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Research
Araştırma

EFFECTS OF PRUNING PRACTICES ON SHOOT DEVELOPMENT OF KIWIFRUIT

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ABSTRACT: In this study, effects of pruning on shoot growth and development of kiwifruit (cv. Hayward) under the conditions of Çarşamba Plain were investigated. Main subject was winter pruning (long pruning, medium pruning and short pruning) and sub-subject was summer pruning (heavy and light pruning). Winter prunings were performed in February and summer prunings were performed in August. Effects of prunings on shoot diameter, growth rate of shoot diameter, shoot length, growth rate of shoot length, shoot dry weight and total shoot vegatative dry weight were investigated in this study.

Decrease was observed in shoot length and shoot diameter decrease with increasing number of sprouts left over a branch. Shoot dry weights were closer to each other in long and short pruning practices since the number of sprout left in short pruning was lower than the number left in long pruning but exhibited strong development. Finally, a pruning practice dominantly short but mixed with some medium pruning was recommended for a stable shoot development.
Key words: kiwifruit, pruning types, shoot development

KİVİDE BUDAMANIN SÜRGÜN GELİŞMESİ ÜZERİNE ETKİSİ

ÖZET: Araştırmada, Çarşamba Ovası koşullarında yetiştirilen kivide (cv. Hayward), budamanın sürgün büyümesi ve gelişmesi üzerine olan etkisi incelenmiştir. Budama uygulamalarında ana konu kış budama uygulamaları (uzun budama, orta budama ve kısa budama) alt konu ise yaz budama uygulamaları (şiddetli ve hafif budama) olmuştur. Kış budamaları Şubat ayı içerisinde, yaz budamaları ise Ağustos ayı içerisinde uygulanmıştır. Araştırmada budamaların, sürgün çapı, sürgün çapı artış hızı (SÇAH), sürgün boyu, sürgün boyu artış hızı (SBAH), sürgün kuru ağırlığı ve toplam sürgün vegetatif kuru ağırlığına olan etkisi incelenmiştir.

Araştırmada, sürgün boyu ve sürgün çapında, dalda bırakılan göz sayısının artmasına bağlı olarak bir azalmanın olduğu görülmüştür. Sürgün kuru ağırlığı yönünden, kısa budamada bırakılan tomurcuk sayısının az olmasına karşın sürgünün kuvvetli gelişmesi; uzun budamada ise tomurcuk sayısının fazla olmasından dolayı toplam sürgün ağırlığının artmasından dolayı, uzun ve kısa budamadan elde edilen değerler birbirine yakın bulunmuştur. Sonuç olarak dengeli sürgün gelişimi için, kısa budama ağırlıklı orta budama ile karışık bir budama uygulamasının yapılması önerilmektedir.
Anahtar Sözcükler: kivi, budama tipleri, sürgün gelişimi

1. INTRODUCTION

Anatolia is the gene origin of several plants and has a rich collection of variety and species. 75 of 138 known species are cultivating in Turkey. Kiwifruit (*Actinidia deliciosa*) is also one of these species (Korkutal et al. 2004). Turkey has various ecological condition due to its geographical location and different climate patterns.

Kiwifruit researches in Turkey have been performed for about 20-25 years, adaptation and demonstration orchards were established during this period especially along the coast lines. As a result of these studies, coastal lines of Blacksea, Marmara and Aegean regions were found to be suitable for kiwifruit growing (Samancı 1990; Özcan 1995).

Kiwifruit has a cuddling, climbing and strongly-developing above-soil parts and shallow rooting below-soil parts. Therefore, pruning and irrigation practices are among the most significant cultural practices in kiwifruit culture. For a proper pruning, shoot development under current climate conditions should properly be investigated.

Objective of this study was to establish a pruning system for rapidly growing kiwifruit culture in Central and Eastern Blacksea Regions extending between Çarşamba Plain and Rize Province under primarily plain conditions.

2. MATERIAL AND METHODS

Experiments were conducted with 6-7 years old kiwifruit vines of Çarşamba Experimental Station of Samsun Soil and Water Resources Institute. The trellis system is T-pole. Climate characteristics of Çarşamba Plain are similar to the climate of Blacksea Region such as summers are hot and dry and winters are cool and rainy. Although, average temperatures in both years followed a similar course between the months from May to September in which light-intensities were measured, the temperature in the year 2003 was slightly lower than the year 2004. It was even below 5^0C during the months of February and March. Again, although relative humidity in both years followed the similar course during the same period, it was lower in the year 2003. Relative humidity decreased to 70% especially in June and July of the year 2003 (Uslu 2006).

Hayward (a cultivar of *Actinidia deliciosa*) was used as the material in this study. Following practices and investigations were used as the methods of the study.

