EFFECTS OF DIFFERENT IRRIGATION INTERVALS ON *MONOSTERIA UNICOSTATA* (HETEROPTERA: TINGIDAE) DENSITIES IN NINE POPLAR SPECIES AND CLONES IN KARAJ, IRAN

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ABSTRACT: Like many countries, water is one of the most important limiting factors for poplar plantation in Iran. So there is essential to study water amount needed for every poplar species and clones. During the years 2009-2010 effects of irrigation intervals on poplar lace bug, *Monosteria unicostata* (Mulsant and Rey) damage rate were studied on the nine poplar clones in Alborz Research Station of Karaj. This study was carried out under a split plot design. Three irrigation intervals with 4, 8 or 12 days interval of irrigations were considered as main experimental plots and nine poplar clones were secondary treatments. This experiment had three repetitions. Two ways analyze of variance were performed. Analyze variance table showed significant differences between irrigation intervals and poplar species and clones ($\alpha < 0.01$). Poplar lace bug density was significantly higher under 4 days irrigation interval than two others treatments. The density of the pest was significantly highest in *P. trichocarpa*. A significant interaction was found between irrigation intervals and the poplar clones. It means that more irrigation could provide suitable conditions for growth and development of *M. unicostata* on every poplar clones.

KEY WORDS: Poplar, clones, *M. unicostata,* irrigation intervals.

Forestry by short-term and compact culture of woody crop species was regarded from 30 years ago, as a rapid manner to produce wood and cellulose sources (Tuskan, 1998). Poplar (*Populous* spp.) from Salicaceae family is one of the fastest growing trees in temperate regions of the world. It has potential for producing a large volume of wood and lumber and used as an ornamental plantings, pulp, plywood, windbreaks, landscapes, soil stabilizers and phyto-remediation (Asare & Madison, 2000). Over 400,000 hectares of Iran are suitable for poplar plantation. Forests and rangelands organization of Iran intend to use this suitable surface for growing fast growth trees such as poplar species. Since 1963, native and exotic species and clones of poplars have been studied under different climates of Iran consistently. These researches comprise evaluation of some agro-technical factors like effects of poplar plantation intervals on yield (Asadi et al., 2005) and different pest densities (Sadeghi, 2008). Effects of tree's shadow on yield of poplars and its pests densities were studied (Sadeghi et al., 2008). They include effects of poplar clones and irrigation intervals on weeds species and clones in nursery (Fanaei, 2011). Khabir & Sadeghi (2012) studied effects of agroforestry system on damage of *Melanophila picta* Pall. In addition, several studies have been carried out on resistance and susceptibility of poplar species and clones against poplar pests and diseases (Modir-Rahmati et al., 1997; Augustin et al., 2000; Han & Fang, 2000; McNabb et al., 2000; Meilan et al., 2000; Singh, 2000; Villar et al., 2000; Yan et al., 2000; Singh & Pandey, 2002; Sadeghi, 2004; Nordman et al., 2005; Sadeghi et al., 2006; Sadeghi, 2007; Hannon et al., 2008; Nikdel & Dordaei, 2008; Ahadiyat et al., 2010; Babmorad et al., 2010; Pahlevan-Yali et al., 2010; Pearson et al., 2010). Poplar lace bug, *M. unicostata*, is one of the most economically important sucking pests of poplar in Iran (Sadeghi, 2004; Sadeghi, 2007). This insect produces pale spots on upper side and small black points on underside leaves of poplar and willow host species. It makes leaves start falling down and trees become weakness and susceptive to some pest attack including xylophagous (Neal & Schaefer, 2000). This insect pest is presented nearly whole part of the country (Sadeghi et al., 2002; Haghighian & Sadeghi, 2006). Babmorad & Sadeghi (2004) reported this pest on 18 species and 50 clones of poplar in Karaj. Babmorad et al. (2010) and Ahadiyat et al. (2010) studied susceptibility and resistance of poplar species and clones against the pest. Because of being one of the poorest countries in water resources, poplar culture is limited in Iran. 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 (Hayati & Lari, 2010). Therefore, there is essential to study on effect of water supply on yield and pests densities of poplar. Guo et al. (2010) have studied effects of flooding water on physiology, morphology and growth response of 13 clones of poplar. Pearson et al. (2010) searched effects of short term and intensive culture on yield of poplar. LeBoldus et al. (2007) studied effect of irrigation stresses on poplar clones. White (1974) showed drought stresses can change herbivorous pest densities of poplar trees. Daane & Williams (2003) have studied effects of irrigation intervals on density of herbivorous insects of vines. Trueta (1993) investigated leafhopper densities on vines under different amounts of irrigation regimes. Irrigation amounts could be manipulated in the relationship between irrigation amounts and some insect pest density (Trichilo et al., 1990). The aim of this study is an evaluation interval of irrigation on *M. unicostata* densities on poplar species and clones in Karaj, Iran.

