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Research Article

Influence of Irrigation Regimes and Poplar Clones on Densities of *Empoasca decedens* (Hom.: Cicadellidae), *Salicicola kermanensis* (Hom.: Diaspididae) and *Diaspidiotus slavoncus* (Hom.: Diaspididae) in Karaj, Iran

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ABSTRACT

During the years 2009-2010, effects of irrigation regimes and nine poplar clones on density of three sucking pests, *Empoasca decedens* Paoli, *Salicicola kermanensis* (Lindinger) and *Diaspidiotus slavoncus* (Green) were studied in Alborz Research Station of Karaj. This study was carried out under split plot design. 4, 8 and 12 days irrigation intervals were considered as main treatment by 3 replications and nine poplar clones as secondary treatments. For sampling of *E. decedens* and *D. slavoncus,* separately four trees from each secondary plot and eight leaves from each tree were chosen, randomly. Then numbers of different nymph instar of *E. decedens* and the scales were enumerated. During *S. kermanensis* sampling, first four trees from each secondary plot then four branches from each tree were selected. Next the numbers of scales on 10 cm of each branch were counted. Finally, the numbers of each pest were calculated in surface unit. Obtained data analyzed by SAS software. The results showed irrigation regimes, poplar species and clones and interaction of them affected on the pests densities, significantly ($\alpha < 0.05$). The highest density of them was seen under 12 day irrigation regimes. The highest density of *E. decedens* was on *P. a.* 44.9. The highest density of *S. kermanensis* was obtained on *P. n. 42.78* and *P. trichocarpa*. The highest density of *D. slavoncus* was on *P. n. 42.78*. The highest densities of *E. decedens* and *D. slavoncus* were observed on *P. a.* 44.9 and *P. n. 42.78* in 12 days irrigation regimes, respectively. Also, the highest density of *S. kermanensis* was on *P. n. 42.78* and *P. trichocarpa* under 12 days. It seems irrigation could change the density of the pests on poplar.