2.1 Pruning practices

Winter Pruning: Long pruning (15-18 buds per shoot, L), medium pruning (10-12 buds per shoots, M) and short pruning (5-7 buds per shoots, S) with 4 replications (Samancı 1990).

Summer Pruning: Heavy pruning (6 leaves after the last fruit, shortening after 6 leaves over vegetative shoots, S) and light pruning (tip trimming from both fruits and vegetative shoots, H), (Galliano et al. 1990) with 4 replications. Control branches were also left for both subjects.

A single vine was used in winter prunings for each practice. Since kiwifruit exhibits a two-directional development as of North-south, each plant was used for two practices in summer prunings. Therefore, 12 plants were used in these experiments.

Each practice was also carried out by taking data according to the directions as of 'sea side – north' and 'road side – south'. Symbols used for practices in experiments were given in Table 1.

2.2 Investigations of shoot development

Shoot Diameter (SD): Diameters of current season shoots over the selected canes were measured once a week during the vegetation period (between the months May to September) from 1 cm above the basal section with a digital calibers (with 0.01 mm sensitivity).

Growth Rate of Shoot Diameter (GRSD): The difference between the last shoot diameter (mm) and the first diameter measurements was divided by the number of days between two measurements.

Shoot Length (SL): Lengths of annual shoots over the selected laterals were measured once a week during the vegetation period (between the months May-September) with a meter.

Growth Rate of Shoot Length (GRSL): The difference between the last shoot length (cm) and the first shoot length measurements was divided by the number of days between two measurements.

Shoot Dry Weight (SDW): All the leaves and fruits were removed over the annual shoots, they were cut into 2-3 cm long pieces, all the pieces were put into paper bags and dried at 70 ^{0}C for 4-5 days until reaching a constant weight. Dried shoot samples were weighed at balances with 0.01 g sensitivity.

Total Shoot Vegetative Dry Weight (TSVDW): Dry weights (g) of all the vegetative parts of a shoot (leaf, shoot) were measured.

2.3 Performance and evaluation of statistical analysis

The data of width and length of shoots, shoot dry weights and total shoot vegetative dry weights were statistically analyzed based on randomized block design by using "MSTAT-C Software". "Duncan Multiple Range Test" under the RANGE sub-program of the same software was used to test the differences among the averages exhibiting differences based on the performed statistical analysis. During the statistical evaluations of the results, significance level (P) between the differences was selected as 5% (significant) and 1% (very significant). "Slide Write 2.0" software was used to create the graphs and error bars specified in graphs were given based on 5% probability limit.

3. RESULTS AND DISCUSSION

3.1 Shoot diameter (SD)

Variations in shoot diameters of kiwifruit vines based on short (a), medium (b), long (c) winter and summer prunings for both year were given in Figure 1, 2 and 3.

In short winter pruning of the year 2003, small increases were observed in shoot diameter after the 76th day at which summer pruning was performed and it was seen that it were constant after the summer pruning. In the year 2004, increase in shoot diameter was more distinctive until 26th day. After the 77th day with summer pruning, these increases were almost constant.

In medium winter pruning of the year 2003, the practices C-M-ST-Ss, M-6L-Rs and M-ST-Ss exhibited a fast diameter increase until the 12th day. Then the increases were almost constant. In the year 2004, the practice M-ST-Ss exhibited a fast increase until 32nd day then showed a constant state. A rapid increase was also observed in practice C-M-6L-Ss until 11th day.

In long winter pruning of the year 2003, a rapid increase in shoot diameter was observed until 12th day, and then a constant increase was observed after especially the 76th day. In the year 2004, a slow increase was seen until 77th day and then followed a constant course.

3.2 Growth rate of shoot diameter (GRSD)

Variations in growth rates of shoot diameters with summer pruning for kiwifruit vines subjected to winter pruning for both years were given in Figure 4. In long winter pruning practices, summer pruning has not caused significant changes in growth rates of shoot diameters. Summer pruning was more effective in short and medium pruning practices.

Table 1. Symbols used in practices in experiments

a...(S,M,L - Short, Medium, Long winter prunings) -6L (from 6 leaves = Heavy summer pruning) – Ss (Sea side)	a*...C (Control) - (S,M,L-Short, Medium, Long winter prunings) – 6L (from 6 leaves = Heavy summer pruning)-Ss (Sea side)
b...(S,M,L - Short, Medium, Long winter prunings) -6L (from 6 leaves = Heavy summer pruning)– Rs (Road side)	b*...C (Control) - (S,M,L- Short, Medium, Long winter prunings) – 6L (from 6 leaves=Heavy summer pruning) –Rs (Road side)
c...(S,M,L - Short, Medium, Long winter prunings) –ST (Sprout trimming = Light summer pruning) – Ss (Sea side)	c*...C (Control) - (S,M,L - Short, Medium, Long winter prunings) – ST (Sprout trimming = Light summer pruning) – Ss (Sea side)
d...(S,M,L - Short, Medium, Long winter prunings) –ST (Sprout trimming = Light summer pruning) – Rs (Road side)	d*...C (Control) - (S,M,L - Short, Medium, Long winter prunings) – ST (Sprout trimming = Light summer pruning) - Rs (Road side)