MATERIALS AND METHODS

The experiments were carried out in Alborz Research Station of the Research Institute of Forests and Rangelands (RIFR) in Karaj. Base of previous studies that had done on adaptabilities of different poplar species and clones in Karaj condition by research Institute of Forests and Rangelands of the country, nine poplar clones with highest yield were selected and used for this study. Theses clones are include *Populus trichocarpa*, *P. euramericana triplo*, *P. euramericana* 561.41, *P. euramericana vernirubensis*, *P. nigra betulifolia*, *P. nigra* 42.78, *P. nigra* 62.154, *P. deltoides* 69.55, *P. alba* 44.9. The experiments design applied for this study was split plot with 3 repetitions. Each repetition was divided to 3 plots known main treatment (irrigation intervals; 12, 8 and 4 days). Each main plot was divided to 9 accessorial treatments. Each accessorial plot included 9 trees of one poplar clone with 2.5*2.5 meters intervals plantation. During 2009-2010 from each tree, 8 leaves were randomly selected in four main geographical directions of trees. Then the numbers of *M. unicostata* (nymphs and adults) were counted and registered. Finally, the leaves were transferred to the RIFR laboratory and their surfaces were measured by a leaf area meters device (Gate house, scientific instrument LTD) in order to calculate number of this pest in surface unit. The recorded data were analyzed by SAS software, (LSD).

RESULTS

Two ways analysis of variance shows significant difference between main treatments (irrigation intervals) for *M. unicostata* density (Table 1). Meanwhile this table shows that poplar clones had significant effect on poplar lace bug densities. According to the table, interaction of irrigation interval treatments and poplar species and clones were significant. The highest density of *M. unicostata* registered under 4 day irrigation interval (Table 2), but there is no significant difference between 8 and 12 day irrigation intervals. Dancun's means comparisons showed the highest density of *M. unicostata* on *P. trichocarpa*. *P. alba* 44.9, *P. nigra betulifolia* and *P. nigra* 62.154 set in the next levels considering *M. unicostata* density. The least density of *M. unicostata* obtained on *P. euramericana triplo* and *P. deltoides* 69.55 (Table 3). Table 4 shows the highest density of *M. unicostata* observed on *P. trichocarpa* treated 4 and 12 days irrigation intervals. *P. alba* 44.9 had high density of the pest under 3 levels of irrigation but there was no significant difference between them. *P. nigra* 62.154 and *P. nigra betulifolia* had higher density of *M. unicostata* treated by 4 days than 8 and 12 days, significantly. Densities of *M. unicostata* on *P. nigra* 42.78 and *P. euramericana vernirubensis* were different in 3 intervals irrigation, significantly. *P. euramericana triplo*, *P. euramericana* 561.41 *and P. deltoids* 69.55 did not show any significant difference treated by the irrigation intervals.

