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Research Article

INVESTIGATIONS OF PRUNING TIME AND INTENSITY ON PHYSIOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS OF APRICOT TREES (VAR. SHAHROUDI) AFTER LATE SPRING FROST

***Javad Ahmadian[1], Ebrahim Ganjimoghadam[2] and Ahmad Asghar Zadeh[1]**
[1]Department of Agriculture, Shirvan Branch, Islamic Azad University, Shirvan, Iran
[2]Agriculture and Natural Resources Research Center, Torogh, Mashhad, Iran
** Author for Correspondence*

ABSTRACT
Apricot is one of the commerical products of the temperate zone, and is cultivated in many parts of the Iran such as the Khorasan Province. Late spring frost is one of the most limiting factors in front of the growers of apricots which is the problem that is reduced the crops. This study was conducted with the main purpose of determining pruning management during the crop year 2012-2013 at Golmakan agriculture researcher station using a two-factorial experiment including pruning time and severity as factors, was stablished in a random block design in four replications with 1 trees in each replication. The first factor was the pruning time at three levels [late March (flowering stage), late April (before the pit hardening) and late May (a month before harvesting)] and the second factor was pruning severity at four levels [thinning out of one-year-old branches, Heading back ½ of one-year-old branches, combination of thinning out and heading back one-year-old branches (conventional) and the control (non-pruning)], respectively. Our results showed that there is a statistically significant difference at 1% level between pruning treatments on weight of the pruned branches, there for thinning out treatment in late May has the highest and control has the lowest rates of pruning branches weight. Also, heading back treatment in the end of March, compared with control led to more growth and more number of one-year-old branches and maximum size of crown after pruning at 1 percent. Maximum number of reproductive and vegetative buds from control treatment at 1 percent level was obtained.

***Keywords**: Apricot, Pruning, Morphological Characteristics, Branches, Buds*

INTRODUCTION
It is believed that apricots were domesticated well over 5000 years ago in the wide area covering Iran, Turkistan, Afghanistan, Middle Asia and Western China and that they were brought to Anatolia in the 4 th century BC from Persia during the voyages of Alexander the Great. During the Roman and Persian wars in the 1 st century BC, apricots spread first to Italy and then to Greece. Eventually apricots spread to Spain and England in the 13th century and to France and America in the 17th century (Faust *et al.*, 1998; Buttner, 2001; Ercisli, 2009). Pruning is one of the most important technical treatments applied on fruit trees. Throughout the tree's life, pruning ensures that limbs are strong enough to support fruit and that branches are properly angled to allow in sufficient sunlight for flower buds to develop and for fruit to ripen (Demirtas *et al.*, 2010a). Pruning not only considerably improves regeneration processes of damaged branches and reduces the size of tree crowns, but also reduces their excessive height (Carlson, 1982; Mika, 1986; Radajewska and Szklarz, 2008; Szklarz and Radajewska, 2009). Pruning promotes good air flow throughout the fruit tree, which helps prevent common tree diseases. Pruning is also effect fruit external and internal quality properties such as color development, total soluble solid/acidity balance etc. (Lord and Greene, 1982). Milozevic *et al.*, (2011) pointed out that the highest positive response to pruning was related to 15 June (late June), 1 July (middle of July) and 15 July (late July) in apricot, respectively. Al-Rawi *et al.*, (2011) reported that using 600 mg per liter Enfaton growth regulator and 30 percent thinning out of branches led to highest average yearly growth in apricot. Fukuda *et al.*, (2002) found that shoots growth in light pruned trees ceased by end of May, while in heavy pruned trees, the shoots continued to elongate until the end of June. Villasante *et al.*, (2012) stated that pruning increase in

the total current season shoot growth in sweet cherry. Blazkova *et al.,* (2012) noticed that tree vigour of all the tested cultivars was about 54% stronger on the Colt rootstock than on P-HL-A. Mizutani *et al.,* (2000) observed that the earlier summer pruning resulted in the greater shoot length and shoot numbers in apple. Demirtas *et al.,* (2010a) classified pruning according to time of this treatments (winter and summer pruning) or tree age (young, middle and older trees). Traditionally in many countries, fruit trees are pruned in its dormant stage, which is a late winter to an early spring. Pruning of apricot trees can also be made at the end of summer to cut back upright shoots on side branches and to remove new, superfluous shoots. In other studies found that tree pruning in summer had also positive influence on flower bud formation, increased fruit quality and allow to control tree development (Miller 1982). Bruno and Evelyn (2001) reported that shoot tipping in cherimoya significantly decreased shoot length according to the date it was done. Demirtas *et al.,* (2010a) indicated that the highest average yield considering trunk cross-sectional area was obtained from pre-harvest summer pruning treatment and the highest share of flower bud was observed in pre-harvest summer+winter pruning treatment in apricot. Szklarz *et al.,* (2011) pointed out there was better flower buds setting and yielding of trees pruned intensively. Sharma and Chauhan (2004) found that the highest fruit yield in lightly pruned trees where 25% of current season growth were removed than the moderate and severely pruned trees where 50 and 75% of the current season growth were removed in peach.