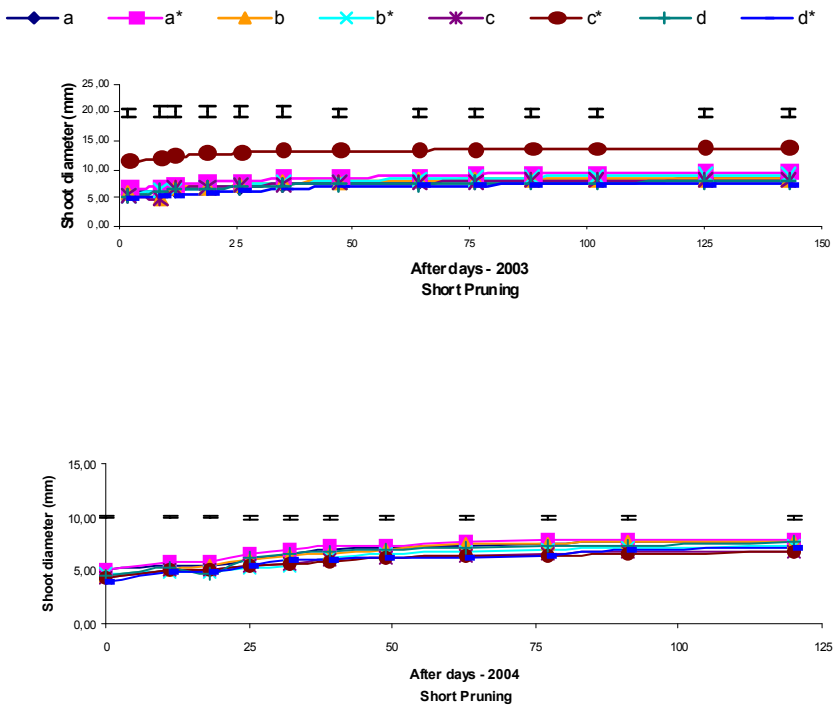

Figure 1. Variations in shoot diameter (mm) in short winter pruning with summer pruning practices

3.3 Shoot length (SL)

Variations in shoot lengths of kiwifruit plants based on short (a), medium (b), long (c) winter prunings and summer pruning for both years were given in Figure 5, 6 and 7.

In short winter pruning of the year 2003, a decrease in shoot lengths was observed in practices S-6L-Ss and S-6L-Rs starting from the 76th day since summer pruning was performed 6 leaves after the last fruit. No change was seen in all the other practices after the 76th day, a constant course was observed in them. In the year 2004, the practice C-S-6L-Ss exhibited a rapid increase until 18th day, then followed a constant trend. While a small decrease was observed in S-6L-Ss after the 77th day, a change was not seen in the other practices. Shoot lengths remained constant in these practices.

In medium winter pruning of the year 2003, a decrease was seen in shoot lengths of the practices M-6L-Ss and M-6L-Rs after the 76th day since the summer pruning was carried out 6 leaves after the last fruit. A faster increase in shoot lengths was observed until 12th day in all practices except for C-M-6L-Ss. A change in shoot lengths was seen after the 76th day. During the year 2004, a slow increase was observed in shoot lengths until the 12th day. Any change was not seen after summer pruning.

