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A Study of the Impact of Pruning on the Growth and Vigority of the Hand-Planted-Haloxylon Trees in Kerman, Iran

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Abstract: Pruning and reaping different quantities (P_{1-5}) of air biomass of the haloxylon trees were studied in two different haloxylon planted areas from the viewpoint of vigority. It was done within the format of the design of fully random blocks with five treatments (pruning from the 10 cm over the collar, pruning 150 cm of the top branches, pruning 100 cm of the top branches, pruning 50 cm of the top branches and control) and four repetitions as possible ways to remove wilting state, dying status and revive the vigor condition of hand-planted shrubs. The index of $VI = H (CD) a^{-1}$ was accepted out of many quantitative indexes as the symbol of vigority (quality) which could show the vigorous quality in the form of a quantitative quantity after testing in hand-planted shrubs of Kerman Province. The average of this index in each of the three germinating conditions (vigorous, wilting and dying) was 1370, 780 and 280, respectively. The statistical studies showed that there was a significant difference among its quantities in different degrees of vigority. In other words, the quantities of this index, in addition to the size of growth showed its quality (the vigority degree) as well. The analysis of the data in LSD method during a 5-year research showed that the impact of P_1 and P_2 on the growth of trees and also VI in both regions were significant. The results showed that the intensive prunings are able to increase the growth of wilting haloxylon and rejuvenate their vigority and freshness.

Key words: Haloxylon, pruning, crown diameter growth, height growth, vigority

INTRODUCTION

Haloxylon shrubs as a resistant plant in different growth areas form more or less sporadic masses in natural form in some of the desert and arid zones of Iran. Since 1962, in which desertification and fighting against the movement of flowing sands were started in a systematic way in Iran, the haloxylon shrub was also broadly used in biological combat against the spread of desert (Amani and Parvizi, 1996). It is such that at present, the haloxylon hand-planted masses covers more than 1.5 million ha of Iranian areas (Shamszadeh and Baghestani, 2003). The very positive results of primary forest plantation made further attention given to haloxylon shrub. It was such that in the rejuvenated area in Lut and Kavir plains, the haloxylon became the dominant and in some cases the unique species (Amani and Parvizi, 1996).

Though the primary basic objective of the hand-cultivated haloxylon was to fix the sand hills, to prevent the movement of flowing sands and to control the sand lands in the margins of deserts (Amani and Parvizi, 1996), but gradually due to irregular use of vegetation converge and water and soil resources along with frequent drought, the phenomenon of desertification had an accelerating trend and the rejuvenation of desert lands was added to the above-mentioned objective. At present, the very useful impact of this big movement (broad areas covered with hand-cultivated haloxylon) has become so diverse that can not be viewed only as a preventive factor for the sand movement, but these masses form a vital stage in the course of developmental change of these regions from the viewpoint of revival and dynamism of the annihilated ecosystem and are considered as the biologic, botanic and ecologic reserves and forest resources (Amani and Parvizi, 1996).

Regretfully, in 1972, (after about a decade of the life of the first hand-planted haloxylon masses in Iran), the emergence of wilting phenomenon in haloxylon shrubs gave rise to concerns and these concerns found a further scope. This was the first spark to give further attention to

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the life of hand-planted haloxylon, highlighting the operation of maintaining in these kinds of plantation (Shamszadeh and Baghestani, 2003; Amani and Parvizi, 1996).

It seemed that pruning (Perry and Gardener, 2008; Sellmer *et al*., 2004), is among these operations being effective in removing dying status and wilting condition of haloxylon trees which can lead to their renovation of freshness and vigority. So, in line with previous studies (Baghestani *et al*., 2008; Shamszadeh and Baghestani, 2003; Amani and Parvizi, 1996; Rahbar, 1986), the different intensity of pruning and studying its impact on the growth and vigority of haloxylon shrubs became the topic of this study.

MATERIALS AND METHODS

After conducting initial studies, studying resources and also reviewing the results of other researches about the primary causes of wilting and dying of the haloxylon trees in Iran and possible methods to prevent from their death, the necessity of performing this research was put in the agenda in spring 2003. In the winter of the same year, its executive phase was started and ended in the autumn 2008 by taking the latest statistical data. The second phase including statistical review, data analysis and was started upon the completion of the first phase and it lasted up to the early 2009.

The infrastructure of this research is based on the factor of pruning (deletion of a part(s) of plant aiming at a certain and definite objective (Sellmer *et al*., 2004; Evans, 2003), maintaining and protecting the health and vigority of plants (Douglas, 2001; Kim and Koehler, 1995) and omission of broken and dry branches (Medagoda *et al*., 2002) that in the ever green plans, its intensive type is used at the end of winter and before the start of new growth (Evans, 2003; French and Appleton, 2002). It is such that some of the plants can be rejuvenated or renovated with full cut down of the air bodies from the surface of the ground or near to that (Sellmer *et al*., 2004; French and Appleton, 2002; Douglas, 2001; Ball and Graper, 1999) and even change their shape (Kane, 2008).

This research was conducted within the format of the design of fully random blocks with 5 treatments and 4 repetition in two different haloxylon planted areas (areas planted with haloxylon shrubs in the suburb of Kerman, N30°17'-02"; E57°42'-02") from the viewpoint of vigority (TolombehKhoshk (T) with wilting haloxylon shrubs and Baqerabad (B) with dying haloxylon shrubs) for five years. Using LSD, the averages were compared during the five year period. In order to test and assess the quantitative index of growth (the product of height and average of the crown diameter divided by age) as the symbol of vigority, data processing was done by using the F-test and Daunken statistical methods.