DISCUSSION

The highest density of *M. unicostata* was registered under four days interval of irrigation, having significant different from 8 and 12 days irrigation intervals. As adult and fifths nymph instars of the pest are feeding from poplar sap, so high provided amount of water in 4 days interval in comparison to 8 and 12 days, make poplar species and clones more susceptible against this sucking pest. These results are confirmed by some studies that show plant stresses change plant quality as a proper food for sucking insects (Mattson & Haack, 1987). Stresses change insect's life history indirectly and host plant physiology directly as well (Schultz, 1988; Waring & Price, 1990; Waring & Cobb, 1992; Schowalter et al., 1999; Breshears et al., 2005; Ditmarová et al., 2010; Ryan & Way, 2011). Rouault et al. (2006) showed water stress effects on population of forest insect pests. Perfect et al. (1986) have confirmed applied water influence on pest management programs. Climate and nature changes affect insect life-factors (Netherer & Schopf, 2010). Huberty & Denno (2004) showed that water stresses of host plant affect herbivorous population dynamics, especially sap-feeders and gall-makers. Survey of Daane & William (2003) showed that leafhopper density had a positive linear function with applied water amounts. Trueta (1993) showed higher leafhopper densities found on vines receiving greater amounts of irrigation water. Patel et al. (2010) showed increasing of irrigation intervals enhance population of thrips, *Scirtothrips dorsalis* Hood in Chili. Perfect (1988) indicated irrigation is an affective factor for the management of agricultural pests. According to Kannan & Mohamed (2001) densities of *Thrips tabaci* Lindeman on onion, increased over short irrigation regimes and reduced over longer irrigation regimes. Simpson et al. (2012) demonstrated that drought reduce the population of *Myzus persicae* Sulzer on cabbage. Tariq et al. (2012) reported that drought affects fecundity and intrinsic rates of increase of *Brassica oleracea* L. and *M. persicae* on *Brassica oleracea*. Research of Paine & Hanlon (2010) verified populations of red gum lerp psyllid, *Glycaspis brimblecombei* Moore increased by lower amount of irrigation and higher fertilization than higher irrigation level and no fertilization. Mody et al. (2009) and Staley et al. (2006) recorded water stresses enhance and reduce susceptibility of plants against insect pests. King et al. (2006) showed water deficiency affect on *Lipaphis erysimi* (Kaltenbach) and *Brevicoryne brassicae* (L.), on canola (*Brassica napus* L.). Daane et al. (1995) reported that density, size, number and reproductive potential of variegated grape leafhopper, *Erythroneura variabilis* Beamer are higher under increase amount of applied water. Under water stresses adult survival and total aphid number of *Macrosiphum euphorbiae* (Thomas) reduces significantly on popato *Solanum tuberosum* L., fields (Nguyen et al., 2007). Johnson et al. (2011) showed drought decreased abundance of *Rhopalosiphum* sp. Density of *M. unicostata* on *P. trichocarpa* is statistically higher than the other tested clones. The clones *P. alba* 44.9, *P. nigra betulifolia* and *P. nigra* 62.154 placed in the second and third levels of infection. Without accounting on irrigation treatments, *P. euramericana triplo* and *P. deltoids* 69.55 clones had significantly lowest infection to *M. unicostata*. These results confirmed by some researches such as studies of Ahadiyat et al. (2010), Sadeghi (2004), Babmorad et al. (2010) and Sadeghi et al. (2006). Ahadiyat et al. (2010) observed highest density of *M. unicostata* on *P. nigra* and *P. alba* and the lowest on *P.euramericana* and *P. deltoids*. Sadeghi (2004) studied on poplar species and clones including, *P. nigra* 63.135, *P. euramericana triplo*, *P. alba*, *P. trichocarpa*, *P. deltoids* 77.51 and *P. e. verniruben*. They showed *P. trichocarpa* and *P. euramericana triplo* being the highest and the least preferred host against *M. unicostata* respectively. According to the researches *P. trichocarpa* had the highest susceptibility against *M. unicostata* under different irrigation intervals. Besides, some researchers (Sadeghi et al., 2006; Babmorad et al., 2010) recorded the maximum eggs of *M. unicostata* on this clone as well. This clone is not recommended to culture for wood production in Karaj because of short growth regime and fast falling down (Bagheri, 2010). *P. alba* 44.9 showed high infection to poplar lace bug under 3 intervals of irrigation. Babmorad et al. (2010) recorded susceptibility of clones against this pest. Also Babmorad et al. (2010) recorded the highest egg amounts of *M. unicostata* on *P. alba* 58.57 and on *P. alba* 44.9 and the lowest was seen on *P. deltoides* 77.51, *P. deltoides* 73.51, *P. deltoides* 69.55 and *P. x euramericana* 561.41. Sadeghi et al. (2004) recorded that leaves of *P. alba* was more infected to *M. unicostata* eggs than leaves of *P. deltoids*. The highest and the least infection had reported in theses to poplar clones respectively. Bagheri (2010) showed clones of this species are susceptive against drought stresses. Considering its slow growing, it just recommended for landscapes programs. According to this study, all of the *P. nigra* clones showed high infection to the pest. *P. nigra* 62.154 has a long growth, suitable volume and density of top, closed top, furrow plantation and resistant against drought stress compared to the other varieties (Bagheri, 2010). Therefore, it is suitable for wood production in regions where *M. unicostata* is not key pest of poplar. Considering high wood production of *P. euramericana vernirubensis* and *P. euramericana* 561.41 (Bagheri, 2010) and resistance to poplar lace bug (Sadeghi, 2004; Sadeghi et al., 2006; Ahadiyat et al., 2010; Babmorad et al., 2010), can being as a candidate for poplar plantation. New researches demonstrated *P. euramericana triplo* and *P. deltoides* 77.51 having lower infection against this pest (Sadeghi, 2004; Sadeghi et al., 2006; Ahadiyat et al., 2010; Babmorad et al., 2010) and resistance to drought stresses (Bagheri, 2010). In conclusion, 8 days irrigation interval is the most reasonable irrigation regimes in Karaj region, because yield of poplar compared with 12 days, is higher, density of *M. unicostata* in comparing with 4 days interval is lower and can economize save at least about 7500 m3 water compared to 4 days interval (Bagheri, 2010).

