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Possibility of Rooting of the Pruned Canes in Grapevine (*Vitis vinifera* L.) then Obtaining Yield Grown in Hydroponic System

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Abstract: The present study was carried out to determine the potentiality of obtaining yield from one year-old hardwood pruned, left over from winter pruning of the vines, grown in a hydroponic system. The cultivar used was Tekirdag Çekirdeksizi (Tekirdag Seedless) and the study was carried out in the vegetation period of 2002. The experiment was established using the completely randomized plots design with four replicates each containing 15 cuttings making a total of 60 cuttings, all of which were planted in a perlite based hydroponic system. A parallel study was carried out in the vineyard using 12 grapevines as the control. The vineyard, comprising the control plants, was planted 14 years ago with 1.5 and 3 m in and between row distances, respectively. The control plants were pruned leaving five buds per hardwood shoots. The cuttings obtained earlier from the winter pruning were planted in perlite in containers with a 20 and 20 cm in and between rows, respectively. Each cutting was left with one to two buds making a total of 25-50 buds per square meter. When the some of the experiment results were taken into consideration, it was seen that while the value of berry weight for hydroponic system was 3.96 g, same criterion for vineyard condition was 4.01 g; value of cluster weight was for hydroponic system was 285.42 g, same criterion for vineyard condition was 287.00 g and total soluble solids and titratable acidity for hydroponic system were 18.95% and 7.65 g L^{-1}, same criteria for vineyard condition were 20% and 6.71 g L^{-1}, respectively. Data regarding berry and cluster characteristics were analyzed and it was determined that berry and cluster characteristics for both hydroponically and vineyard grown produce were similar.

Key words: Grapevine, *Vitis vinifera* L., hydroponic system, prunned canes

INTRODUCTION

Grapevine (*Vitis vinifera* L.) is not only tolerant but also responds well to excess pruning. As a cultural practice up to 70-80% of the vine is removed and disposed off during winter pruning to ensure a suitable physiological balance. Depending on the training form practiced, a vinestock with a total of 20 one year-old canes carry approximately 200-300 winter buds. Following winter pruning, during which approximately 180-280 buds carrying primordia for yield are disposed off, usually a vinestock is allowed to carry 20 buds. It is known, however, that the one year-old canes, disposed off following winter pruning carry winter buds which do not develop but remain dormant in the year they are initiated, develop shoots in the following season producing the main yield of a vinestock. Depending on their location on the vinestock, buds are classified as active, passive, adventive and winter buds among which the most important one being the winter bud[1,2]. Winter buds contain three shoot primordia each of which, in most cases, carry cluster primordia, availability of which in the buds of not only the hardwood scions left on the vinestocks but also in the same type of scions discarded after the winter pruning must have a similar production potentiality. It is a general practice that ca. 80% of the one year-old hardwood scions therefore its yield potentiality in the form of cluster primordia in the winter buds, are pruned and disposed.

Hydroponics is the growing of plants without soil and this technology was developed from experiments carried out to determine what substances make plants grow and plant composition[3]. During the last years, the soilless cultivation of different types of plant specie has been increasingly shifted to closed systems. The main advantage provided by closed systems is the restriction of surface and ground water pollution through greenhouse effluents, which are rich in nitrates and phosphates. Moreover, recycling the excess nutrient solution, which runs off after each watering application, results in considerable fertilizer savings[4].

It was thought that the yield potentiality in the hardwood cuttings disposed off after the pruning may be saved by inducing these rootless, solitary scions in a

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perlite based hydroponic system, which is the aim of the present study.

MATERIALS AND METHODS

The present research was carried out to determine the potentiality of pruning wood of the Tekirdag Çekirdeksizi to produce yield in a perlite based hydroponic system in Turkey in the 2002 vegetation period. During the experiment, a climatical condition of vineyard was given in Table 1. The soils where the research was conducted were clay, poor in organic matter, moderate in phosphorus contents, but rich in potassium content[5] and the pH 6.9 to 7.5.

Pruning wood of 14 year-old and Guyot trained cv. Tekirdag Çekirdeksizi which is the table grape cultivar was used as the plant material in the experiment. A total of two one-year old canes, each carrying 10 buds, together with the perennial parts of the both arms were removed (Fig. 2a and b).

Berry characteristics of the cultivar Tekirdag Çekirdeksizi, a progeny of Alphonse Lavallee x Sultani Seedless, used were black, round, medium rind thickness and seedless[6,7].