Determining the index of growth and vigority: We know that the quantities of height and crest diameter of trees (along with consideration of their ages) concurrently indicate growth. The existence of united indexes which include these three quantities and could provide possibility of comparing the shrubs of haloxylon from the viewpoint of germination and indicate the quality of growth from the viewpoint of vigority is very important. Such an index had been used before by Rahbar (1986) in some areas under the plantation of haloxylon shrubs. This could be employed in the planted haloxylon trees of Kerman Province (It is the widest province located in the South East of Iran in geographical coordinates: 54°25' 60" to 59° 51' 43: of Eastern longitude and 26° 22' 16" to 31° 56' 40" of Northern latitude) after testing (The simple and bi-dimensional index H CD 10^{-1} a^{-1} was considered appropriate due to the fact that it had attached equal significance to the three factors of height, crown diameter and age of shrubs and out of the four types of growth index, all being basically the product of the dimensions of growth divided by age were selected as the index of growth and vigority. The digit 10 was placed in the denominator of the fraction of this index to make the obtained figures reduced). In this line, after conducting classic studies and reviewing the maps of plant coverage, air photos (in scales of 5000^{-1}, 20000^{-1} and 50000^{-1}), field visits on 8 to 11 year old haloxylon planted areas in Kerman City (Center of Kerman Province which is located in the geographical coordinates of 57° 42' 02" of Eastern longitude and 30° 17' 02" of Northern latitude), Shahdad, Bam and Zarand (cities of Kerman Province), the map of the condition of vigority of haloxylon planted areas was prepared in three germination status of vigor, wilting and dying. Then, in each of the mentioned growing condition, two pieces (repetition) relatively of the same age and far from each other were selected. Thus, totally out of haloxylon planted areas of the mentioned cities (the fourfold districts), 24 pieces were selected for the purpose of assessing the vigority index. In each piece, the height and average of the crown diameter of 45 haloxylon trees (shrubs) were measured. In the continuation, in order to study the application of the mentioned index as a quantitative and qualitative index in hand-cultivated haloxylon plants of Kerman Province, the F-test statistical method was used for the significance test of the difference of the quantities of the index in three germination processes of vigor, wilting and dying. The

result of variance analysis is presented in Table 1. As it is observed in the table, the difference of the quantities of the forecasted index in different conditions of growth is significant at the level of one percent. Comparing the average of the sizes of this index in Duncan multiple range test (Table 2), it indicates that there is an intensive difference between the quantities of this index in different positions of growth. So based on this analysis, the suggested index not only indicate the size of growth but also indicated its quality (vigorous, wilting or dying status) and can be used as the VI (vigority index) in haloxylon planted areas of Kerman Province.

Selection of regions, allocation of treatments and method of data reaping: In the continuation of the processes, having a more detailed and precise study of shrub planted areas of the suburb of Kerman, a map was prepared on the condition of vigority (the distribution of vigor, wilting and dying pieces) of the hand cultivated forest. After that, of the two germination positions of wilting and dying, two relatively pieces of the same age and with a smooth affluence degree were selected and four blocks were divided randomly in each piece. Pruning was arranged from the 10 cm over the collar (P_1), pruning 150 cm of the top branches (P_2), pruning 100 cm of the top branches (P_3), pruning 50 cm of the top branches (P_4) and control (P_5) were determined as the treatments of the test and allocated to each of the blocks randomly (in each treatment, the statistics of each of the 45 haloxylon trees were made). Taking different quantities of the air bodies of the trees (P_{1-5}) was started in January 2003 and ended in the middle of February. Then the height and average of the diameter of the crown of treated trees were measured and registered. Every year, after the end of the growth period, the quantities of the annual growth of height and average of the diameter of the crown of shrubs were measured for five years (all measuring were made at the end of the germination season in September to October); and at the end of five years, they were used as a base for judgment.

Table 1: Analysis of variance for vigority index (H (CD) $(10a)^{-1}$) in 3 vigority condition

SOV	df	SS	MS	F_c	F_t
Between vigority condition	2	145226	72613	36.85**	3.47 $F_{5\%}$ 5.78 $F_{1\%}$
Error	21	41382	1970.57		
Total	23	186608	8113.39		

Table 2: Mean of vigority index (H (CD) $(10a)^{-1}$) in 3 vigority condition

Dying	Wilting	Vigorous
280	780	1370
←——99%——→	←—— 99%——→	

RESULTS

The impact of pruning on the growth of the height of wilting haloxylon trees (T region): At the end of the first year of germination (after pruning of haloxylon trees) in this region, the annual growths of the height in treatments of P_1 to P_5 were obviously different. This difference between each of treatments of P_1 to P_4 with each other and with the control (P_5) was significant at the statistical level of 1%. At the end of the second year of germination, similar results were obtained. But the significant difference among treatments of P_1 and P_2 was at the statistical level of 5%. The obtained results at the end of the third to fifth year of germination were totally similar to each other and different with the first and second years of germination. It was such that no significant difference was observed between treatments P_1 and P_2 and also P_3 and P_4, but the difference between these two groups of treatment with control was significant at the statistical level of 1% (Table 3).

The impact of pruning on the growth of the height of dying haloxylon trees (B region): The results obtained from the data analysis of the first year of germination showed that the difference between treatments of P_1, P_2 and P_3 and also difference of each with the control was

Table 3: Comparing the averages of height in two regions of Tolombehkhoshk (T) and Baqerabad (B) in LSD method

		Height (cm)				
Regions	[1]P.I.	2004	2005	2006	2007	2008
T		46.734 aA	22.500 aA	17.037 aA	14.393 aA	13.003 aA
B		37.164 aA	16.360 aA	10.250 bB	07.113 bB	04.673 bB
LSD 5%		09.849	07.066	04.957	02.104	01.745
LSD 1%		16.057	12.969	06.260	03.862	03.203
	P_1	99.343 aA	38.833 aA	27.675 aA	22.025 aA	17.733 aA
	P_2	62.333 bB	31.483 bB	22.349 bB	17.733 bB	15.733 aA
	P_3	26.400 cC	13.392 cC	08.383 cC	06.292 cC	04.958 cC
	P_4	18.017 dD	08.933 dD	06.825 cC	05.733 cC	04.458 cC
	P_5	03.650 eE	04.508 eE	02.983 dD	01.983 dD	01.308 dD
LSD 5%		04.290	02.431	02.313	01.654	01.291
LSD 1%		05.644	03.199	03.044	02.177	01.699
T	P_1	117.32 aA	42.150 aA	35.050 aA	28.400 aA	25.667 aA
	P_2	66.750 bB	37.933 bA	31.867 aA	26.733 aA	23.933 aA
	P_3	30.150 cC	17.950 cC	08.617 cC	08.117 cC	07.650 cC
	P_4	15.317 dD	10.567 dD	07.467 cC	07.283 cC	06.600 cC
	P_5	04.133 eE	03.900 eE	02.183 dD	01.433 dD	01.167 dD
LSD 5%		03.939	03.937	03.370	02.190	02.053
LSD 1%		08.373	05.186	04.440	02.885	02.707
B	P_1	81.367 aA	35.517 aA	20.300 aA	15.650 aA	09.800 aA
	P_2	57.917 bB	25.033 bB	12.832 bB	08.733 bB	07.533 bB
	P_3	22.650 cC	08.833 cC	08.150 cC	04.467 cC	02.267 cC
	P_4	20.717 cC	07.300 cC	06.183 cC	04.183 cC	02.317 cC
	P_5	03.167 dD	05.117 cC	03.783 cC	02.533 cC	01.450 cC
LSD 5%		03.519	02.626	02.489	02.229	01.575
LSD 1%		05.789	04.221	03.279	03.226	02.075

[1]Pruning intensity. The averages with the same letter are of the same group. The small letters in English show the comparisons at the level of 95% and the capital letters show the comparisons in 99% certainty

significant at the 1% level, whereas, the difference between the two treatments of P_3 and P_4 was not significant in any levels. The difference between treatments with the exception of two treatments of P_3 and P_4 which were in lack of any difference was significant at the level of 1%. The observed differences among treatments were equal at the end of the second to the end of the fifth year of germination and were different with the first year of germination with a slight difference. It was such that no difference was observed between treatments P_3 to P_5 and the difference between treatments of P_1 to P_3 was still maintained at the level of 1% (Table 3).