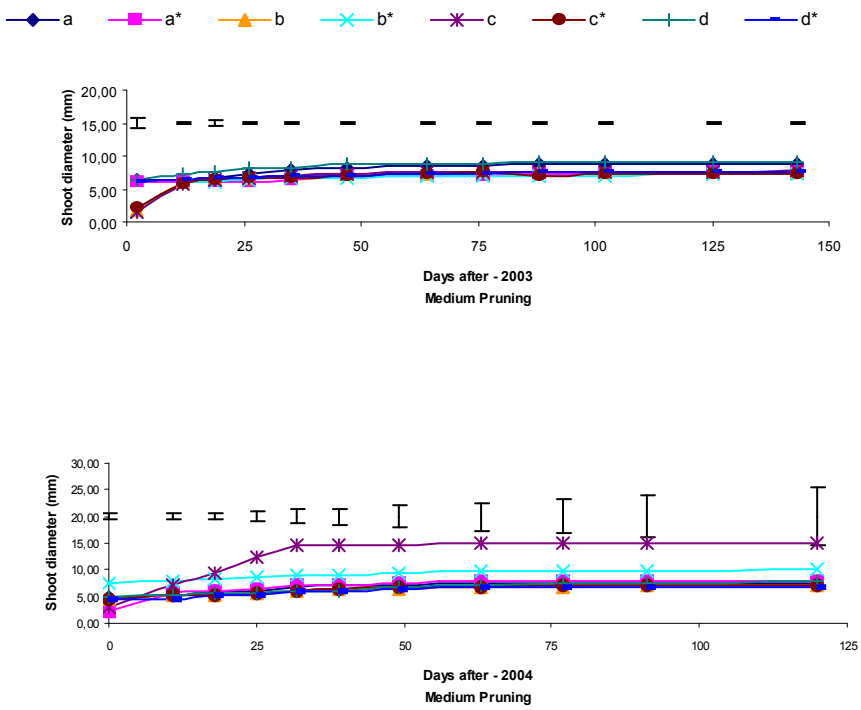

Figure 2. Variations in shoot diameter (mm) in medium winter pruning with summer pruning practices

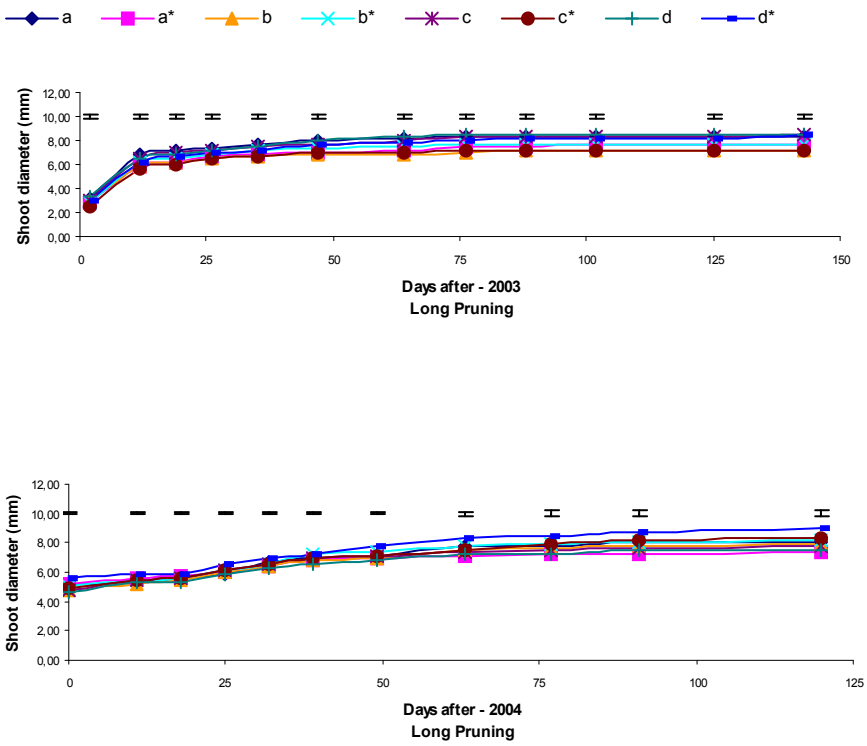

Figure 3. Variations in shoot diameter (mm) in long winter pruning with summer pruning practices

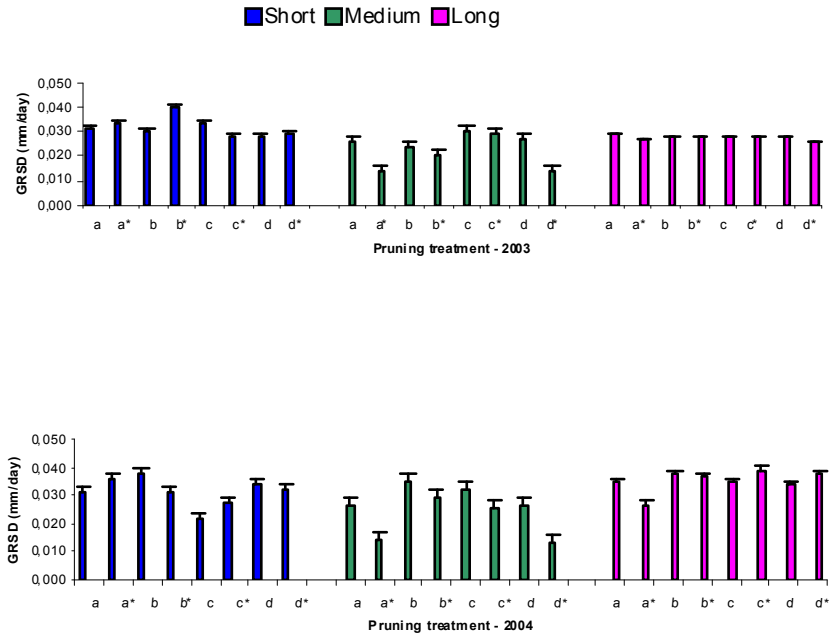

Figure 4. Variations in growth rates of shoot diameters (mm/day) based on pruning practices