INTRODUCTION

Research Institute of Forests and Rangelands of Iran has been considered planting of fast-growing trees as a priority because Lack of forests and need to wood and wood products. Poplar (*Populus* spp.) from Salicaceae family is one of the fastest growing trees in temperate and tropical regions of the world. Poplar is used for wood, lumber, pulp, plywood production, windbreaks, ornamental plants, soil stabilizers and phyto-remediation (Asare and Madison, 2000). According to usages and Importance of poplar, areas of under poplar cultivation are increasing. Now poplar plantation in Iran is 120, 000 hectares, while according to reports of Research Institute of Forests and Rangelands of Iran, over 400, 000 hectares of Iran are suitable for poplar planting. There are several limiting factors for planting poplars in Iran. Insects are one of the most important factors. Poplar leafhopper, *E. decedens*, is one of the important sucking pest of poplar in Iran (Sadeghi, 2007). It is recorded from Mediterranean region, Middle Eastern countries such as Pakistan and Iran and some western Asiatic countries such as China, North Korea and India . *E. decedens* was first reported in 2003 on poplar trees from Iran in Chaharmal and Bakhtiary province (Haghighian et al., 2003). It is a polyphagous pest that feeds on a various range of host plant. The adults and nymphs puncture the undersides of leaves and suck out juices. Their feeding can cause stop growth, yellowing, burning and fall off the leaves. *S. kermanensis* and *D. slavoncus* are two important armored scales that damage poplar in Iran, too. They are widespread pests that suck host plant's sap**.** They are cause reduction growing, leaf drop and branch dieback. They appear in high density on leaves, branches and trunk of plants. Sometimes, heavy infestations of them kill the host plants. The other limiting factor is lack of water resources. Annual average raining in Iran is about 250 millimeters which is lower than Asia. Iran is located on 25-40 degrees of latitude and 44-64 degrees of longitude and 76 percentages of regions of Iran go on drought. According to several studies, water stresses and lack of water affected on pests density (Rhoades, 1979; Mattson and Haack, 1987; Trichilo et al., 1990). Weather changes and environmental pressure changed parameters of life pests (Netherer and Schopf, 2010). Climate conditions effect on forest pests populations (Garibaldi et al., 2011). Based on white's studies (1974 and 1984), drought stress has changed pests' densities. Rouault et al. (2006) researched effects of water stresses on forest pests' population and reaction of herbivorous insects to water stresses. They reported drought effects on population of xylophagous, phyllophagous, minosis and sucking pests. Some studies were done about relation of water stress and sucking pests on host plants. Influence of irrigation management on leafhopper densities on vines is studied by Trueta (1993). Effects of water stresses on *Solanum tuberosum* L. to *Macrosiphum euphorbiae* (Thomas) are researched by Nguyen et al. (2007). Influences of drought on population of *Myzus persicae* Sulzer on cabbage is studied by Simpson et al. (2012). Paine and Hanlon (2010) surveyed populations of red gum lerp psyllid, *Glycaspis brimblecombei* Moore, under water stresses conditions. King et al. (2006) researched effects of water deficiency on *Lipaphis erysimi* (Kaltenbach) and *Brevicoryne brassicae* (L.), on canola (*Brassica napus* L.). Abundance of *Rhopalosiphum* sp. under drought conditions is studied by Johnson et al. (2011). Population of thrips, *Scirtothrips dorsalis* Hood, in different irrigation conditions is surveyed by Patel et al. (2010). Densities of *Thrips tabaci* Lindeman on onion under short irrigation is assayed by Kannan and Mohamed (2001). Water stress or drought changed feeding and survival of *Chrysomela populi* L. on poplar (La-Spina et al., 2010). There was reported *C. populi* prefer some poplar clones to feeding and oviposition in comparing other clones (Sadeghi, 2000). Glynn *et al*., 2004 reported feeding and oviposition of *Phratora vulgatissima* (L.) on Salix species. Drought decreased growth of *Lymantria dispa*r (L.) larva on poplar (Hale et al., 2005). Based on report of Hogg et al. (2008), drought affected on resistance of poplar against xylophagous and phyllophagous pests. The best program to control poplar pests, is using of resistant clones and converting of irrigation times and methods (Sadeghi, 2007). So, there is essential study of resistant poplar clones against pests and disease and determine of water requirement of them. The aim of this study is evaluation of different irrigation regimes on *E. decedens*, *S. kermanensis* and *D. slavoncus* densities on poplar species and clones in Karaj, Iran.

MATERIAL AND METHODS

The experiments were carried out (2009-2010) on nine superior poplar clones and species (table 1) in Alborz Research Station of the Research Institute of Forests and Rangelands (RIFR) in Karaj.

Places of experiments is located on 35° 48' N and 51° E, loamy and sandy soil, semi tropical climate. During 2009-2010, Mean annual maximum temperature, Mean annual minimum temperature, Mean annual relative humidity and annual raining were; 22.69°C, 10.03°C, 46.08 % and 238.8 mm, respectively.

The planting was designed according to split plot with 3 replications. Each experiment was divided to 3 plots known main treatment (irrigation regimes; 4, 8 and 12 days) and each main plot was divided to 9 secondary plots. Each accessory plot included 9 trees of one poplar clone with 2.5*3 meters intervals plantation. To remove environmental effects, there was planted one row poplar in border of each accessory plot. There were six meters distances of main plots together. In late winter 2006, one year old seedlings of each clone that had been planted in nurseries were transferred to the main plots.

W.S.C. (type 3) was sat in the water entry to estimate the amounts of water for each plot. The plots were irrigated in growth seasons.

For sampling of *E. decedens*, four trees were selected from each accessory plot. Then, 8 leaves were chosen in four main geographical directions from each tree randomly.

Then numbers of *E. decedens* nymphs and adults were counted. Next, the leaves were transferred to the RIFR laboratory and their surface was measured by leaf area meter device (Gate house, scientific instrument LTD) in order to calculate number of this pest in surface unit. (Babmorad et al., 2013).

Sampling of *D. slavoncus* was done similar to *E. decedens* that it was done in early spring.

For sampling of *S. kermanensis*, in early spring four trees were chosen from each accessory plot. Then from four branches of each tree (in four main geographical directions), ten centimeters from each branch's base were randomly selected. Then the diameter of each branch was counted by coils and the area of branches was computed. Next, the number of scales was counted and the number of each pest was estimated in the surface unit.