The impact of pruning on the average of the growth of the height of dying and wilting haloxylon trees (growth average of the two regions of T and B): The data analysis resulting from the impact of different treatments of pruning on the changes of the height of the dying and wilting haloxylon trees showed that pruning may have impact on the growth of the height of the haloxylon trees. It was such that at the end of the first and second year of germination, not only the difference between each treatments of P_1 to P_4 with treatment of P_5 was very significant, but also the difference between treatments was also significant at 1% level. The results at the end of the third and fourth year of germination was fully similar but were slightly different from the first and second year of germination. It was such that no significant difference was observed between P_3 and P_4 treatments. In the fifth year of germination, also as the impact of P_1 and P_2 treatments on the annual growth of the height of haloxylon trees was close to each other and no significant difference was seen in any level (Table 3).

The impact of pruning on the growth of the diameter of the crown of wilting haloxylon trees (T region): At the end of the first year of germination, the difference between treatments of P_1 to P_4 with control (P_5) and also the difference between treatments of pruning with each other was significant at the level of 1%. At the end of the second year of germination, the results seemed to be still similar to the first year, but no significant difference was observed in any statistical level between P_3 and P_4 treatments, whereas the difference between the two mentioned treatments with P_5 treatment also decreased and became significant at the statistical level of 5%. Finally in the third year of germination, despite the equality of results with the second year, only the significant difference between treatments P_3 and P_4 with treatment of P_5 was omitted. The data analysis showed that in the fourth and fifth years of germination, the results were very similar with each other but different from the third year of germination. It was such that no significant difference was seen between P_1 and P_2 treatments and also treatments of P_3 to P_5. Only a significant difference was observed at the level of 1% between the treatments of the first group (P_1, P_2) and treatments of the second group (P_3, P_4, P_5) (Table 4).

Table 4: Comparing the averages of crown diameter in two regions of Tolombehkhoshk (T) and Baqerabad (B) in LSD method

		Crown diameter (cm)				
Regions	[1]P.I.	2004	2005	2006	2007	2008
T		55.176 aA	29.500 aA	24.567 aA	17.333 aA	15.630 aA
B		42.187 aA	20.743 aA	14.787 bB	08.723 bB	06.497 bB
LSD 5%		18.545	09.044	08.335	04.785	03.448
LSD 1%		34.037	15.517	09.133	08.182	06.329
	P_1	122.48 aA	50.033 aA	42.525 aA	27.308 aA	21.917 aA
	P_2	60.750 bB	42.467 bB	32.967 bB	21.942 bB	19.483 bB
	P_3	33.483 cC	14.666 cC	09.441 cC	06.792 cC	06.125 cC
	P_4	21.175 dD	11.675 cC	08.617 cC	05.567 cC	04.767 cC
	P_5	05.517 eE	06.766 dD	04.833 dC	03.533 cC	03.425 cC
LSD 5%		05.831	03.455	03.303	02.975	01.581
LSD 1%		07.672	04.546	04.346	03.915	02.380
T	P_1	136.55 aA	57.917 aA	55.083 aA	33.617 aA	30.383 aA
	P_2	74.183 bB	50.417 bB	44.933 bB	31.167 aA	27.750 aA
	P_3	37.800 cC	18.800 cC	09.700 cC	09.400 bB	08.300 bB
	P_4	20.550 dD	13.633 cC	08.600 cC	08.033 bB	07.333 bB
	P_5	06.800 eE	06.733 eC	04.517 cC	04.450 bB	04.383 bB
LSD 5%		08.582	05.573	05.530	03.709	03.168
LSD 1%		11.306	07.341	07.286	04.569	03.725
B	P_1	108.42 aA	42.150 aA	29.967 aA	21.000 aA	13.450 aA
	P_2	47.317 bB	34.517 bB	21.000 bB	12.717 bB	11.217 bB
	P_3	29.167 cC	10.533 cC	09.183 cC	04.183 cC	03.950 cC
	P_4	21.800 cC	09.717 cC	08.633 cC	03.100 cC	02.200 cC
	P_5	04.233 eE	06.800 cC	05.150 cC	02.617 cC	01.667 cC
LSD 5%		07.931	05.312	04.109	03.637	02.310
LSD 1%		10.449	07.998	05.414	04.791	03.161

[1]Pruning intensity. The averages with the same letter are of the same group. The small letters in English show the comparisons at the level of 95% and the capital letters show the comparisons in 99% certainty

The impact of pruning on the growth of the diameter of the crown of the wilting haloxylon trees (B region): The data analysis at the end of the first year of germination showed that the difference between treatments P_1 and P_2 was significant at the level of 1%, whereas no significant difference was seen between P_3 and P_4 treatments. The difference between the two treatments of P_1 and P_2 and also the treatments of P_3 and P_4 with the treatment of P_5 became significant at the level of 1%. The difference between the two treatments of P_3 and P_4 with control (P_5) in the second year of germination reduced and was not become significant, whereas the results obtained in the second to fifth year of germination were fully similar with each other. It was such that no significant difference was seen between treatments of P_3 to P_5 and the differences between the treatments of P_1 and P_2 were still maintained at the level of 1% significance (Table 4).