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Table 1. Two ways analysis of variance table of *M. unicostata* densities on 9 poplar clones on three irrigation regimes.

Variation sources	density of *M. unicostata*			
	df	Mean Square	*F*-value	*P*-value
I	2	0.708	25.49	<.0001**
C	8	1.896	68.25	<.0001**
I*C	16	0.278	10	<.0001**

I: Irrigation interval, C: Clone, **: significant difference at α = 1%

Table 2. Means number of *M. unicostata* in each cm² on irrigation intervals.

Irrigation regimes	Mean
Every 4 days	0.064a
Every 8 days	0.034b
Every 12 days	0.037b

Means followed by the same letter are not significantly different (P = 0.05; SAS Institute 2002).

Table 3. Means number of *M. unicostata* in each cm² of leaves of poplar clones.

Clones	mean
P. n. betulifolia	0.054c
P. n. 42.78	0.027d
P. n. 62.154	0.058c
P. a. 44.9	0.076b
P. e. triplo	0.005e
P. e. vernirubensis	0.018de
P. e. 561.41	0.016de
P. d. 69.55	0.003e
P. trichocarpa	0.15a

Means followed by the same letter are not significantly different (P = 0.05; SAS Institute 2002).

Tabe 4. Means number of *M. unicostata* on 9 poplar clones under three different irrigation intervals.

Clones	Irrigation intervals		
	12 days	8days	4days
P. n. betulifolia	0.0028 ± 0.0008i	0.0491 ± 0.0132fgh	0.1268 ± 0.0342b
P. n. 42.78	0.0017 ± 0.0006i	0.0497 ± 0.0128fgh	0.0279 ± 0.0016ghi
P. n. 62.154	0.0534 ± 0.0031efg	0.0052 ± 0.0019i	0.1162 ± 0.0144bc
P. a. 44.9	0.083 ± 0.0108de	0.0851 ± 0.0136cde	0.0621 ± 0.0076ef
P. e. triplo	0.0037 ± 0.0008i	0.0033 ± 0.0016i	0.0069 ± 0.0017i
P. e. vernirubensis	0.0015 ± 0.0004i	0.0013 ± 0.0006i	0.0524 ± 0.0075efg
P. e. 561.41	0.0014 ± 0.0004i	0.0173 ± 0.0054hi	0.0303 ± 0.0045fghi
P. d. 69.55	0.0010 ± 0.0004i	0.0026 ± 0.0008i	0.0057 ± 0.0016i
P. trichocarpa	0.1898 ± 0.0191a	0.0961 ± 0.0116bcd	0.1653 ± 0.0097a

Means followed by the same letter are not significantly different
(P = 0.05; SAS Institute 2002).