MATERIALS AND METHOD

This study was conducted at Golmakan agriculture researcher station using a two-factorial experiment including pruning time and severity as factors, was stablished in a random block design in four replications with 1 trees in each replication at during the crop year 2012-2013 using 6 year old trees of apricot var. Shahroudi on seedling rootstock. The first factor was the pruning time at three levels [late March (flowering stage), late April (before the pit hardening) and late May (a month before harvesting)] and the second factor was pruning severity at four levels [thinning out of one-year-old branches, Heading back ½ of one-year-old branches, combination of thinning out and heading back one-year-old branches (conventional) and the control (no pruning)], respectively. The treatment trees were attempted to be of maximum uniformity. After selecting the trees with the aim of distinguishing them from other trees, their trunks were painted and their specifications (treatment type and its time of application) were recorded and attached to the tree. Applied treatments of severity pruning were as follows:

Thinning out one year old branches = one year old branches which were longer than 40 cm were eliminated from this treatment.

Cutting back ½ of the one year old branches = ½ of one year old branches which were longer than 40 cm was eliminated in this treatment.

Combination of thinning out and cutting back of one year old branches (conventional) = after counting the number of one year old branches which were longer than 40 cm, 50 percent of the branches was thinned and the other 50 percent was cut back in this treatment.

Control (non-pruning). The properties under investigation included: main arms diameter, the number of branches formed after pruning, the number of vegetative and reproductive buds and crown volume. Total volume of crown was calculated based on its height and width as follows (Westwood, 1996):

For a tree whose height is more than its width: Crown volume: $4/3\pi ab^2$

For a tree whose width is more than its height: Crown volume: $4/3\pi a^2 b$

In these formulas:

$\pi = 3.14$

a = ½ major axis

b = ½ minor axis

The data were analyzed using MSTATC and diagrams were drawn using Excel. The means were compared in levels 1 and 5 using Duncan test.

RESULTS AND DISCUSSION

The Effect of Pruning Time and Severity on the Number of Branches Formed After Pruning

The results obtained from the analysis of data variance indicated that pruning time and interactive effect of pruning time and severity on branches formed after pruning was non-significant and that pruning severity was significant in probability level 1 (table 1). Comparison of the means showed that pruning time did not affect the number of branches formed after pruning. The effect of pruning severity showed that heading back treatment and control treatment contained highest (3/892 branches) and lowest (1/6 branches) number of branches, respectively. The reason is that heading back might lead to peripheral buds' release due to the elimination of terminal buds and therefore elimination of apical dominance. Therefore, the number of branches formed after pruning increases. The results also showed that the number of branches formed in thinning out branch treatment was less than that of the combination of thinning out and heading back. Investigation of interactive effect of pruning time and pruning severity indicated that heading back treatment contained highest (4/1 branches) and control treatment contained lowest (1/5 branches) number of branches in late March.

Table 1: Analysis of variance for characteristics of apricot (var. Shahroudi)

S.O.V	df	Crown Volume	Number of Reproductive Buds	Number of Vegetative Buds	Number of branches formed after pruning	Main Arm Diameter
Replication	3	0.568 ^{ns}	136.972^{ns}	41.917 ^{ns}	0.581 ^{ns}	0.629 ^{ns}
Time of Pruning	2	11.170**	36.021^{ns}	9.750 ^{ns}	0.206 ^{ns}	0.343 ^{ns}
Intensity of Pruning	3	2.768**	5868.083**	974.47 **	7.275**	1.178 ^{ns}
Time× Intensity	6	0.495**	258.271**	28.056 ^{ns}	0.84 ^{ns}	2.498 ^{ns}
Error	33	0.226	108.033	17.311	1.187	1.166
CV	-	22.94	6.10	5.98	14.12	26.47

**, ** significantly at the 1% and 5% levels of probability respectively and ns (non significant)*

The Effect of Pruning Time and Severity on Main Arms Diameter

The results obtained from the analysis of data variance indicated that pruning time, severity and also the interactive effect of time and severity pruning did not increase the main arms diameter significantly (table 1). Comparison of the means showed that pruning time and severity did not affect the main arms diameter. Investigation of mean comparison of interactive effect of pruning time and severity on main arms diameter indicated that the control treatment and thinning out treatment respectively contained the highest (5/621 cm) and lowest (2/996 cm) increase in main arms diameter in late May which was not consistent with Ikinci (2012) results which stated that summer pruning increases the main arms diameter. This is due to the type of cultivar and pruning time. While investigating The effects of different pruning treatments on the growth, fruit quality and yield of apricot, Demirtas *et al.*, (2010 a) stated that the highest diameter of the main arms was obtained from the summer + winter pruning treatment before harvesting.