The impact of pruning on the average of the growth of the crown diameter of dying and wilting haloxylon trees (growth average of T and B regions): The data analysis at

Table 5: Comparing the averages of VI[1] in two regions of Tolombehkhoshk (T) and Baqerabad (B) in LSD method

		VI				
Regions	[2]P.I.	2004	2005	2006	2007	2008
T		45.475 aA	09.838 aA	07.913 aA	04.499 aA	03.925 aA
B		26.787 bA	04.822 aA	02.320 bB	01.740 bB	00.571 bB
LSD 5%		10.418	05.411	02.666	02.564	01.427
LSD 1%		19.120	09.931	04.893	03.607	02.619
	P_1	128.92 aA	19.706 aA	14.017 aA	08.115 aA	05.799 aA
	P_2	38.392 bB	13.330 bB	09.508 bB	05.690 bB	04.640 bB
	P_3	08.446 cC	02.095 cC	00.929 cC	00.825 cC	00.439 cC
	P_4	04.689 cC	01.174 cC	00.782 cC	00.637 cC	00.312 cC
	P_5	00.202 cC	00.345 cC	00.346 cC	00.345 cC	00.049 cC
LSD 5%		06.878	01.760	01.637	01.022	00.497
LSD 1%		09.050	02.316	02.153	01.345	00.654
T	P_1	165.12 aA	25.240 aA	21.320 aA	11.552 aA	09.650 aA
	P_2	47.777 bB	18.916 bB	16.090 bB	09.159 bB	08.553 bA
	P_3	09.750 cC	03.148 cC	00.999 cC	00.866 cC	00.780 cC
	P_4	04.450 cC	01.576 cC	00.949 cC	00.676 cC	00.567 cC
	P_5	00.277 cC	00.311 cC	00.209 cC	00.271 cC	00.075 cC
LSD 5%		10.636	03.136	02.930	01.254	00.898
LSD 1%		14.012	04.132	03.860	01.652	01.183
B	P_1	92.727 aA	14.172 aA	06.715 aA	04.678 aA	01.948 aA
	P_2	29.007 bB	07.745 bB	02.926 bB	02.222 bB	00.727 bB
	P_3	07.143 cC	01.043 cC	00.859 cC	00.784 cC	00.099 cC
	P_4	04.929 cC	00.772 cC	00.615 cC	00.599 cC	00.057 cC
	P_5	00.128 cC	00.379 cC	00.484 cC	00.419 cC	00.024 cC
LSD 5%		08.769	01.965	01.620	00.960	00.830
LSD 1%		11.552	02.589	02.034	01.265	00.966

[1]Pruning intensity, [2]VI (vigority index) = H (height)×CD (crown diameter) (10 age)-1. The averages with the same letter are of the same group. The small letters in English show the comparisons at the level of 95% and the capital letters show the comparisons in 99% certainty

the end of the first year of germination indicated a very significant difference between treatments of P_1 to P_4 with P_5 treatment. Also, the differences between treatments were also significant at the statistical level of 1%. The obtained results at the end of the second year of germination were similar to the first year but between the two treatments of P_3 and P_4, no significant difference was observed. In the third year of germination, the results were like those of the second year. Only, the difference between the P_4 and P_5 treatments decreased and became significant at the statistical level of 5%. The data analysis in the fourth and fifth years indicated a full similarity among the trend of changes in these two years. It was such that neither the difference between P_4 and P_5 treatments was significant nor there was a significant difference between P_3 to P_5 treatments and also the difference between P_1 and P_2 treatments was maintained at the statistical level of 1% (Table 4).

The impact of pruning on vigority of wilting haloxylon trees (T region): The study and analysis of data showed that in a 4-year period (2004-2007), the treatments of P_1 to P_3 were different at the statistical level of 1%, but there was no significant difference between P_3 to P_5 treatments. The difference of each of P_1 and P_2 treatments with the control (P_5) was also very significant. At the fifth year of germination (2008), the difference between P_1 and P_2 treatments decreased and became significant at the 5% statistical level and the situation of other treatments was similar to the 4-year period (2004-2007) (Table 5).

The impact of pruning on vigority of the dying haloxylon trees (B region): The data analysis showed that in a 5-year period of research, there was no difference between the years of germination. It was such that at the end of the first year of germination (2004), the difference between P_1 to P_3 treatments was significant at the level of 1%, whereas, between P_3 to P_5 treatments, no significant difference was observed at any level. The above-mentioned position in the following four years (2005-2008), without any change was maintained similar to the first year of germination (Table 5).

The impact of pruning on vigority average of the dying and wilting haloxylon trees (average of vigority of T and B regions): The study of data showed that in all years of germination (2004-2008), the difference between P_1 to P_3 treatments was significant at 1% statistical level. No significant difference was observed between P_3 to P_5 treatments (Table 5).

DISCUSSION

The studies conducted on the causes of wilting and dying of the main part of hand-planed haloxylon trees in Iran and methods to remove this dilemma are admirable. The results of these series of researches may be used in the haloxylon plantations from now on. Though, the important point is that the consequences of the researches have rarely been able to prevent from the death of the present haloxylon trees and revive their greenness.

For instance, the mass efficiency improvement of haloxylon trees and also the pruning of the end of the haloxylon top branches are among the conducted projects which have not had any considerable impact on the growth and greenness of the too-much-wilting and dying planted haloxylon trees despite their noticeable importance and features. So, the idea which indicates taking away an intensive volume of air volume (intensive and severe pruning) of the wilting and dying haloxylon trees could influence their greenness took form within a research project and was implemented.

Aiming at reviving the vigorous status and removing wilting and dying status of hand-planted haloxylon trees,

at present the Organization for Forests and Pastures of Iran uses the results of this research in developing and implementing growing plans for haloxylon trees plantations in the country.

In order to avoid wilting and dying state of haloxylon trees, or to remove that conditions, it was necessary to create a balance between the germination potential of the areas and the mass and the quantity of the air living mass. For the purpose of removing this problem, one of the specific ways was to prune the single trees.

As it was observed, reaping different quantities from the air biomass of wilting haloxylon trees could lead to the growth of the height (Table 3), crown diameter (Table 4) and rejuvenation of vigority (Table 5), which was an expectable issue (Baghestani *et al*., 2008). The growth after pruning of the height in the first and second year in the wilting haloxylon trees areas (T region) was in harmony with the intensity of pruning, but from the third year of germination onwards, the impacts of P_1 and P_2 and also P_3 and P_4 were close to each other and similar. In other words, concerning the growth of height, between the pruning from the 10 cm over collar and pruning 150 cm from the top branches and also between pruning 100 cm of top branches and pruning 50 cm of the top branches, no significant difference was felt. The growth after pruning of the height of trees in dying planted haloxylon (B region) was to some extent different from the wilting hand planted haloxylon areas of (T region). It was such that only pruning of the 10 cm over collar (P_1) and pruning 150 cm of top branches (P_2) could maintain their impact on the growth of height up to the end of the fifth year. So, as with this aspect, they were different from other treatments (P_3, P_4 and P_5), So, it can be said that in the dying hand cultivated haloxylon trees, it is better to use the P_1 and P_2 treatments and in the wilting planted haloxylon trees area, the treatment of P_1 or P_2 (depending on the secondary objectives) should be used to increase the growth of height in a 5-year period. But in general, in both wilting and dying haloxylon planted areas, using the P_1 or P_2 treatment (depending on secondary objectives) was effective on the growth of the height of trees in a 5-year period.