Finally, the registered data were analyzed by SAS software.

Table 1: Name and origin of superior studied poplar clones

Poplar clone	Origin
P. n. betulifolia	Italy
P. n. 42.78	Iran-Karaj
P. n. 62.154	Turkey
P. a. 44.9	Iran
P. e. triplo	Europe-America
P. e. vernirubensis	America
P. e. 561.41	Turkey
P. d. 69.55	America
P. trichocarpa	America

RESULTS

Table 2 shows significant difference between main treatments (irrigation regimes), poplar clones and their interaction for density of *E. decedens*, *S. kermanensis* and *D. slavoncus*. The highest densities of these pests were recorded in 12 days irrigation regimes, but there is no significant difference between 4 and 8 days (Table 3). Dancun's means comparisons showed the highest and the least densities of *E. decedens* were on *P. a.* 44.9 and *P. e. triplo,* respectively (Fig. 1). *P. trichocarpa* set in the second level considering *E. decedens* density. The highest density of *S. kermanensis* was observed on *P. n. 42.78* and *P. trichocarpa* (Fig. 2). Also, the highest density of *D. slavoncus* was on *P. n.* 42.78 (Table 4 and Fig. 3). According to the table 5, the highest density of *E. decedens* was on *P. a.* 44.9 under 12 days irrigation regimes but there was no significant difference between 4 and 8 days. The highest densities of *S. kermanensis* and *D. slavoncus* were on *P. n.* 42.78 under 12 days.

Table 2: Variance analysis of *E. decedens*, *S. kermanensis* and *D. slavoncus* densities on nine poplar clones in three irrigation regimes

Variation sources	density of *E. decedens*				density of *S. kermanensis*				density of *D. slavoncus*			
	Df	Mean Square	*F*-value	*P*-value	Df	Mean Square	*F*-value	*P*-value	Df	Mean Square	*F*-value	*P*-value
I	2	0.081	19.72	<.0001**	2	1.1708	6.54	0.0015**	2	0.2844	11.36	<.0001**
C	8	1.154	281.55	<.0001**	8	0.9027	5.04	<.0001**	8	0.1309	5.23	<.0001**
I*C	16	0.329	80.32	<.0001**	16	0.5759	3.21	<.0001**	16	0.1391	5.56	<.0001**

I= Irrigation interval, C= Clone, **: significant difference at α = 5%

Table 3: Means number of *E. decedens*, *S. kermanensis* and *D. slavoncus* in three irrigation regimes

Irrigation regimes	Mean number of *E. decedens*	group	Mean number of *S. kermanensis*	group	Mean number of *D. slavoncus*	group
4 days	0.0094	B	0.0094	B	0.0	B
8 days	0.0101	B	0.0	B	0.0010	B
12 days	0.0143	A	0.0283	A	0.0092	A

Means followed by the same letter are not significantly different

Table 4: Means number of *E. decedens*, *S. kermanensis* and *D. slavoncus* on each cm² of poplar clones' leaves

Clones	Mean number of *E. decedens*	group	Mean number of *S. kermanensis*	group	Mean number of *D. slavoncus*	group
P. n. betulifolia	0.0093	C	0.0025	B	0.0026	B
P. n. 42.78	0.0068	CD	0.0547	A	0.0185	A
P. n. 62.154	0.0062	CD	0.0013	B	0.0020	B
P. a. 44.9	0.0571	A	0.0055	B	0.0026	B
P. e. triplo	0.0007	F	0.0	B	0.0	B
P. e. vernirubensis	0.0017	EF	0.0007	B	0.0001	B
P. e. 561.41	0.0049	C	0.0011	B	0.0	B
P. d. 69.55	0.0039	DE	0.0	B	0.0	B
P. trichocarpa	0.0128	B	0.0474	A	0.0048	B

Means followed by the same letter are not significantly different

Table 5: Means number of *E. decedens*, *S. kermanensis* and *D. slavoncus* (X±SD) on nine poplar clones in three different irrigation regimes