Agricultural perlite, as the growing medium, of 2.5-4.5 mm granule diameter[8-11] and a nutrient solution composition of which was prescribed mainly by Nikov *et al.*[12] as well as others[13-18] were used. A drainage pipe of 10 cm diameter was installed to ensure circulation of the nutrient solution in the containers of 5 m length, 0.5 m width and 0.45 m height[19].

Requirements of various growth stages of the shoots were taken into consideration and micro and macro element concentrations of the nutrient solutions were adjusted accordingly and the pH was balanced at 6.0-6.2 using the phosphoric acid. Also, every 20 days, the nutrient solution was replaced with the fresh one[13-19]. Mean temperature of the perlite, as the root zone medium in the containers, was maintained at 25°C in the hydroponic system, layout of which is presented in the Fig. 1[20-26].

The experiment was established in the Completely Randomized plots design with four replicates[27]. A total of 60 pruning woods were planted in four plots each of which containing 15 pruning woods. As the control treatment, a parallel experiment was established in the vineyard using 12 vinestocks on which five buds per square meter was left after the pruning. The vineyard was planted 14 years ago with 1.5 and 3.0 m in and between row distances, respectively. The pruned hardwoods were planted in the perlite containers with an equal distance in and between rows of 0.20 m. Each hardwood cutting carried 1-2 buds making a total of 25-50 buds per square meter. Data obtained were subjected to the analyses of variance using the MSTAT statistical software.

Obtaining of the pruning hardwood: One year old hardwoods and the older arm they are attached to were removed during winter pruning in late February. The inclusion of the arm to the hardwood pruned was aimed at providing them with carbohydrate, much needed in the initial shoot development (Fig. 2a and b). All but except for one one-year old hardwood shoots i.e. the one at the tip, originating from the hardwood from which yield was obtained last year, were cut from base and disposed (Fig. 2c-f). Then this particular one-year old hardwood was pruned leaving 10 buds and on the bark of its base as well as on the base of the two year old hardwood it's attached to several scratches was made to facilitate rooting (Fig. 3a and b).

In 1 March 2002, the pruned hardwood consisting of two parts, which are the one-year old and at its base the two year-old, still connected and intact as explained above, were planted, in the perlite at a depth of 25 cm vertically and horizontally, respectively (Fig. 3c and d).

The top two buds, i.e. the 9th and 10th buds, were removed, if considered necessary, from the one-year old hardwoods to provide advantage over to the rooting in 15-20 April 2002. Regarding the remaining shoots, one to two strongly developing as well as cluster carrying shoots was left and the rest were discarded.

Shoots and clusters developing in the hydroponic system were constantly observed and kept under control in comparison to the ones grown in the vineyard during the vegetation period (Fig. 4a-d).

Ripe clusters from both the hydroponic system and the vineyard were harvested on 13 September 2002. Data regarding the characteristics studied were obtained from a total of 80 clusters selected randomly from both hydroponic and vineyard plots, totaling eight plots from the both, each of which providing 10 clusters (Fig. 4e-j). Following the harvest, the plant material grown in the hydroponic system was removed and disposed off, discharging the system.

Table 1: Climatical conditions in 2002

Months	Jan.	Feb	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Mean temperature (°C)	7.4	7.4	12.7	12.2	16.5	20.7	25.3	25.5	21.9	17.5	10.5	2.4
Relative humidity (%)	87.2	79.3	74.5	76.5	67.0	61.5	65.3	67.0	71.3	71.7	77.6	84.1
Rain fall (mm)	50.0	87.0	23.0	69.0	57.0	9.0	21.0	9.0	51.0	2.0	110.0	211.0

