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The Relationships Between Shoot Elongation and Shoot Removal Force in Some Grape Cultivars (*V. Vinifera* L.)

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Abstract: Shoot elongation of some grape cultivars is rapid especially in the first period of vegetation, strong wind conditions has also a considerable effect on the realization. This study was carried out to determine the effect of 2-Chloroethyl-trimethylammonium chloride (=CCC) on shoot removal force in grapevine and it was in growing period of 2001, in Turkey (Latitude 41°4,6' north, Longitude 27°25' east) and 6 years-old and Cordon Royat trained grapevines (*Vitis vinifera* L. cvs. Sauvignon Blanc and Semillon) were used. According to randomized block design, 4 replications and 2 cultivars, 3 dosages and 3 grapevines per plot were used (totally 72 vines). CCC application dosages were 0ppm (control), 100ppm, 250ppm and spraying 28-30 days before flowering and relationships between shoot removal force and shoot elongation were examined. As a result, shoot removal force and internode diameters were increased, on the contrary shoot elongation was reduced by CCC applications.

Key words: *Vitis vinifera* · Sauvignon Blanc · Semillon · Shoot removal force · Shoot elongation

INTRODUCTION

It has been proved that there are some substances, which are synthesized within the body of plants and improve growth and these substances have been named as plant growth regulators. In time, it has been observed that not only growth stimulating substances but also growth inhibiting substances have been synthesized within the body of the plants [1, 2].

2-Chloroethyl-trimethylammonium chloride (=cycocel =CCC =chlormequat) reduces the shoot growth by blocking GA_3 biosynthesis [3], also by increasing CCC dosages the shoot growth stops [4].

Earlier experiments indicated that application of Chlormequat retarded shoot elongation [5], reduced shoot growth and enhanced lateral development [6] and it was very effective in controlling vine growth and improving percentage of fruiting buds, growth characters, vine nutritional status, percentage of berry set, yield, number of clusters and cluster weight [7].

Besides, in the Fiano/420A graft combination which was trellising horizontal cordon, shoot growth in all CCC treatments was reduced (by 21-25%), CCC applications resulted in lower berry drop, increase in berry number and weight [8]. Foliar application of cycocel (1000mg/L) to grape cv. Arkavati led to reduction in shoot length and leaf area and lowered the endogenous gibberellin content in shoot tips [9]. However, clusters/vine and yield were increased by the application of CCC in second year while weight of cane prunings/vine was reduced in first year [10]. At the same time, CCC treatment reduced the seasonal cumulative primary shoot growth; increased the seasonal cumulative lateral shoot growth, but had no affect on the total number of lateral shoots; reduced the shoot growth elongation rate % during the first 2 phenological stages of growth [6].

Early and late treatments of Cycocel were reduced vegetative development in both treatments [11]. Sehrawat *et al.* reported that the spray of cycocel significantly reduced the current season growth [4]. No post-effects of the CCC treatment were observed in the following year [12].

The mechanism of the effect of CCC on increasing fruit set is believed to be due to inhibition of shoot growth [13].

2000ppm CCC was applied to Muscat of Alexandria shoots 2 weeks before anthesis. CCC increased cluster weight and berries per cluster. It decreased berry size and shoot length and doubled the number of second crop clusters [14]. On the other hand, Kim confirmed that CCC applied to the soil in mid-July retarded the shoot growth; no retardation effect was found as to cluster and berry

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growth [15]. Cycocel solution was added 2 weeks before flowering. The fruit set was inversely proportional to the shoot growth in the weeks after flowering [3]. 600ppm dosage of CCC applied 2 weeks before flowering and it reduced shoot growth and increased berry set [16]. In Afuz-Ali cv. Lilov *et al.* [17] sprayed in spring with various CCC concentrations on buds. Shoot growth was thereby reduced and the number of blossoms and grapes was increased (by 25-44% and by 20-41% respectively). Claus, points out that depending on the cv. and year, the shortly application of CCC once before flowering was sufficient to reduce longitudinal growth by 25-30%. CCC treatment can improve the fruit setting, which however does not improve the yield on account of a reduced individual berry weight [18].

Giorgessi and Cargnello, stated that the 3000-4000ppm dosages CCC application before flowering in cvs. formed long internodes [19]. Koblet and Perret [20] also reported that the Riesling, Silvaner, Blue Burgundy and Bouvier cvs. were clearly affected by CCC. The shoot length, fresh weight and number of internodes were reduced in each case. In 1968 and 1969 the CCC-treated vines showed, a lower sprouting rate of the buds on the basal shoot, a reduced growth vigour, shorter internodes [21]. Therewith the average number of seeds per berry and the distribution of the berries was not affected by CCC [3].