Usually, to the extent that the intensity of pruning and rate of reaping the air biomass of plant is higher, to the same extent the observed reflection in the method and rate of the growth after pruning will be more vivid (Pinkard *et al*., 2004). The trend of the annual growth of height in terms of type treatment (P_1 to P_5) showed that the first year of germination (after pruning) in both regions (T and B) was associated with an increasing and accelerating growth. But with the passage of time (in a 5-year period), the mentioned trend tended towards a fixed growth state. The 150 to 250% difference of germination (depending on the type of pruning and in harmony with the intensity of pruning) of height in the first year with the germination of the second to the fifth years and existence of a slight difference of germination of the second to the fifth years with each other confirm this growth stability (Histograms of the annual growth of height from the Fig. 1-3).

Another dimension of growth is the growth of the crown diameter which its increase took place in harmony with the height growth. It seems that in the intensive pruning (P_1, P_2), the rate of the increase of the growth of crown diameter was higher as compared with the height growth (Table 2). Certainly, it can be said that both in the areas under the wilting planted haloxylon trees areas (regions similar to T region) and also in the regions in which the dying haloxylon planted trees are available (regions similar to B region), only the more intensive pruning (P_1, P_2) were able to change and increase the rate of the growth of the crown diameter. Perhaps, it can be said that in proportion with the increase of wilting state and arrival into the realm of dying status, the impact of P_1 and P_2 treatments on the growth of the crown diameter was clearly observable. Though, in the wilting planted haloxylon, with the passage of time, the impacts of P_1 and P_2 became closer to each other and finally the difference reached to a non-significant level. But in general, it can be said that the use of intensive pruning (P_1 and P_2), could at least in a 5-year period cause the increase of the growth of diameter of the crown of wilting and dying haloxylon trees (Table 2). The quick and jumping increase of the diameter of the crown in wilting and dying haloxylon trees areas in particular in the first germination year after pruning is seen in all treatments (P_1 to P_4) becoming almost balanced in a 5-year trend and finding a relative stability (Histograms of the annual growth of the crown diameter from the Fig. 1-3).

The coincident growth of the height and diameter of the crown (while considering the age of trees) which was accepted in this article as the symbol or index of growth and vigority enjoyed a higher importance as compared with the growth of height or growth of diameter of crown, but the importance of these two dimensions of growth should not be faded or ignored, because depending on the secondary objectives, it is possible to use the review of these dimensions for the change in the apparent shape of trees which is not discussed in this article. In this research, the pruning of wilting and dying planted haloxylon trees (shrubs) were conducted aiming at reviving the vigority (and remove dying status and wilting states). This indicates the importance of the vigority symbol which was given attention.

As it was shown, pruning could revive the wilting and dying planted haloxylon trees (Table 3) and had a