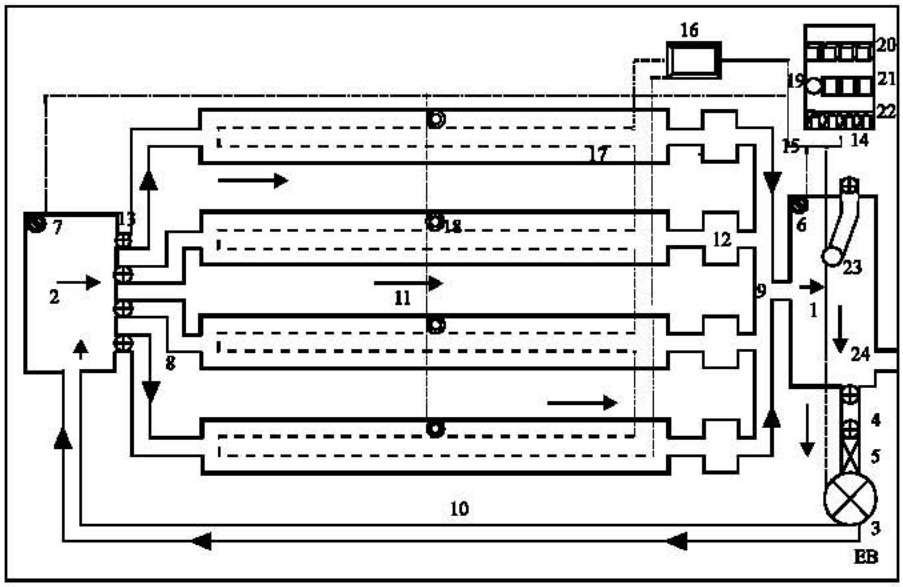


Fig. 1: Simple diagram of hydroponic system[30,31]

1. Collecting tank of nutrient solution, 2. Main (nourishing) tank of nutrient solution, 3. Circulation pump of hydroponic system, 4. Filter, 5. Check-valve, 6., 7. Conductors with mercury attached to buoy, 8. Nourishing pipes, 9. Drainage pipes, 10. Transfer pipes, 11. Canals, 12. Reservoirs, 13. Valves, 14. Remote panels, 15. Connection cables of electricity system, 16. Transformer station (10 KW; 380 V/48 V), 17. Resistances (which is warmed from base), 18. Thermostats, 19. Clock with timer, 20. Conductors, 21. W automatons, 22. Clemencies; 23. Buoys, 24. Drainage pipe of collecting tank

