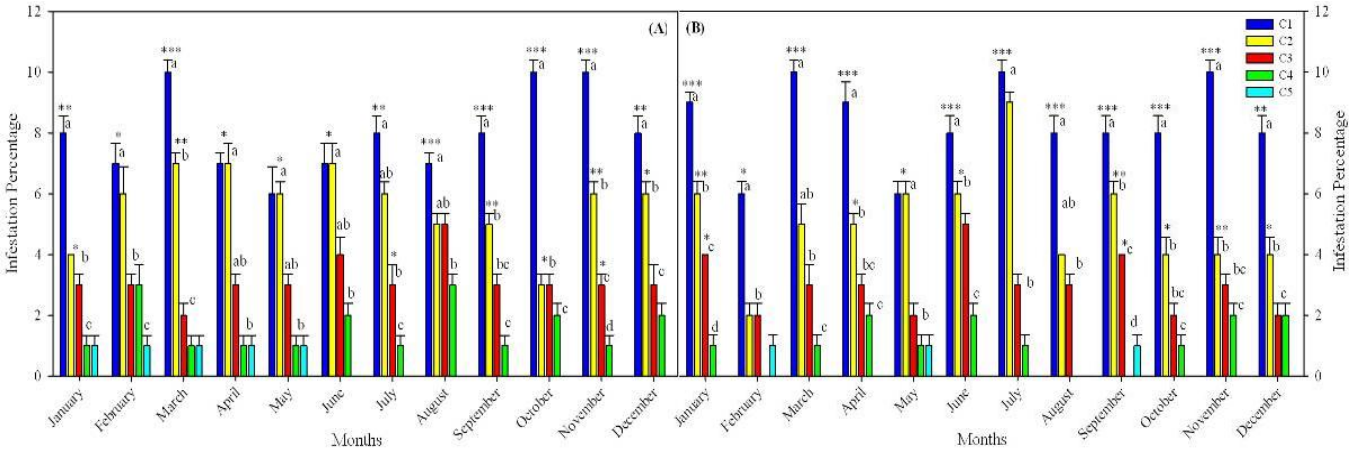

Figure 6. The infestation percentage of Red Palm Weevil (RPW) + SE (Standard Error) of five different heights categorized as C1=50cm, C2=51-100cm, C3=101-150cm, C4=151-200cm, and C5=201-250cm (n=25) during 2007 (A) and 2008 (B) at village Palah (Therhi). Statistically significant differences (ANOVA at a P value of <0.05) are marked with an asterisk where, *, **, ***, equals P=0.05, P=0.01 and P=0.001; letters show significant differences (P<0.05) on selected month among different heights of date trees.

in the month of December, 2007 at Palah (Therhi) Sindh, Pakistan (Figure 6a).

During 2008, RPW had significantly (P<0.001) greater infestation on C1 height, followed by (P<0.01 and P<0.05) C_2 and C_3 heights as compared to C_4 and C_5 heights in the month of January, at Palah (Therhi) Sindh, Pakistan (Figure 6b). In the month of February, RPW had significantly (P<0.05) higher infestation on C_1 height as compared to C_2, C_3, C_4 and C_5 heights. C_1 height had significantly (P<0.001) higher infestation of RPW, followed by C_2 and C_3 (P<0.05) heights as compared to C_5 height in the month of March. In the month of April, RPW had significantly (P<0.001) higher infestation on C_1 height, followed by (P<0.05) height as compared to C_5 height. The attack of RPW was significantly (P<0.05) higher on C_1 and C_2 heights as compared to C_3, C_4 and C_5 heights in the month of May. In the month of June, October, November and December, RPW had significantly (P<0.001) higher infestation on C_1 height, followed by on C_2 height (P<0.01 and P<0.05) as compared to C_5 height of date trees. In the months of July, C_1 and C_2 heights were significantly (P<0.001) infested by RPW as compared to C_3, C_4 and C_5 heights. Red palm weevil had significantly (P<0.001) higher infestation on C_1 height, followed by C_2 and C_3 (P<0.01) as compared C_5 height of the date palm trunk in the month of August and September at Palah (Therhi) Sindh, Pakistan (Figure 6b).

Insecticidal control

In the year 2007, the recovery percentage of date palm trees infested by RPW were significant (P<0.001) by Spirotetramat, followed by Fipronil, Chlorpyrifos and Methidathion (P<0.01 and P<0.05) as compared to Flubendiamide, Imidacloprid, Abamectin, Indoxacarb, Spinosad and Profenophos at Pahore (Khairpur) Sindh Pakistan (Figure 7a). Most significant (P<0.001) damage recovery was significantly recovered on 60 days after application of Spirotetramat followed by 45 days, 30 days as compared to 15 days after application. Same trend was observed in Fipronil and Chlorpyrifos, while in Methidathion it was bit different as most recovery (P<0.05) was recorded on 60 and 45 days and least in 30 and 15 days after application during 2007, at Pahore (Khairpur) Sindh Pakistan (Figure 7a). Damage recorded was significantly (P<0.001) higher where Spirotetramat, followed by Fipronil, Chlorpyrifos and Methidathion (P<0.01 and P<0.05) was applied as compared to Profenophos, Indoxacarb, Spinosad, Flubendiamide, Imidacloprid and Abamectin application in the year 2008, at Pahore (Khairpur) Sindh Pakistan (Figure 7b). The most significant damage recovery (P<0.001 and P<0.01) was found on 60 days and 45 days after application of Spirotetramat and Fipronil insecticides, followed by 30 days (P<0.05) as compared with 15 days of application. After the application of Chlorpyrifos and Methidathion the most recovery (P<0.05) was recorded on 60 and 45 days and least in 30 and 15 days during 2008 at Pahore (Khairpur) Sindh Pakistan (Figure 7b).