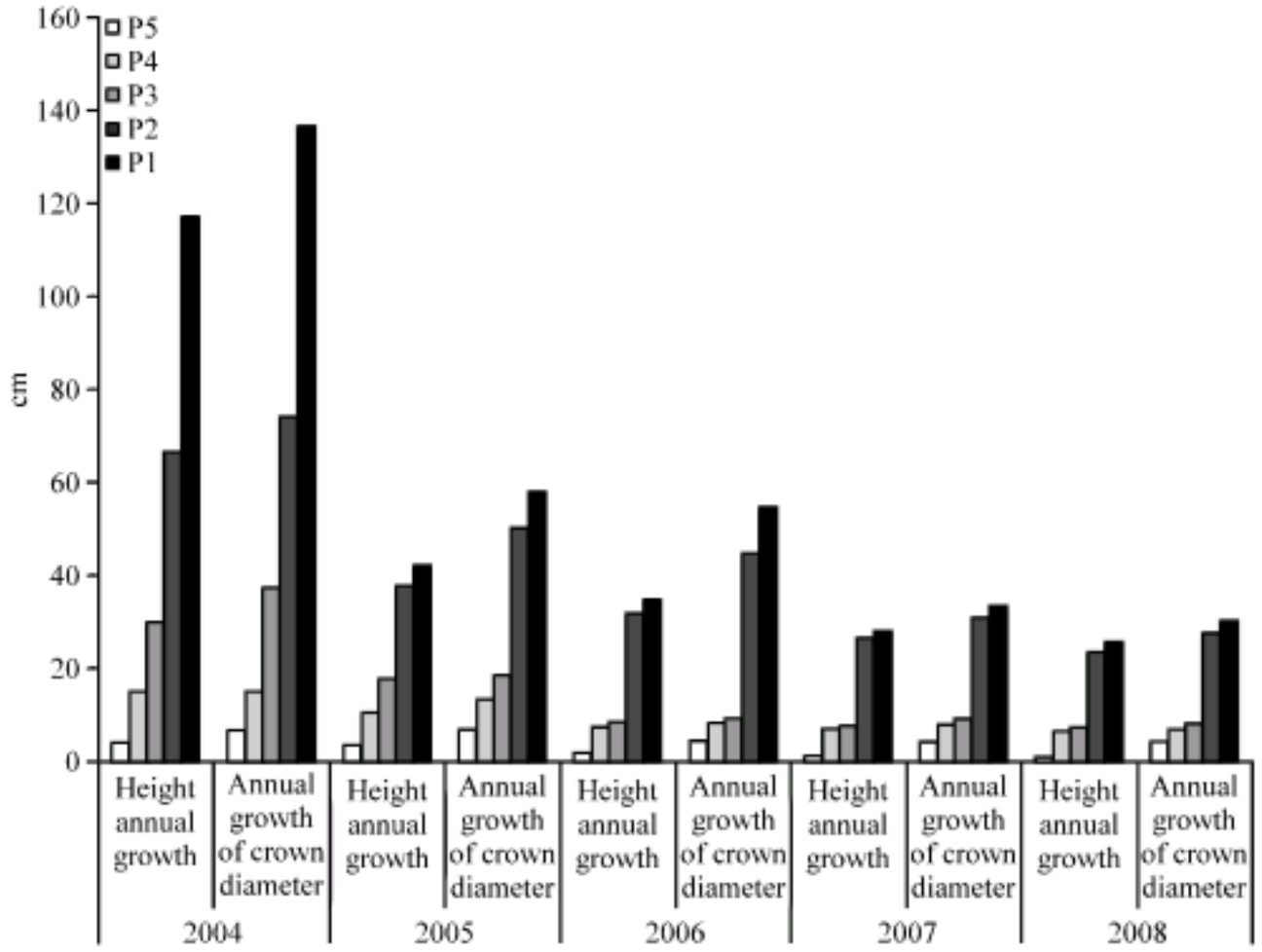

Fig. 1: The impact of the five-fold treatments of pruning (P_{1-5}) on the growth of height and diameter of the crown of the wilting hand-planted haloxylon trees (T region) in a 5-year period (2004-2008)

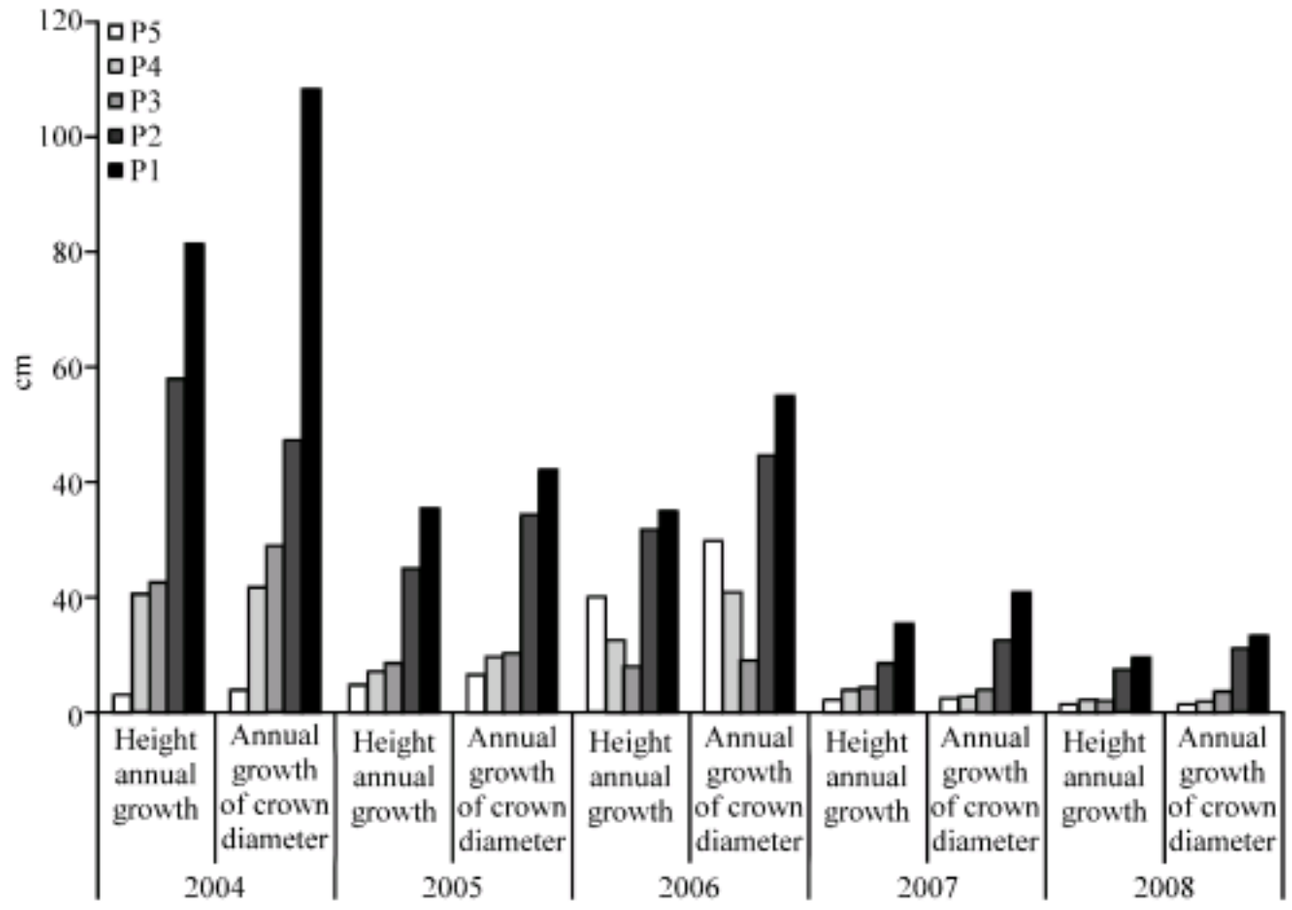

Fig. 2: The impact of the five-fold treatments of pruning (P_{1-5}) on the growth of height and diameter of the crown of the dying hand-planted haloxylon trees (B region) in a 5-year period (2004-2008)

positive impact on rejuvenation and increase of freshness of haloxylon shrubs (Baghestani *et al*., 2008). It was clearly presented that only intensive pruning (P_1 and P_2) can remove wilting and dying states of hand planted haloxylon trees and at least, in a 5-year period, they could maintain this advantage definitely (Table 3). Studies showed that the intensity of growth and vigority which was made in intensive pruning, in the first year of germination after pruning, were modified in the following years (2005-2008) and became close to a significance average (Fig. 4-6). It seemed that the growth and vigority being created after intensive pruning in the wilting