Pertsnev *et al.* sprayed CCC on SO4 cuttings when shoots length had reached 60-70 cm. The positive reaction of the retardants was an increase of the diameter and a better maturity of the canes and higher cutting yields [22]. While spraying the inflorescences 15 days before flowering with CCC (100-1000 ppm) reduced, at increasing concentration, the shoot length growth (up to 39.5%). CCC treatment during or 10 days after flowering had only a slight effect on the shoot growth [12].

Thus, Sarkisova *et al.* [23] applied CCC to the soil or sprayed in various concentrations (0.1-0.5%). Even a single spraying inhibited growth. Spraying 2 to 4 times with 0.1% CCC solution inhibited growth and maturation of 1-year-old shoots and the shoot lignification was reduced.

Trellis systems and spacings applied without paying attention to the regional conditions. When determining trellis choice predicted vigor must also be considered. Standard size trellis systems, which are used without considering the vigour of the cultivar and rootstock, soil and climatic conditions and geographic situation and shoot removal force, are increased. Various types of climatic conditions (rainfall, light duration, sun exposure, temperature, humidity and soil fertilization) are seen earth. For this reason, shoot elongation and growth of cultivars in spring, can change due to the climatic conditions of the regions.

In some regions, there are 45-50cm distance between shoot leaning wire and shoot tying wires on training systems. In vigorous cultivars, until first shoot reached to the lower wire, strong wind can break some of the shoots. So, grape growers try to find different solutions about it. Although there are some solutions like stretching an additional wire between the lower and 2-upper wire, abasement the 2-upper wire on to the lower wire (approximately 30cm above than lower wire), adaptation of some movable mechanisms to lower wire, tying of the shoots with long string, they call for additional cost and labor moreover it is difficult to apply them in the established vineyards. But, the result of the strong wind is the excessive shoot losses and great damages occur. Consequently, yield losses is inevitable. This is not a foreseeable loss. The cost we ignore is nearly equal to one year management cost of vineyard.

Furthermore, it is difficult to maintain present training system after intensive shoot breaking. Therefore, control of the training system can transform to undesirable form in a few years. On the other hand, it is determined that in shoots rapid growth; the enlargement rate of bud base diameter was insufficient and attachment of shoot on the one year old branch was weak. For this reason, it is known that in the first stage of vegetation (the grand period of growth), shoot breakage was densely in rapid growing shoots than slow growing ones. Therefore, it is thought that CCC can be used to create a balance between the shoot elongation rate and enlargement rate of bud base diameter. Considering the reducing shoot elongation, increasing the shoot diameter and tissue tightening effect of CCC, this study was made whether CCC can be used for reducing the shoot elongation rate and increasing the shoot removal force in the case of upper wires placed in 45-50cm distances.

The aim of this study was to determine the relationships between shoot elongation and shoot removal force in *Vitis vinifera* L. cvs. Sauvignon Blanc and Semillon.

MATERIALS AND METHODS

Plant Material and Cultivation Conditions: This research was carried out in Turkey (Latitude 41°4,6' north, Longitude 27°25' east) and Cordon Royat (double) trained and 6 year-old *Vitis vinifera* L. cvs. Sauvignon Blanc (very vigorous) and Semillon (vigorous) [13], grapevines (grafted on 5BB rootstock) were used.

(a) (b)

Fig. 1a,b: a. General view of vineyard 10 days after CCC application
b. Measurement of shoot removal force by a dynamometer

(a) (b)

Fig. 2a,b. a.Attachment of shoot on one-year cane
b. Shoot base

Treatments: CCC (2 – chloroethyl - trimethyl ammonium chloride = cycocel= chlormequat) was applied as a plant growth retardant by spraying [23]. The experiment was set up according to randomized block design with 4 replications and each parcel had 6 grapevines and 3 CCC dosages (0, 100, 250ppm) were applied. Pure water was applied to control parcels.

In the trial, 72 grapevines and 576 shoots (4 shoots from each side branch) were used and CCC applications were performed when the shoots had 6 to 8 leaves, at $07:^{00}$ to $08:^{00}$ A.M., 28-30 days before anthesis (Figure 1a).

Measurements and Their Times: Shoot length (cm, shoot length from the proximal tip to distal tip by a meter), internodes diameter (mm, from the 0 node to 1st node by calipers, which was sensitive to 0.01mm) and shoot removal force [kg-force=kgf, newton meter, which was sensitive to 100g (Figure 1b, Figure 2a and b), was attached to 3rd internodes and it was pulled by horizontally action] measurements were done.