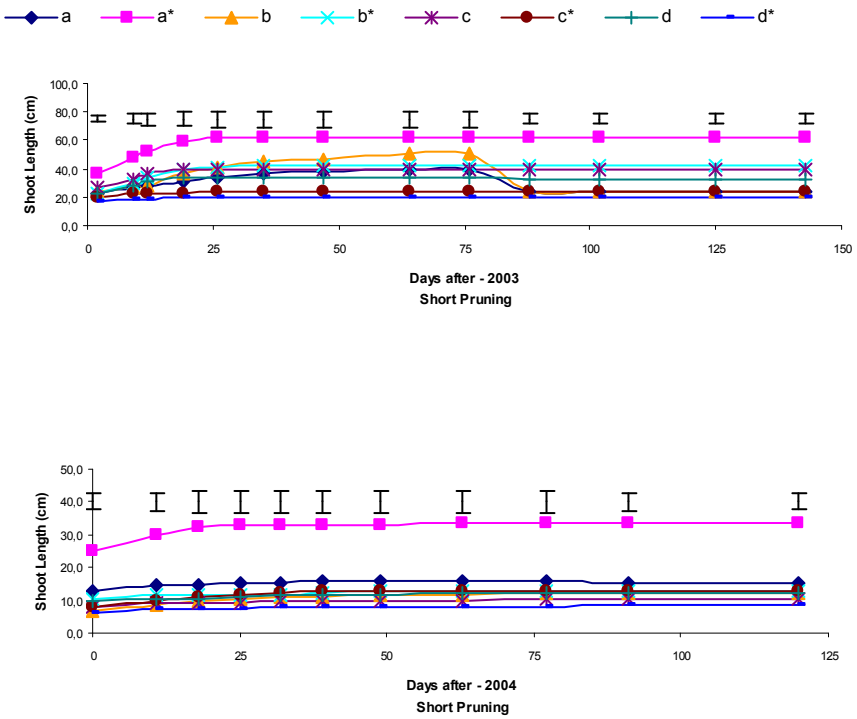

Figure 5. Variations in shoot lengths (cm) in short winter pruning with summer pruning practices

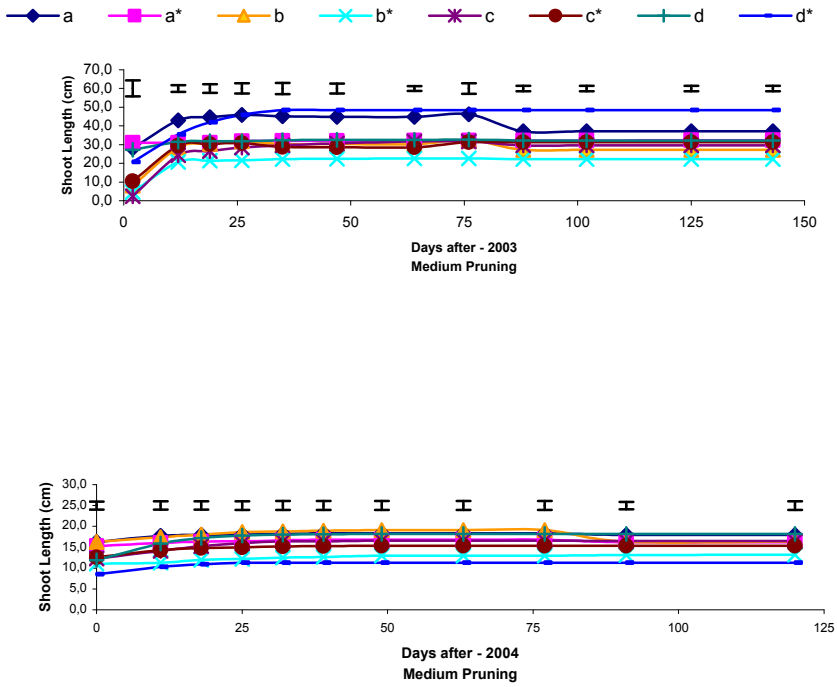

Figure 6. Variations in shoot lengths (cm) in medium winter pruning with summer pruning practices