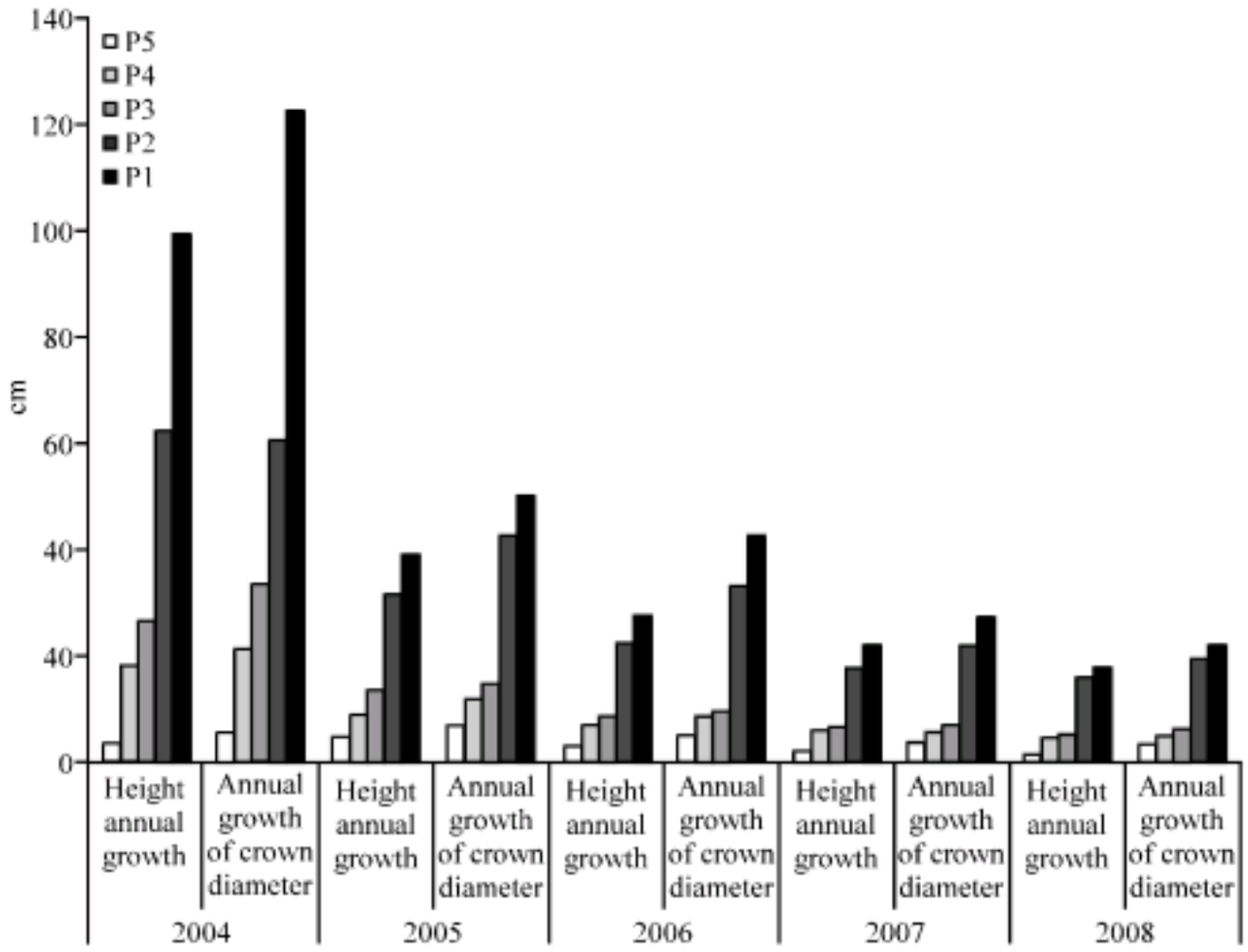

Fig. 3: The impact of the five-fold treatments of pruning (P_{1-5}) on the average of the growth of height and diameter of the crown of the wilting and dying hand-planted haloxylon trees (average of the growth of the T and B regions) in a 5-year period (2004-2008)

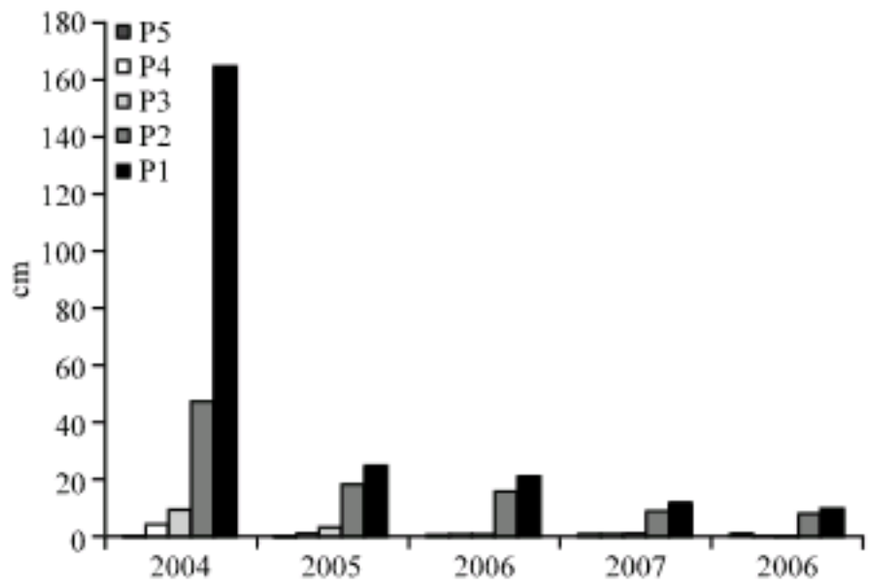

Fig. 4: The impact of the five-fold treatments of pruning (P_{1-5}) on the vigority (VI) of the wilting hand-planted haloxylon trees (T region) in a 5-year period (2004-2008)

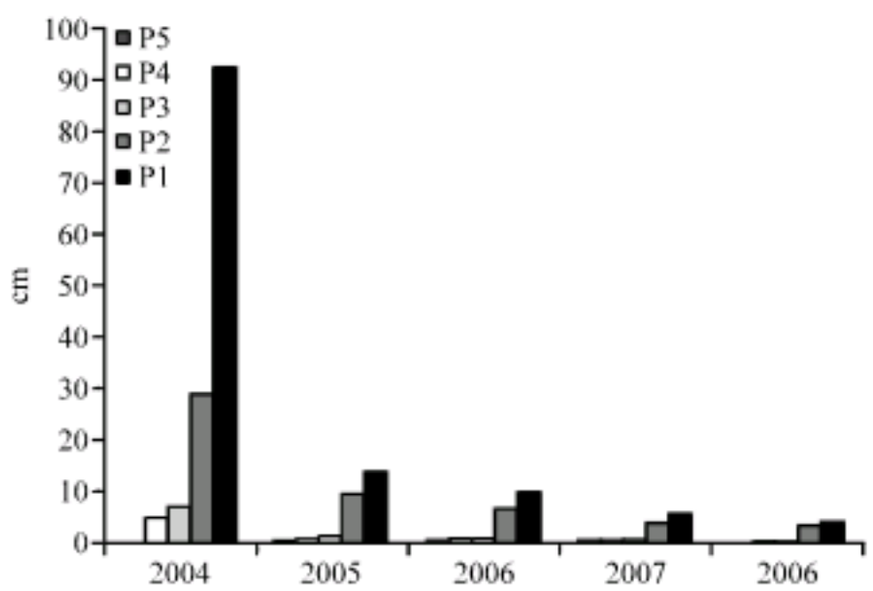

Fig. 5: The impact of the five-fold treatments of pruning (P_{1-5}) on the vigority (VI) of the dying hand-planted haloxylon trees (B region) in a 5-year period (2004-2008)

planted haloxylon trees were higher than those of the dying planted haloxylon trees areas (a comparison of the histograms of P_1 from Fig. 4 and 5 with each other and also a comparison of histograms P_2 of the mentioned Figures with each other), that will demand further explanation and discussion.