Shoot lengths were measured 6 times on April 29, May 2, 5, 8, 10 and 27. Internode diameters and shoot removal forces were measured 4 times on May 2, 5, 8 and 10.

Statistical Analysis: MSTAT-C program was used for evaluation of data and the differences between the means were determined by using LSD test.

RESULTS

In this study, statistical analyses were made to determine differences for each cultivar, individually.

Sauvignon Blanc

Shoot Length (cm): According to analyses of variance, the main effects of the dosages and times and their interaction were significant (Figure 3). The main effect of CCC dosages it was determined that 250ppm reduced shoot length to 35.69cm in cv. Sauvignon Blanc.

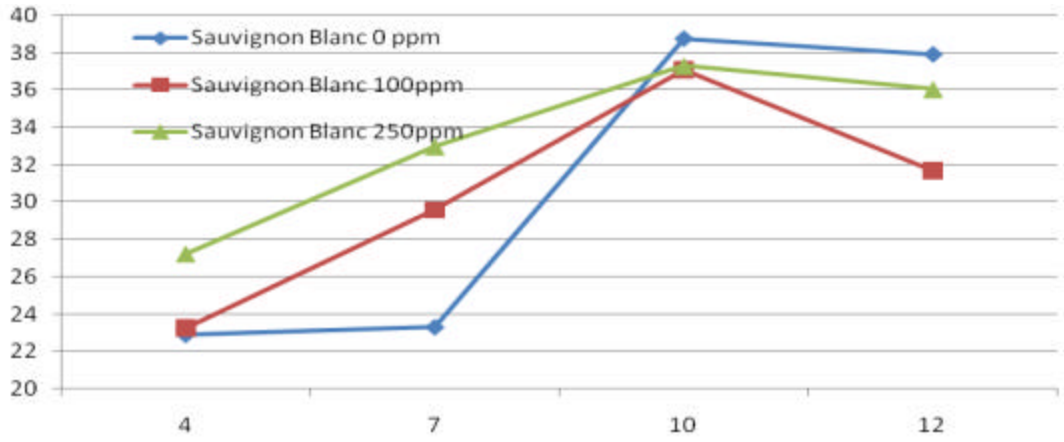

Fig. 3: Sauvignon Blanc cvs. shoot lenghts (cm)

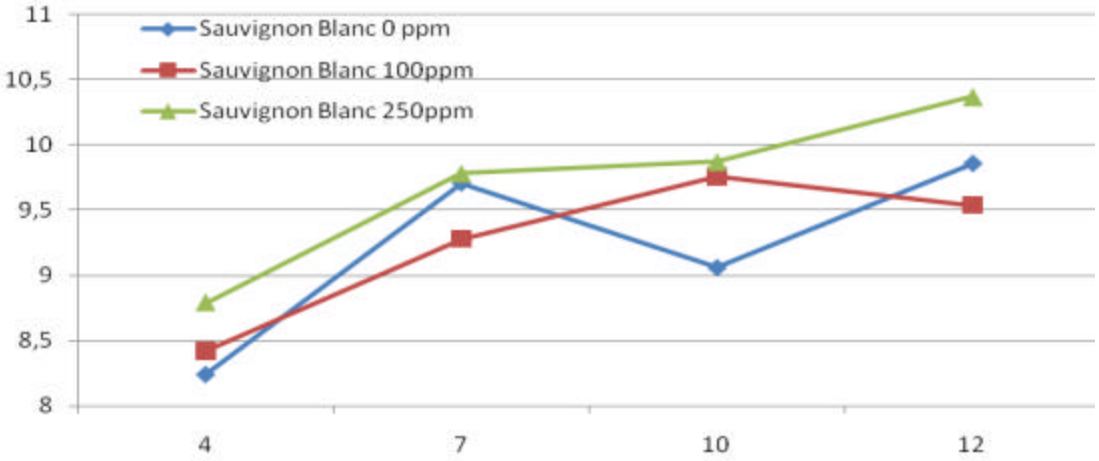

Fig. 4: Internode diameters in Sauvignon Blanc cvs. (mm)