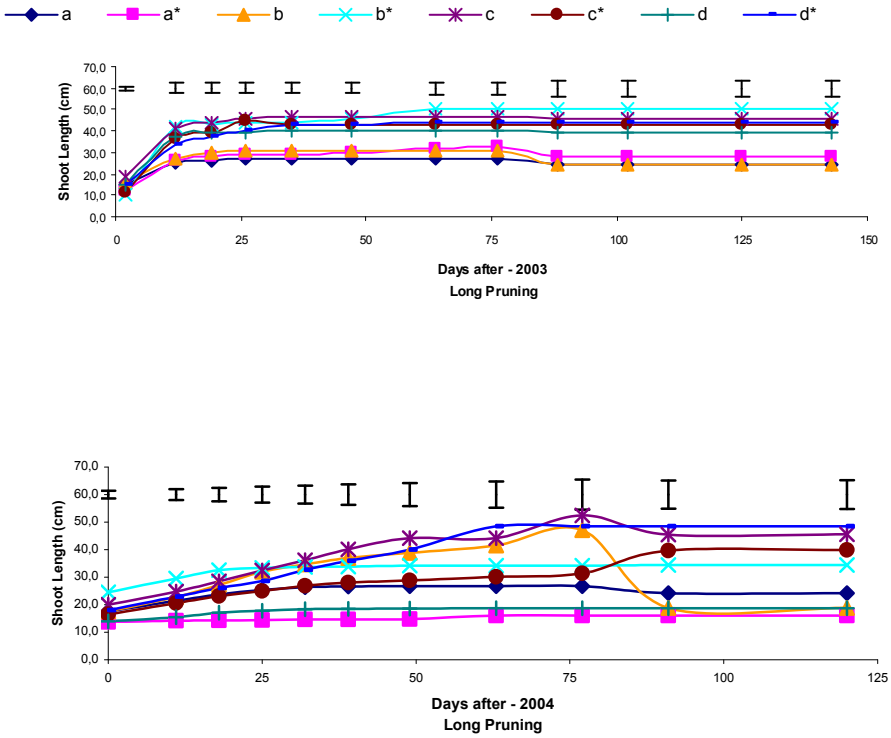

Figure 7. Variations in shoot lengths (cm) in long winter pruning with summer pruning practices

In long winter pruning of the year 2003, again a decrease was observed in practices L-6L-Ss and L-6L-Rs due to summer pruning. Shoot lengths remained constant after 47th day in all treatments except for C-S-6L-Ss (64th day). In the year 2004, a decrease was also seen in L-6L-Ss and L-6L-Rs due to pruning practices and a small increase was observed after 77th day in C-L-6L-Ss.

3.4 Growth rate of shoot length (GRSL)

Variations in growth rates of shoot lengths of winter pruned kiwi plants based on summer pruning for both years were given in Figure 8. The lowest growth rate of shoot length was observed in medium pruning in both years. Summer pruning practices were effective in growth rate of shoot length in for all three winter pruning practices.

3.5 Shoot dry weight (SDW)

Variations in shoot dry weights of winter pruned kiwifruit plants based on summer pruning practices were given in Figure 9. Shoot dry weight was higher than 4 g in short winter pruning. It fell down to 2.5 g in medium pruning in both years. It was at least 4 g in long pruning according to averages of the two years. The lowest shoot dry weight was obtained from medium pruning as it was in leaf dry weight.

3.6 Total shoot vegetative dry weight (TSVDW)

Variations in total shoot vegetative dry weight of winter pruned kiwifruit plants based on summer pruning practices were given in Figure 10. It was anticipated that difference in total shoot dry weights between years were due to climatical factors. While short and medium winter prunings exhibited closer values to each other, a different state was observed in long pruning. Total shoot vegetative dry weight increased with increasing shoot length, but this increase was linear up to a certain point.

There are several researches carried out on shoot growth and development of kiwifruit. Grant and Ryugo (1984) determined that dry matter and diameter of basal section of shoots growing in shadow underneath the canopy were smaller than the diameters of the ones growing over the canopy. In this study, it was found that when the number of sprout over a branch increased, length and diameter of shoots growing at tips of the plant were smaller than the ones growing at lower parts of the plant. Also decreases were observed in diameters of the shoot at tip sections with increasing number of sprout.