Pruning was very influential in reviving the growth and vigority of the wilting and dying hand-cultivated haloxylon trees areas. It is recommended as an acceptable approach to remove wilting and dying hand-planted haloxylon trees fields. The vigority index (VI) showed that only the intensive pruning (P_1 and P_2) could remove dying status and wilting states of the hand-cultivated haloxylon trees plantations. Considering these issues in these types of areas, this method is strongly emphasized. The intensive pruning could guarantee the growth and vigority of the hand-planted haloxylon tree areas for at least five years.

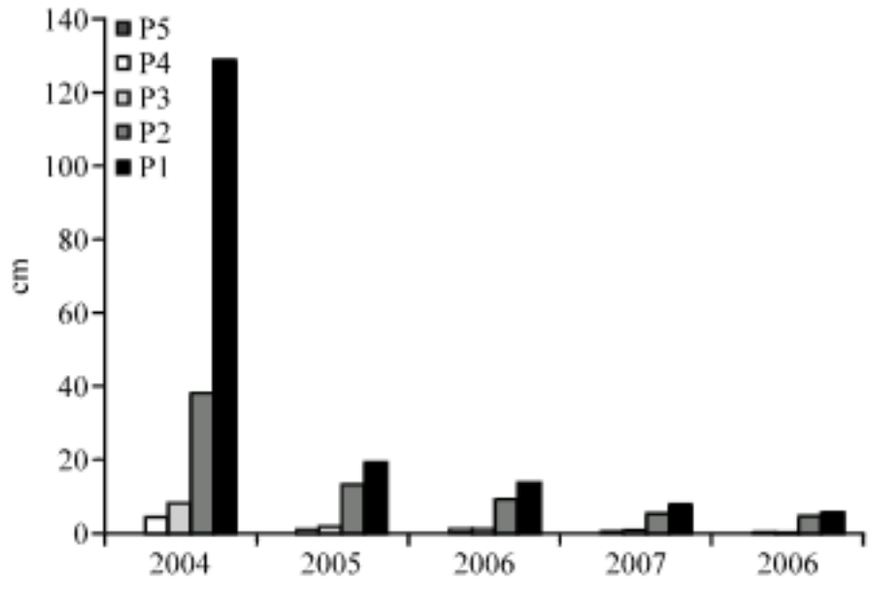

Fig. 6: The impact of the five-fold treatments of pruning (P_{1-5}) on the average of the vigority (VI) of the wilting and dying hand-planted haloxylon trees (average of the vigority of the T and B regions) in a 5-year period (2004-2008)

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REFERENCES

Amani, M. and A. Parvizi, 1996. Saksaul (Silviculture). Research Institute of Forests and Rangelands, Iran, pp: 118.

Baghestani, M.N., M.T. Zare and M. Abolghasemi, 2008. Changes on canopy cover width and height of *Haloxylon aphyllum* species stimulated by pruning, in one of the afforested areas of yazd province. Iran. J. Range Desert Res., 14: 478-489.

Ball, J. and D. Graper, 1999. Pruning deciduous shrubs. Extension Extra, ExEx 6033, September 1999, Horticulture/Forestry, College of Agriculture and Biological Sciences, South Dakota State University, USDA. http://agbiopubs.sdstate.edu/articles/ExEx6033.pdf.

Douglas, S., 2001. Pruning: An introduction to why, how and when, Plant science day 2001 short talk. The Connecticut Agricultural Experiment Station, New Haven. http://www.ct.gov/caes/cwp/view.asp?a=2824&q=378088.

Evans, E., 2003. Pruning shrubs. NC State University. http://www.ces.ncsu.edu/depts/hort/consumer/factsheets/shrubs/index.html.

French, S.C. and B.L. Appleton, 2002. Pruning shrubs: A guide to successful pruning. Virginia Cooperative Extension, Virginia Polytechnic Institute and State University, Publication No. 430-459. http://pubs.ext.vt.edu/430/430-459/430-459.html.

Kane, B., 2008. Does pruning reduce the risk of tree failure?. Massachusetts Urban Forestry Program, The Citizen Forester, March 2008, No. 123. http://www.mass.gov/dcr/stewardship/forestry/urban/cf_08-3.pdf.

Kim, H. and G.J. Koehler, 1995. Theory and practice of decision tree induction. Omega, 23: 637-652.

Medagoda, I., S.M.A. Punchikumarihamy and P.M. Bandaranayake, 2002. Varietal evaluation and rehabilitation studies on rambutan (*Nephelium lappaceum* L.). Ann. Sri Lanka Dep. Agric., 4: 169-176.

Perry, S. and M. Gardener, 2008. Pruning flowering shrubs. Colorado State University Extension, Garden Notes No. 619, Larimer County. http://www.ext.colostate.edu/pubs/columngw/gr080426.html.

Pinkard, E.A., C. Mohammed, C.L. Beadle, M.F. Hall, D. Worledge and A. Mollon, 2004. Growth responses, physiology and decay associated with pruning plantation-grown *Eucalyptus globulus* and *E. nitens* (Deane and Maiden) Maiden. For. Ecol. Manage., 200: 263-277.

Rahbar, E., 1986. Effects of Population Density and Precipitation on Vigority of *Haloxylon* spp. Research Institute of Forests and Rangelands, Iran.

Sellmer, J.C., V.J. Cotrone, M. McGann and J.R. Nuss, 2004. Pruning ornamental plants. The Pennsylvania State University Extension Bulletin. No. AGRS-95, pp: 28. http://pubs.cas.psu.edu/FreePubs/pdfs/AGRS95.pdf.

Shamszadeh, M. and N. Baghestani, 2003. Pruning effect on important pests' density old saxaul in yazd province. Pajouhesh Va Sazandegi, 16: 17-20.