DISCUSSION

Degree of orchard infestation study was carried out for two years (2007 and 2008). The infestation of RPW was higher (16%) in the months of June, July and August during the year 2007 and 2008 (Figure 4a and b). Similar results have also been reported in previous studies by Kumar et al. (2004), who investigated the infestation of RPW and found higher infestation in the months of June

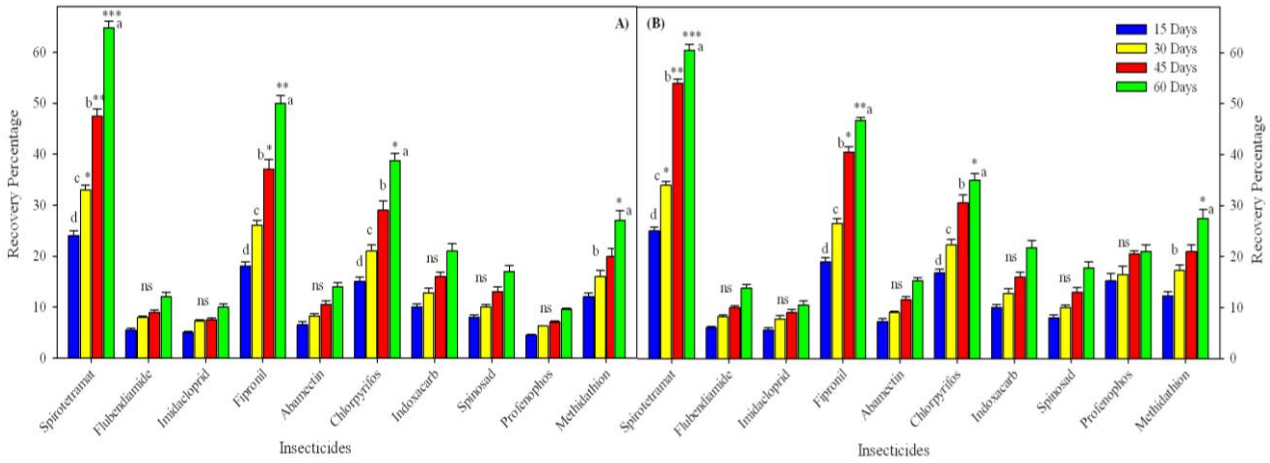

Figure 7. The Recovery percentage damaged date trees by RPW + SE (Standard Error) through application of ten different insecticides (n=10) during 2007 (A) and 2008 (B) at Pahore (Khairpur) Sindh Pakistan. Statistically significant differences (ANOVA at a P value of <0.05) are marked with an asterisk where, *, **, ***, equals P=0.05, P=0.01 and P=0.001; letters show significant differences (P<0.05) on selected insecticides among different observational days.

and July. While infestation of RPW was also higher in the months of February and March 2007 and 2008, this might be due to removal of sucker in these months Ferry and Gomez (2002). The least attack (8%) of RPW was in the months of January, September, October, November and December in both the years 2007 and 2008. Kumar and Maheswari (2003b) have found contradicting results as higher infestation in the month of September. Infestation of RPW was significantly different all the locations Khairpur, Kingri, Kotdigi and Therhi Sindh, Pakistan in the months of January, February, April, May, June, July, August, September, October, November and December during 2007 and 2008 (Figure 4a and b). The results are in the agreement of Kumar and Maheswari (2003a), who has reported location/district wise significant different infestation percentage of RPW. In the year 2008, same trend of results were observed despite a small difference, which was little higher attack (17%) of RPW during February and March.

Place of infestation of RPW on date palm tree stem /trunk at five different heights was observed for two years 2007 and 2008 at two different locations. The higher attach of RPW was observed on 0 to 50 cm height of the date tree at both the locations, while most infested location was Palah which had (82%) infestation of RPW as compared to Karamabad (75%) (Figures 4a, b, and 5a, b) was recorded. The results are with the agreement of Khalifa et al. (2001), who has reported significant higher (98%) infestation of RPW on 0 to 100 cm height of date palm trunk. This suggests that most of the suckers are removed from the bottom of the date tree, so RPW weevil mostly attacked on wounds/cuts from where the removal of suckers takes place. This could be the habitat of this destructive insect pest. Where as, lower attack of RPW was observed at Palah (18%) followed Karamabad 25% the date palm trunk height of 50-151cm (Figures 4a, b, and 5a, b).

Ten different insecticides were applied through trunk injection to control RPW infestation damage on date palm. Injection method of different insecticides is an effective control method to control RPW attack damage (Lepesme 1974; Nirula 1956a; Mathen and Kurian, 1966, 1967). Spirotetramat insecticide was found most efficient treatment to control RPW infestation, which controlled recovered 43% date palm trees, followed by Fipronil (33%), Chlorpyrifos (26%) and Methidathion (19%) during the year 2007 and 2008 (Figure 7a and b). Ajlann et al. (2000) have found contradicting results and observed Chlorpyrifos (Chloropyriphos) was least effective to control RPW attack damage. Many scientists have suggested that injection of different insecticides can control RPW attack very well (Frohlich and Rodewald, 1970; Laksbmanan et al, 1972; Rao et al., 1973). While least control of RPW attack/damage recorded was by Imidacloprid (8%), Flubendiamide (9%), Abamectin (10%), Spinosad (12%), Indoxacarb (15%) and Profenophos (13%) respectively (Figure 7a and b).

Different locations have difference in infestation of RPW which can be due to temperature and relative humidity fluctuations. Vertical distribution of infestation was mostly on 0-50cm height of the date trunk at various locations as compared to 51-250cm. Spirotetramat insecticide was found most effective to control RPW attack/damage on date trees, followed by Fipronil, Chlorpyrifos and Methidathion.

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