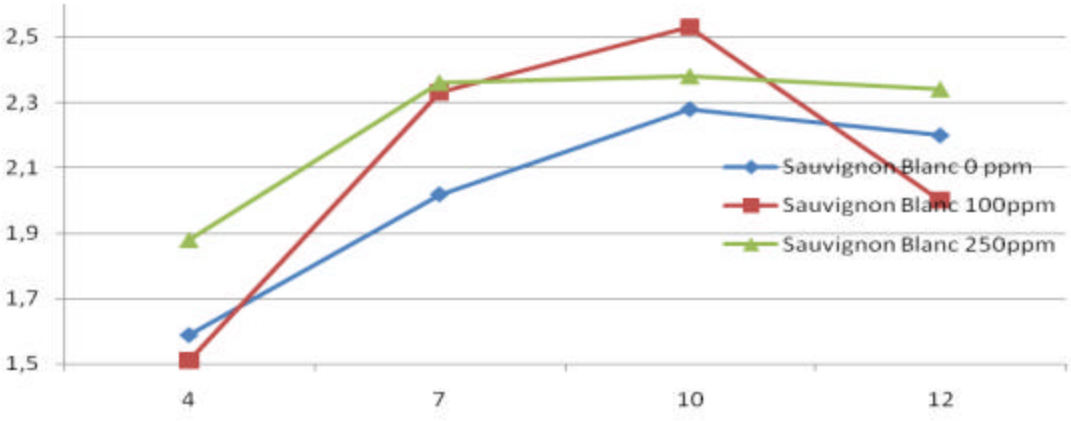

Fig. 5: Shoot removal forces in Sauvignon Blanc cvs. (kg-force)

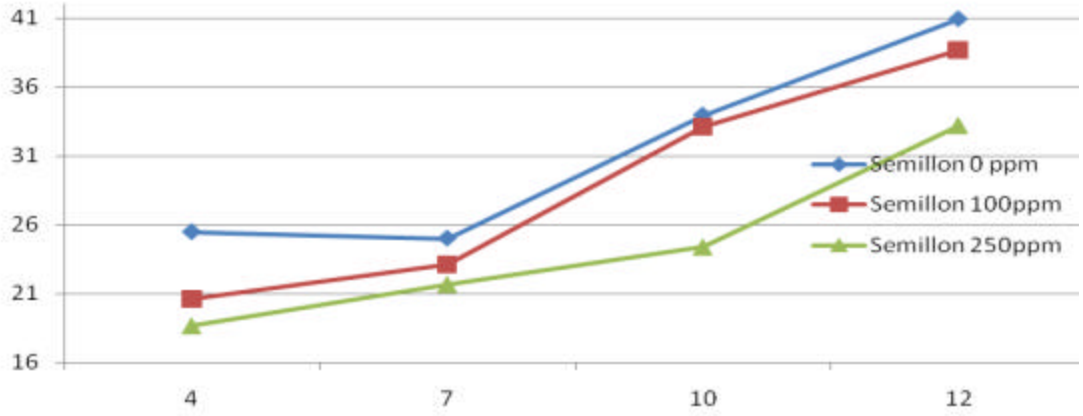

Fig. 6: Semillon cvs. shoot lenghts (cm)

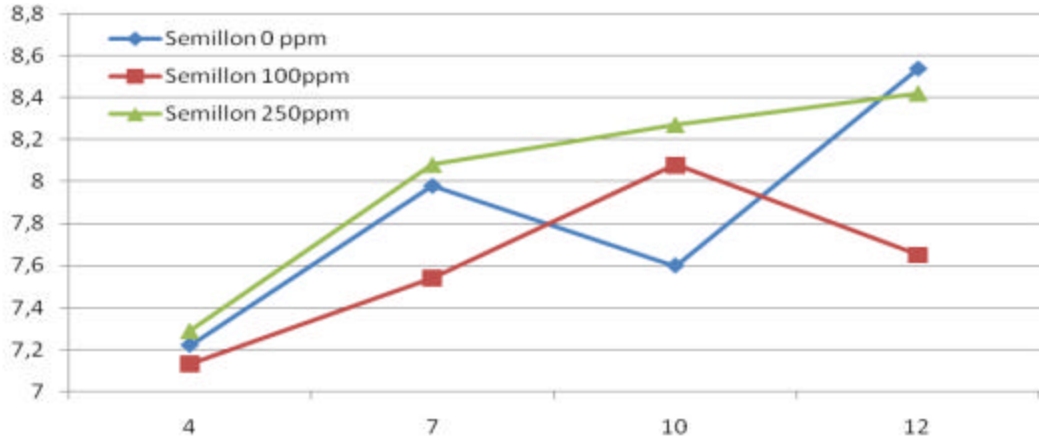

Fig. 7: Internode diameters in Semillon cvs. (mm)