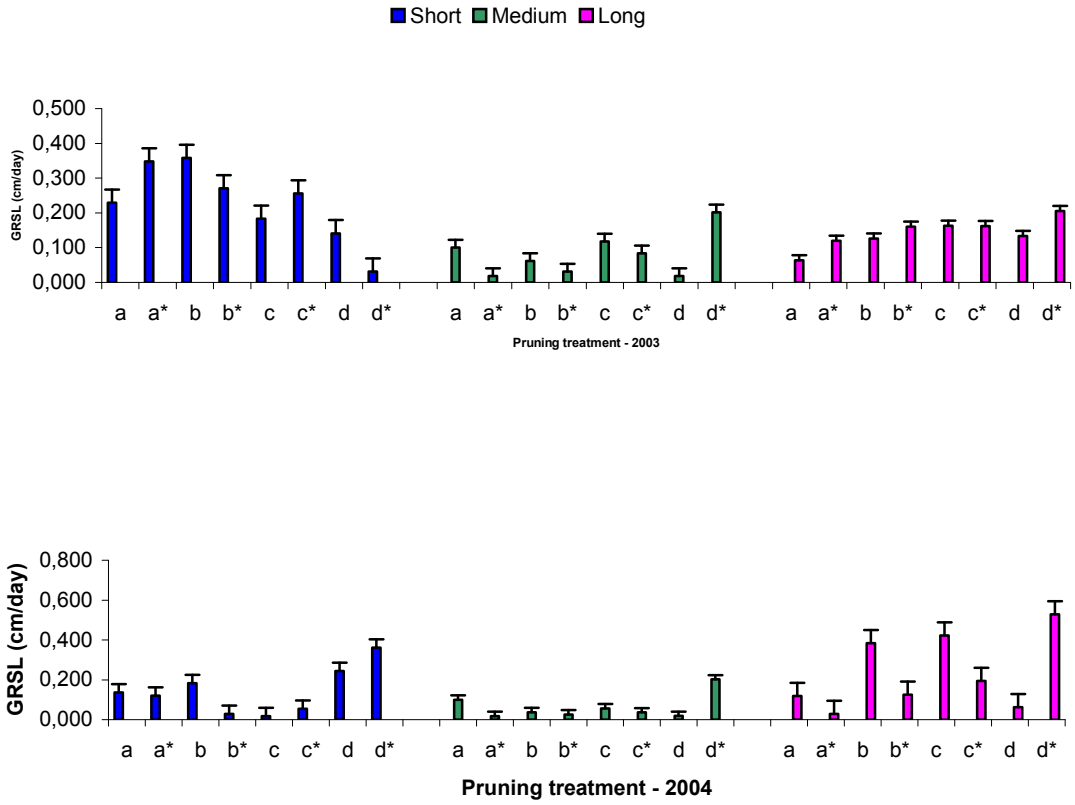

Figure 8. Variations in growth rate of shoot length (cm/day) based on pruning practices