Irrigation regimes	Clones	*E. decedens*		*S. kermanensis*		*D. slavoncus*	
		Means±SD	Group	Means±SD	Group	Means±SD	Group
4 days	*P. n. betulifolia*	0.0164 ± 0.0014	C	0.00362±0.00243	C	0.0±0.0	B
	P. n. 42.78	0.0173 ± 0.0024	C	0.00504±0.00504	C	0.0±0.0	B
	P. n. 62.154	0.0089 ± 0.0026	DE	0.0±0.0	C	0.0±0.0	B
	P. a. 44.9	0.0322 ± 0.0020	B	0.0±0.0	C	0.0±0.0	B
	P. e. triplo	0.0000 ± 0.00002	G	0.0±0.0	C	0.0±0.0	B
	P. e. vernirubensis	0.0016 ± 0.0009	G	0.0±0.0	C	0.0±0.0	B
	P. e. 561.41	0.0000 ± 0.00003	G	0.0±0.0	C	0.0±0.0	B
	P. d. 69.55	0.0000 ± 0.00	G	0.0±0.0	C	0.0±0.0	B
	P. trichocarpa	0.0050 ± 0.0012	EFG	0.03289±0.01675	B	0.0±0.0	B
8 days	*P. n. betulifolia*	0.0012 ± 0.0005	G	0.0±0.0	C	0.00087 ± 0.0009	B
	P. n. 42.78	0.0003 ± 0.0001	G	0.0±0.0	C	0.0±0.0	B
	P. n. 62.154	0.0018 ± 0.0003	G	0.0±0.0	C	0.00592 ± 0.0035	B
	P. a. 44.9	0.0347 ± 0.0027	B	0.0±0.0	C	0.00094 ± 0.0004	B

	P. e. triplo	0.0003 ± 0.00009	G	0.0±0.0	C	0.0±0.0	B
	P. e. vernirubensis	0.0002 ± 0.00006	G	0.0±0.0	C	0.0±0.0	B
	P. e. 561.41	0.0127 ± 0.0014	CD	0.0±0.0	C	0.0±0.0	B
	P. d. 69.55	0.0085 ± 0.0008	DEF	0.0±0.0	C	0.0±0.0	B
	P. trichocarpa	0.0308 ± 0.0028	B	0.0±0.0	C	0.00163 ± 0.0007	B
12 days	*P. n. betulifolia*	0.0039 ± 0.0008	EFG	0.00015±0.00015	C	0.00688 ± 0.0033	B
	P. n. 42.78	0.0029 ± 0.0007	FG	0.07702±0.03681	A	0.05562 ± 0.0211	A
	P. n. 62.154	0.0053± 0.0012	EFG	0.00192±0.00081	C	0.0±0.0	B
	P. a. 44.9	0.1046 ± 0.00658	A	0.00827±0.00230	C	0.00698 ± 0.0027	B

Table 5 Continues

	P. e. triplo	0.0020 ± 0.001	G	0.0± 0.0	C	0.00007 ± 0.00004	B
	P. e. vernirubensis	0.0025 ± 0.0004	G	0.00104±0.00062	C	0.00034 ± 0.0002	B
	P. e. 561.41	0.0030 ± 0.001	FG	0.00085±0.00085	C	0.0±0.0	B
	P. d. 69.55	0.0032 ± 0.0007	EFG	0.00004±0.00003	C	0.0±0.0	B
	P. trichocarpa	0.0027 ± 0.0005	FG	0.03828±0.01646	B	0.01284 ± 0.0078	B