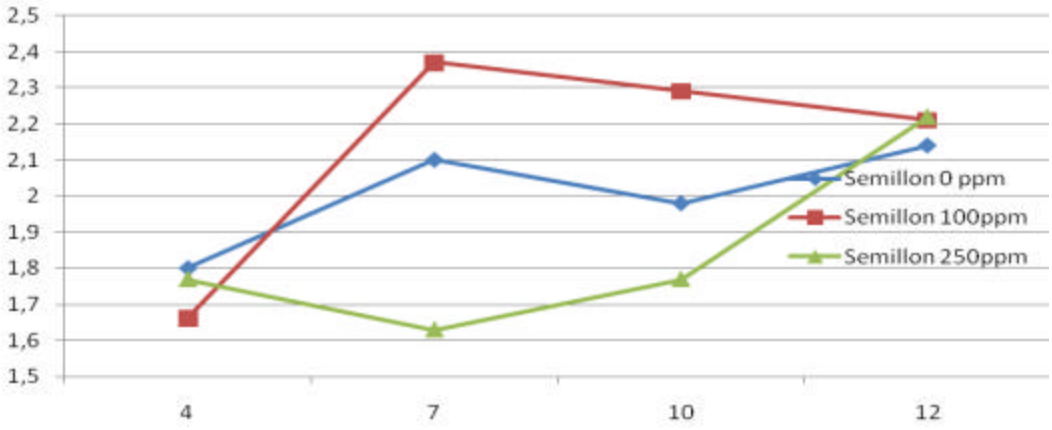

Fig. 8: Shoot removal forces in Semillon cvs. (kg-force)

Although there was a marked decrease in shoot length, in 10-12 days after CCC application; main difference was appear 30 days after the application. For this reason measurements were made 30 days after CCC application and shoot lengths were measured as 115.57cm (for control), 97.66cm (for 100 ppm) and 79.88cm (for 250 ppm) in cv. Sauvignon Blanc. It was determined that 100ppm CCC application was reduced by 15%, 250ppm CCC was reduced by 30% shoot length fairly.

Internodes Diameter (Between 0 and 1st Nodes) (mm): When data were evaluated significant differences for the main effects of time were found statistically, (cv. Sauvignon Blanc at 1%) for the internodes diameters.

In Figure 4, it was found that although it was not significant statistically, there was an increase not only in internodes thickness but also CCC dosage. During the growing period of shoot, an increase was observed naturally in internodes diameter.

Shoot Removal Force (kgf): Shoot removal force data were analyzed, it was found that differences of time main effect in cv. Sauvignon Blanc were significant at 1% (Figure 5). Along with the increase in CCC dosages and duration of the time, shoot removal force increased 2.025kgf for control; 2.099kgf for 100ppm; 2.240kgf for 250ppm in cv. Sauvignon Blanc.

Semillon

Shoot Length (cm): Dosage and time main effects and their interactions were found to be significant in cv. Semillon (Figure 6).

It was determined that 250ppm CCC dosage reduced shoot length to 37.01cm (31%) and 100ppm CCC dosage reduced shoot length to 13.26cm (11%). Shoot lengths of cv. Semillon were measured as 116.05cm (for control), 102.79cm (for 100ppm) and 79.04cm (for 250ppm) one month after the CCC application.

Internodes Diameter (Between 0 and 1st Nodes) (mm): According to the analyses of variance, time main effect of internodes diameter in cv. Semillon was found to be significant at 1%, level of significance (Figure 7).

Shoot Removal Force (kgf): When the data was analyzed, main effects of CCC dosages and times and their interaction on shoot removal force were found to be insignificant at %1. While shoot removal force increased according as a time regularly in cv. Semillon, because randomly selected shoot sizes were small, 250ppm CCC dosage gave the lowest value according to shoot removal force (Figure 8).

DISCUSSION

Previous experiments [15] have demonstrated that CCC treatment in mid-July retarded the shoot growth. Findings of Koblet and Perret [20], showed that CCC clearly affected the shoot length, fresh weight and number of internodes were reduced in each case. Fabbri *et al.* [6], were used 140R and they resulted the same effect.

Although it was not significant statistically, there was an increase in internodes diameters with the CCC dosage increase like Pertsnev *et al.* [22]. Internode diameters naturally increased according to the time.

Since CCC is depresses the cell division and blocks the biosynthesis of gibberellic acid, cell sizes and their numbers in tissues of grapevine shoots reduce, shoot lengths and shoot elongation rate get less, but diameters of shoot were increase.

According to the result of established balance between the diameter increase of bud base and shoot length, it is thought that shoot removal force increases because of good lignification. On the contrary Sarkisova *et al.* [23] reported that application of 2 to 4 times with 0.1% CCC solution was reduced shoot lignification.

As a result, considering the effect of CCC for reducing of the shoot elongation and increasing the shoot removal force, the lowest CCC dosages (=100ppm) can be suggested for stopping or reducing the easily shoot breakage easily in spring growing period.

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