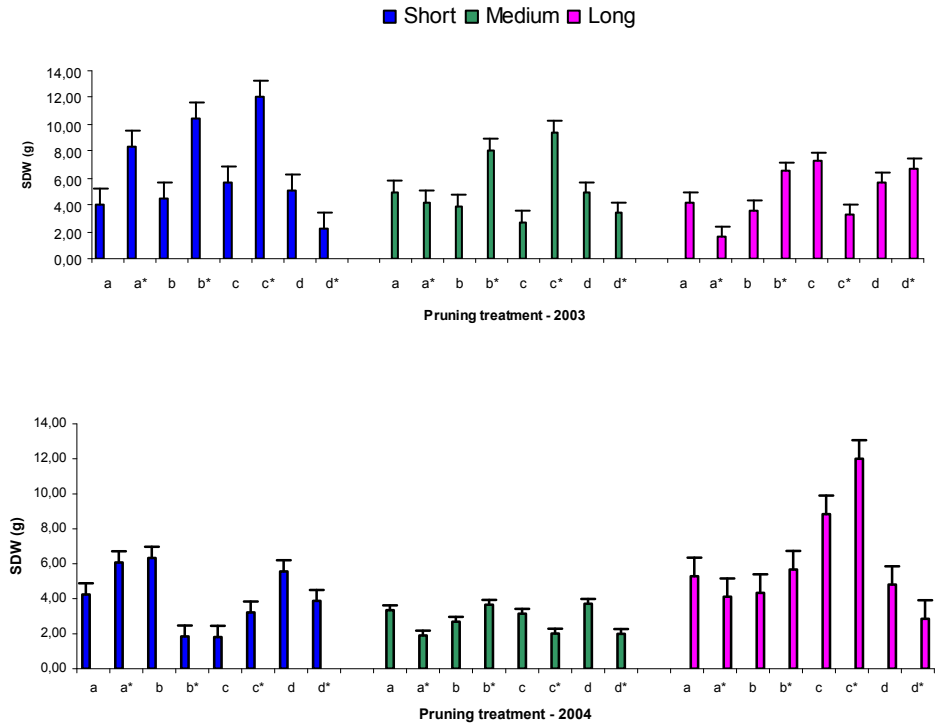

Figure 9. Variations in shoot dry weights (g) based on pruning practices

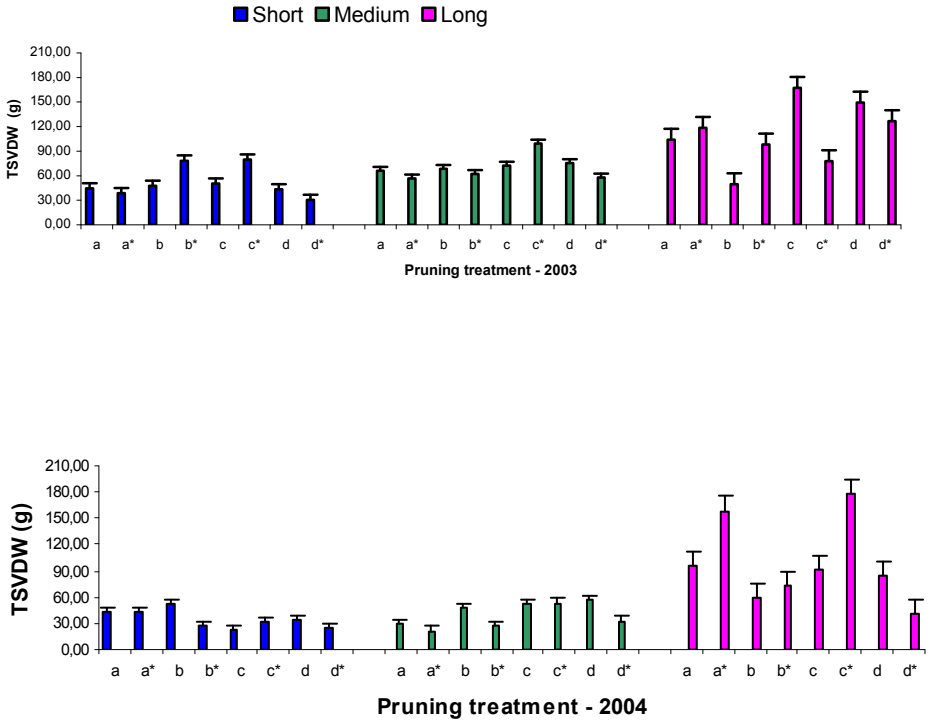

Figure 10. Variations in total shoot vegetative dry weight (g) based on pruning practices

Uzun (2001) stated that increase in shoot length reduced the strength of shoot. Shoot lengths exhibited a distinctive increase until the 25th day in three winter pruning practices. An increase was not observed in any of them after summer pruning. Higher shoot lengths in the first year may be due to lower temperatures during the period until June of the year 2003 than the next year. However, Buwalde and Smith (1987) found that while the yield of a single shoot smaller than 0.25 meter was 2.5 kgm^{-1}, the yield decreased to 1.1 kgm^{-1} when the length is more than 1 meter and the reason was lower sprout densities with increasing shoot length. Uzun (1996) found the highest plant heights in tomato and eggplant under low light and high temperature conditions.

It was observed in this study that summer pruning practices in long winter pruning did not create any significant change in growth rate of shoot diameter, summer pruning practices were more effective in short and medium pruning. The lowest growth rate of shoot length was observed in medium pruning in both years. Summer pruning practices were effective in growth rate of shoot lenght in for all three winter pruning practices.

Shoot dry weight was higher than 4 g in short winter pruning. It fell down to 2.5 g in medium pruning in both years. It was at least 4 g in long pruning according to averages of two years. The lowest shoot dry weight was obtained from medium pruning as it was in leaf dry weight. Uzun et al. (1998) conducted a research on this topic and state that distribution of dry matter in various parts of the plant and yield were effected by plant canopy-light intereption relationships. It was anticipated that difference in total shoot dry weights between years were due to climate factors. While short and medium winter prunings exhibited closer values to each other, a different state was observed in long pruning. Total shoot vegetative dry weight increased with increasing shoot length, but this increase was linear up to a certain point. Monteith (1977) indicated that dry matter accumulation was linearly related to total PAR (Photosynthetic Active Radiation) interepted by the plant up to a certain point. Also, the statements of Uzun et al. (1998) indicated the significantle of pruning in kiwifruit culture.

4. CONCLUSIONS

In this study, it was found that shoot diameter and length were almost constant after 25th day (June). it was observed that when the number of sprout over a branch increased, length and diameter of shoots growing at tips of the plant were lower than the ones growing at lower parts of the plant.

While the shoot dry weights in short and long pruning were closer to each other, the values were insignificantly lower in medium pruning. The highest shoot dry weights were obtained from long pruning practices.

Shoot dry weights were closer to each other in long and short pruning practices since the number of sprout left in short pruning was lower than the number left in long pruning but exhibited strong development. Therefore, short pruning is significant in kiwifruit culture for high quality fruits. Finally, since heavy pruning exhausts the plants significantly, a pruning practice dominantly short but mixed with some medium pruning was recommended for a stable shoot development. Also, summer pruning practices can also be carried out at proper rates mixed with other practices.

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