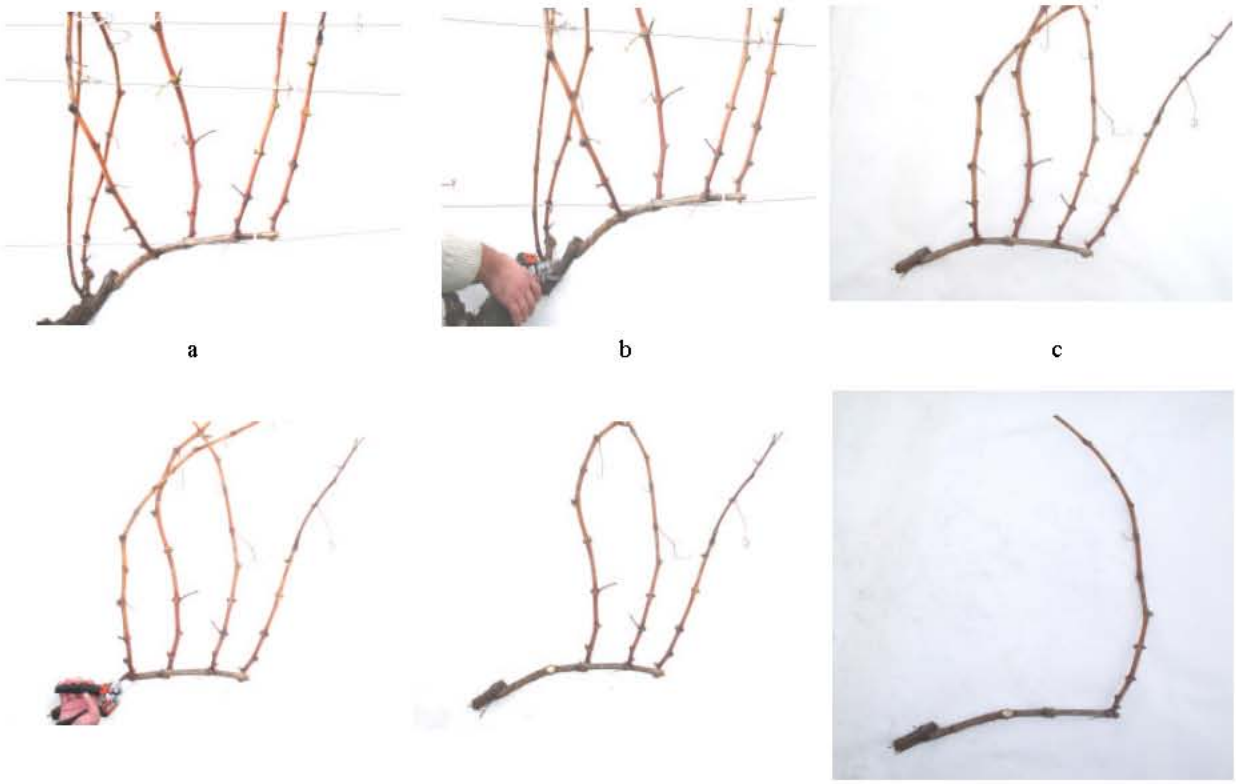
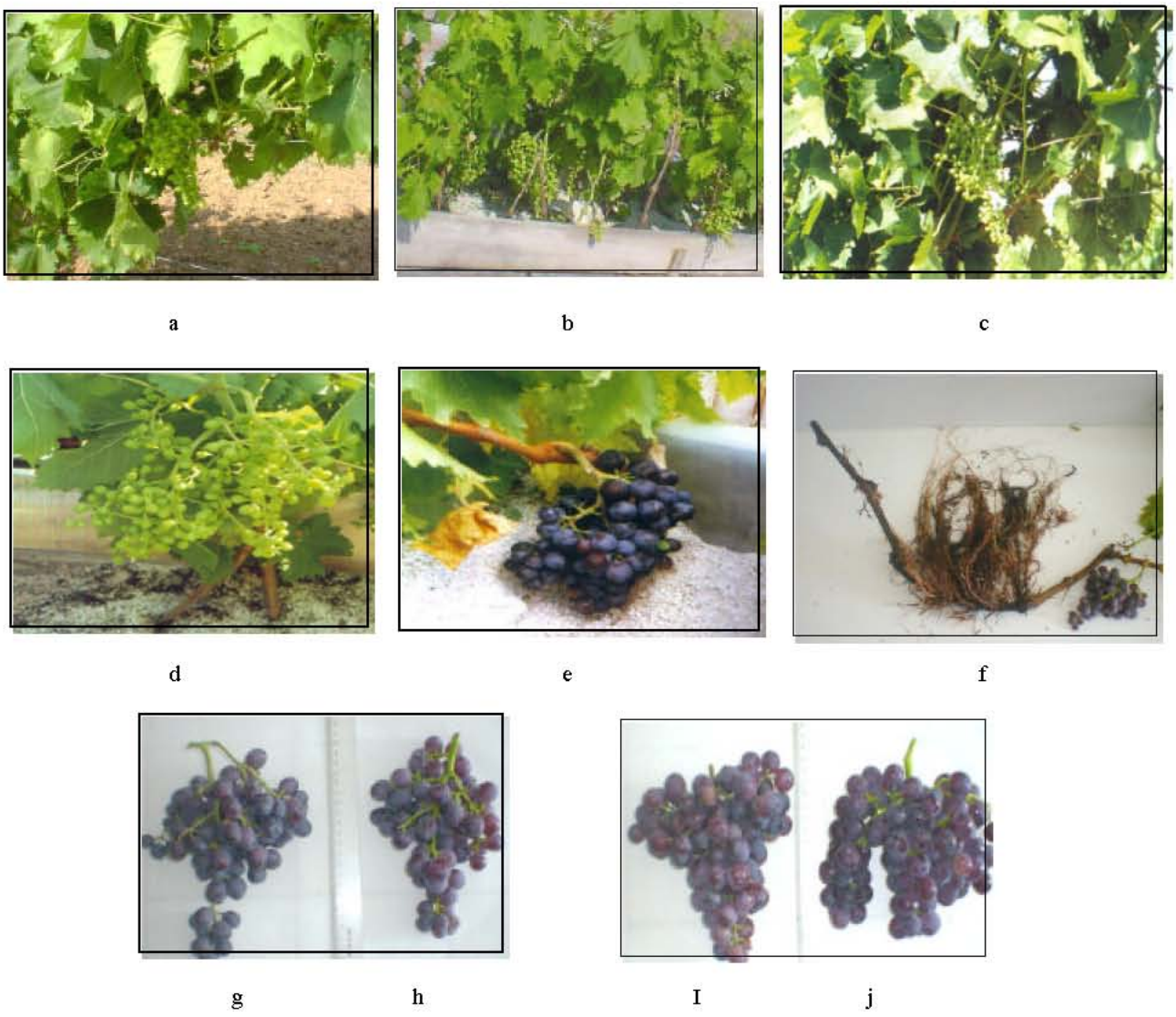


Fig. 2a-f: Taking of experimental materials from vineyard and preparation for planting

a b c d

Fig. 3a-d: Planting of experimental materials into hydroponic system



a b c

d e f

g h I j

Fig. 4a-j: Growth stages in vineyard conditions and hydroponic system and obtained clusters

RESULTS

Data regarding berry and cluster characteristics of the cv. Tekirdag Çekirdeksizi grown in both the hydroponic system and vineyard were analyzed statistically and it was determined that apart from the data for berry width, differences between the treatments were statistically non-significant (Table 2).