The Effect of Pruning Time and Severity on Crown Volume

The results obtained from data analysis indicated that pruning time and severity on crown volume in probability level of 1 percent is significant but the interactive effect of pruning time and severity was not significant (table 1). Comparison of the means showed that pruning time had a positive effect on the crown volume so that the trees pruned in late March had the highest (2/664 cubic meters) and those pruned in late May had the lowest (1/116 cubic meters) amount of crown volume. However, there was no difference between treatments in late March and late April. Results of mean comparisons of pruning severity showed that trees with heading back treatment had respectively the highest (2/664 cubic meters) and the lowest (1/553 cubic meters) crown volumes, compared to the control trees which was not consistent with Szklarz *et al.*, (2011) reports stating that the severe pruning increases the crown width and its photoreception. This can be due to the type of cultivar variation. However, no difference was observed in trees' crown volume in thinning out treatment and combination of thinning out and heading back

treatment with control treatment. Investigation of interactive effect of pruning time and severity also indicated that cutting back treatment and control treatment in late March had the highest (3/688 cubic meters) and lowest (0/7243 cubic meters) crown volume, respectively.

The Effect of Pruning Time and Severity on the Number of Reproductive Buds

The results obtained from the analysis of data variance indicated that the effect of pruning time on the number of reproductive buds was not significant but the pruning severity and the interactive effect of pruning time and severity were significant at1 percent level (table 1). Comparison of the means indicated that pruning time did not affect the number of reproductive buds formed on the current growing season branches after the pruning which was not consistent with results of Demirtas *et al.,* (2010 a) stating that the highest percent of buds is obtained in summer + winter pruning treatment before harvesting. This might be due to the difference in type of items and pruning treatments. Comparison of the pruning severity effect means showed that control trees compared to thinning out treatment of one year old branches respectively had the highest (199/7 buds) and lowest (152/5 buds) number of reproductive buds which is consistent with Kumar *et al.,* (2005) stated that light pruning increases the flowers compared to other treatments. It also indicated that there was no difference between thinning out treatment and the combination of thinning out and heading back treatment. Investigation of interactive effect of pruning time and severity indicated that the control treatment and thinning out of one year old branches in late April had respectively the highest (199/4 buds) and lowest (142/3 buds) number of reproductive buds.

The Effect of Pruning Time and Severity on the Number of Vegetative Buds

The results obtained from the analysis of data variance indicated that pruning time and the interactive effect of pruning time and severity on the number of vegetative buds was not significant but pruning severity at 1 percent probability level was significant (table 1). The comparison of the means showed that pruning time did not affect the number of vegetative buds on the current growing season branches after pruning. Still the comparison of the effect of pruning severity indicated that control trees compared to the thinning out treatment had respectively the highest (81/42 buds) and lowest (61/5 buds) number of vegetative buds which was consistent with Demirtas *et al.,* (2010 a) found that the number of vegetative buds in control treatment was higher than other treatments. Investigation of the interactive effect of pruning time and severity also indicated that control treatment and thinning out of one year old branches in late April had respectively the highest (85 buds) and lowest (60/25 buds) number of vegetative buds.

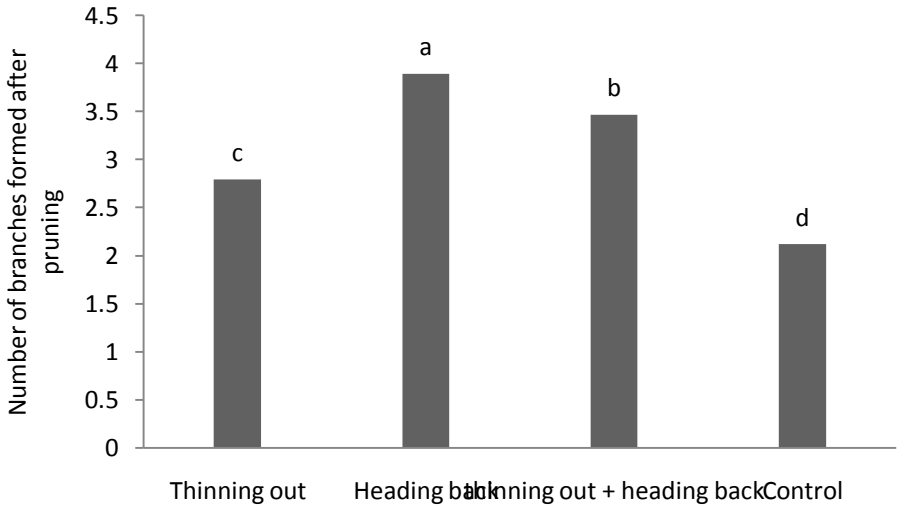

Figure1: The effect of pruning severity on the number of branches formed after pruning