Means followed by the same letter are not significantly different

Fig. 1: Damage of *E. decedens* on *P. alba*

Fig. 2: Damage of *S. kermanensis* on *P. n. 42.78*

Fig. 3: Damage of *D. slavoncus* on *P. n.* 42.78

DISCUSSION

Based on obtained results, the highest density of *E. decedense* were on *P. a.* 44.9. It seems *P. a.* 44.9 is a more preference host to *E. decedense* compared to other clones. *P. n. 42.78* and *P. trichocarpa* had the highest density of *S. kermanensis*. The population of *D. slavoncus* was the highest on *P. n.* 42.78. So, *P. a.* 44.9 is a more preference host to *E. decedense*, *P. n. 42.78* and *P. trichocarpa* are more preference host against *S. kermanensis* and *P. n.* 42.78 is a more preference host plant to *D. slavoncus* compared to other clones. According to Sadeghi (2007) showed that infection rate of *P. d. marilandica, P. alba*, *P. e. gelrica, P. e. triplo, P. e. vernirubensis* and *P. n.betulifoia* against *E. decedens* was high, significantly. They showed that the highest density of this pest was on *P. d. marilandica* and *P. alba* and the least of leafhopper's density was on *P. n. betulifoia*. Talebi et al. (2011) showed infection rate of *P. e. marilandica, P. e. gelrica, P. e. vernirubensis* and *P. e. triplo* were high against *E. decedens*. Talebi et al. (2007) showed injury of *E. decedens* was high on *P. nigra*, *P. e. vernirubensis* and *P. e. Triplo*. Koskela et al. (2004) reported that *E. decedens* damaged *P. nigra* clones. Our results showed the highest density of *E. decedens*, *S. kermanensis* and *D. slavoncus* were registered in 12 days irrigation regimes. Density of *E. decedens* on *P. a. 44.9* was 0.0571 but this amount on this clone under 12 day regimes was 0.1046. Density of *S. kermanensis* on *P. n. 42.78* and *P. trichocarpa* were 0.0547 and 0.0474, respectively while these amounts on these clones in 12 days regimes were 0.077 and 0.0383. Density of *D. slavoncus* on *P. n. 42.78* was 0.0185 but this amount on the clone in 12 days regimes was 0.0556. It means that irrigation regimes changed densities of the pests because the lower amounts of irrigation in 12 day regime increased density of *E. decedens* on susceptible clone *P. a. 44.9*, density of *S. kermanensis* on susceptible clone *P. n. 42.78* but not about *P. trichocarpa*, and Density of *D. slavoncus* on *P. n. 42.78*. These results are confirmed by some studies that show plant stresses change plant quality as a proper food for sucking insects (Mattson and Haack, 1987). Drought increases amino acids in plants that are particularly important to phloem sucking pests (Bernays & Chapman, 1994). Rouault et al. (2006) showed water stress effects on population of forest insect pests. Perfect et al. (1986) confirmed applied water influences on pest management programs. Climate and nature changes effect on insect life-factors (Netherer and Schopf, 2010). Huberty and Denno (2004) showed that drought changes herbivorous population dynamics, especially sap-feeders and gall-makers. Survey of Daane and William (2003) showed that leafhopper (*Erythroneura variabilis* Beamer) reaction to changes in plant water stress. Perfect (1988) indicated irrigation is an affective factor for management of agricultural pests. Mody et al. (2009) and Staley et al. (2006) showed water deficiency enhance and reduce susceptibility of plants against insect pests. Daane et al. (1995) reported that density, size, number and reproductive potential of variegated grape leafhopper; *E. variabilis* are higher under increased amount of applied water. Miles et al. (1982) confirmed drought increase rate of development *B. brassicae* L. on plants. Tariq et al. (2012) reported that drought effects on fecundity and intrinsic rates of increase of *Brassica oleracea* L. and *M. persicae* on *Brassica oleracea*. Paine and Hanlon (2010) verified populations of red gum lerp Psyllid, *G. brimblecombei* as a sucking pest increased by lower amount of irrigation and higher fertilization than higher irrigation level and no fertilization. King et al. (2006) showed water deficiency effect on *L. erysimi* and *B. brassicae*, on canola (*B. napus*). Johnson et al. (2011) illustrated drought decrease abundance of *Rhopalosiphum* sp. in water stresses condition. Total aphid number of *M. euphorbiae* reduces significantly on popato *S. tuberosum*, fields (Nguyen et al., 2007). White (1969) showed stress of trees causes outbreaks of psyllids in Australia. According to obtained results and compared with other studies, irrigation is one of the important factors of integrated pest management of poplar. Therefore, with regulation of irrigation regimes can control poplar susceptibility to pests.

CONCLUSION

Usage of resistant poplar species and clones against pests and with regulate of irrigation regimes can control poplar susceptibility to pests.

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