Table 2: Berry and cluster characteristics of the cv. Tekirdag Çekirdeksizi grown in the hydroponic system and vineyard

Berry and cluster characteristics	Hydroponic	Vineyard
Berry weight (g)	3.96	4.01
Berry length (mm)	17.80	18.81
Berry width (mm)	20.84b	18.23a
Cluster weight (g)	285.42	287.00
Cluster length (cm)	18.01	19.29
Cluster width (cm)	13.92	14.84
Cluster volume (cm^3)	250.67	251.45
Total soluble solids (%)	18.95	20.00
Titratable acidity (g L^{-1})	7.65	6.71

For all the characteristics studied, except for the berry width and titratable acidity, even though statistically nonsignificant, higher values were obtained from the vineyard grown berries and clusters in comparison to the hydroponically grown ones in that while berry weight and length were 4.01 g and 18.8 mm, respectively of the vineyard grown berries, the values for the same characteristics from the hydroponic system were 3.96 g and 17.80 mm, respectively. Regarding berry width, however, a significant difference at 1% level in favor of the hydroponically grown berries, was determined.

Weight, length, width and volume of the vineyard grown clusters were 287 g, 19.29 cm, 14.84 cm and 251.45 cm^3, respectively and even though not significant, displayed greater values than the hydroponically grown clusters for the same characteristics at 285.42 g, 18.01 cm, 13.92 cm and 250.67 cm^3, respectively.

Regarding berry juice extract characteristics, while total soluble solids were higher from the vineyard compared to the hydroponically grown berries with 20 and 18.95%, respectively; titratable acidity was higher for the hydroponically grown berries than the ones from the vineyard, being 7.65 and 6.71g L^{-1}, respectively (Table 2 and Fig. 4e-j).

DISCUSSION

It is a well known fact that carbohydrates stored in the form of starch, in one-year old hardwood and older arms, are hydrolysed and utilized, especially at the beginning of the vegetative development, in the continuation of which a gradual decrease in the starch content is observed, which lasts until it is produced, at required levels, by the leaves[2]. Hence, existence at satisfactory levels of carbohydrates in the tissues affect positively of bud burst, shoot initiation and development which take place early in vegetative development. Departing from this fact, to better facilitate the initial vegetative development, the pruning woods, i.e. one year old woods, were removed together with the older arms they are attached to and planted intact.

Also, removal of 1-2 top shoots at 5-10 cm length, positively affected the development of the hardwood, on which the shoots and clusters grew, as well as the rooting of the hardwood.

Berry size in grape, a criterion in cultivar identification, even though is a characteristic determined genetically, may be affected by the other factors such as development of the vine, water regime applied, number of flowers in a cluster as well as its berry set and the age of the vine[2]. We presently determined that while the berry weight and length for the vineyard grown berries (3.96 g and 17.80 mm) were greater than the hydroponically grown ones (4.01 g and 18.81 mm), berry width was greater in favor of the hydroponically grown berries (20.84 mm) than the other (18.23 mm) (Fig. 4g-j). Differences regarding berry weight and length, data between the vineyard and hydroponic growing conditions were statistically insignificant whereas hydroponically grown berries displayed significantly greater berry width which may be attributed to the fact that better supply and circulation of nutrients in the hydroponic system may have been effective only on this particular characteristic. This is in agreement with Mathews and Anderson[28] that water content of the vine is effective in the berry development in that dry weather conditions the vines exposed during the experiment therefore limited availability of water in the soil, may have a hindering effect in the water use which in turn resulted in berries with smaller width in the vineyard grown plants.

Regarding total soluble solids data obtained from the vineyard (20%) was higher than the data from the hydroponic system (18.95%), on the contrary, however, with regards to titratable acidity; hydroponically grown berries displayed a higher average value (7.65 g L^{-1}) than the other treatment (6.71 g L^{-1}). A balanced increase in the total soluble solids and maintenance of the titratable acidity at a certain level in table grapes is a well accepted approach. Present result regarding titratable acidity is in line with those of Coombe and Monk[29] showing that irrigation affects and in fact results in some increase in the titratable acidity.

The hydroponic method suggested here resulted in berry and cluster characteristics similar to the vineyard grown ones; therefore, in the alternative production of

grapes, if especially used for early table grape varieties, the method will facilitate the production within a short time of approximately six months.

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