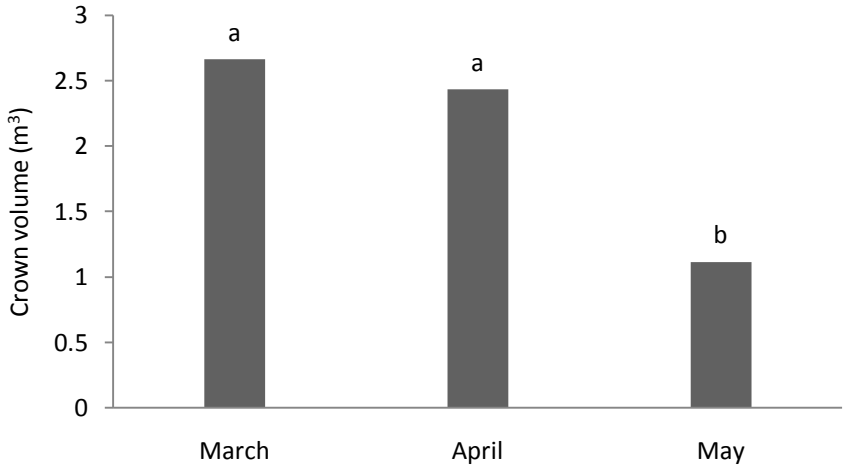

Figure 2: The Effect of Pruning Time on Crown Volume

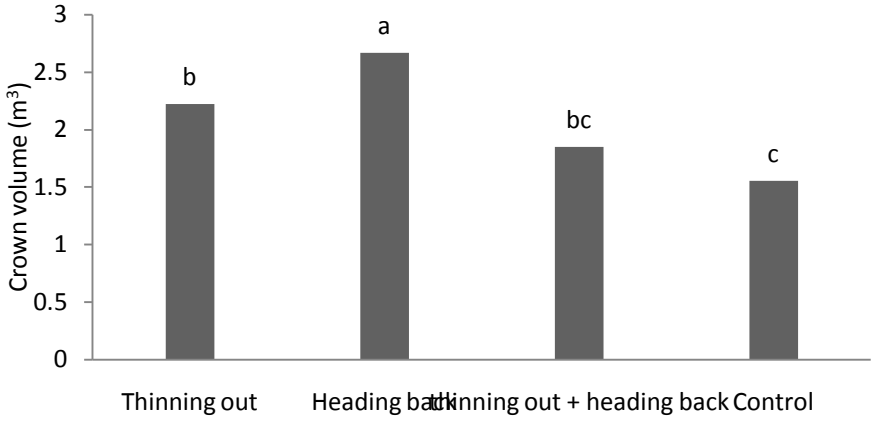

Figure 3: The effect of pruning severity on Crown Volume

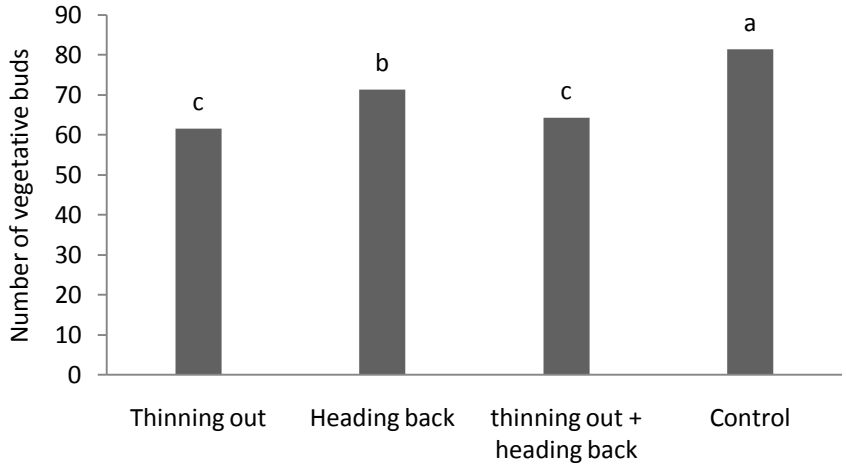

Figure 4: The Effect of Pruning Severity on the Number of Vegetative Buds

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