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Effects of Different Gamma Radiation Doses on the Shooting and Growing of the One-eyed Scions of the Canes of Amasya Grape Variety

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ABSTRACT

This research was carried out in order to determine GR_{50} dose which reduces the shooting height at the rate of 50% as compared to control and give rises to mutation at the dormant eyes of canes of Amasya grape variety which were irradiated with four different gamma doses (20, 25, 30 and 35 Gy). The canes irradiated with different doses were prepared as one-eyed cuttings and then rooted in perlite environment in a glasshouse for three months. The shooting percentages of the one-eyed scions decreased with increasing radiation doses, accordingly their shooting times prolonged. It was also found that average shoot height, average number of nodes, average internode length and vigour values decreased comparing to the control. Number of roots and rooting percentage of the one-eyed canes irradiated with 20 and 25 Gy gamma radiation declined compared to control and no rooting was observed on the canes irradiated with 30 and 35 Gy doses. As a result, GR_{50} dose was found as 21.46 Gy for Amasya grape variety.

Key words: Amasya grape variety, scion, gamma radiation, GR_{50} dose

INTRODUCTION

Turkey has an important agricultural potential as its range of ecological conditions and the broad variability of the species. Branch of viniculture among agricultural practices in Turkey is of importance for national economy. According to 2000 statistical data, 3,6 million tons of fresh grapes were produced in 541 000 ha vineyards in Turkey (Anonim, 2000). Çanakkale, located at northwest part of Turkey, has 1,18% of the vinicultural areas of the country, having a total of 6 489 ha vineyards (Dardeniz, 2002). In 1997-1999, average yield of fresh grape was 7900 kg ha^{-1} and total grape production was 53 550 tons in the province (Anonim, 1999). Amasya grape variety is a middle-late variety which is of great importance in the annual production of the table varieties of Çanakkale. The most profitable production is obtained from the table grape varieties in the late growing season of the province. Limited number of grape varieties having some characteristics such as seedless, last season production and resistant to conservation and transportation restricts the profitability of viniculture in both the province and whole country. Therefore, it is thought that development of new table grape varieties using different breeding methods will contribute to national economy.

The aim of the plant breeding programs is to create a broad variability for different plant species using various techniques and then to develop new varieties from this variability depending upon the breeding aim. Mutations in the genetic structure of the cultivated plants for the desired characteristics provide development of new varieties in a short time. Different mutagens that give rise to sudden inheritance variation in the numbers and structures of plant chromosomes or the structures of the genes will result in new characteristics of the plants (Gaul, 1977; Donino and Sonnino, 1998). Radiation is one of the best-known physical mutagens used the generation of genetic variations in the plant breeding (Lima da Silva and Doazon, 1995). Müller in 1927 on Drosophila and Stadler in 1928 on corn and wheat using X-rays started to make mutations using artificial methods. After this research, X and gamma rays were used to improve different characteristics of plants and to obtain new varieties and species (to increase productivity and quality, resistance to disease and pests and extreme conditions etc.) (Miah *et al.*, 1966; Gökçora, 1973; Demir, 1980). Many researchers have made many studies using different mutagens (physical or chemical) on different plants (Donini, 1978; Yalçın, 1992; Aufhammer *et al.*, 2000; Klu and Haarlent, 2000). But the mutagens used generally resulted in problems such as, loss of pigments, decrease in protein content, delay of development and rooting of the plant, and sterility. Radiation dissociates the atoms of water molecule and causes the generation of hydroxyl radicals that are the most reactive. Therefore it enhances the free radical concentration in the living cells (Leibovitz and Siegel, 1980). In an earlier study, it was found that increasing radiation doses on M_1 generation was resulted decreases on plant height, root height, plant numbers and plant numbers alive (Gaul, 1977). Other studies concerning this subject show that the radiation treatments are feasible to apply on different parts of the plants such as tubers, cuttings, seeds and stems but the amount of radiation dose applied is important for successful results (Gaul, 1977; Çoban, 1998).

As a result, this research was carried out to determine the effects of different gamma radiation doses on the shoot height of Amasya grape variety and to find out the GR_{50} dose. Different radiation doses were applied to canes of Amasya grape variety. Afterwards the results obtained from this research will guide to similar studies on the same grape variety. In the forthcoming studies, generating genotypic variation using mutation may also result in mutant/mutants genotypes that can be used for grape breeding programmes.

MATERIALS AND METHODS

This research was carried out in a glasshouse of Çanakkale Fruit Production Station, Agriculture and Rural Affairs Ministry in 2002.

Canes from a 12-year-old vineyard of Amasya grape variety were cut in mid-February and put in 1 mm thick black plastics bags, and stored at 4°C for 2 months (Gerhardt and Cheng-Yung Cheng Schneider, 1971). After then, 20, 25, 30 and 35 Gy gamma radiation doses were applied to the dormant-eyed canes on April 4, 2002. For this purpose, blood ray apparatus, IBL 437 C, (5100 Ci source power) was used at Istanbul University, Çapa Medical School. The canes stored at 4°C before and after the radiation treatments were cut in 5 cm long, one-eyed scions and selected in 9-10 cm thick and then planted in perlite in boxes one day after the treatment.

One-eyed canes of Amasya grape variety were planted at 4x4 cm density in plastic boxes (40x50x20 cm) containing perlite in 30 cm thick and arranged in a randomised plot experimental design in four replications. Each replication consisted of 18 scions. The boxes were fertilized at planting with 13 g/box N-P-K as 15-15-15%. The scions kept in a glasshouse for 3 months at 25±3°C were observed weekly. The one-eyed canes were planted out on July 9, 2002 and then the values of shooting percentage, vigour, and average shoot height, average number of nodes, average internode length, rooting percentage and average number of roots were determined. The lengths of internodes and shoots were measured by electronic compass and determination of vigour was done according to 0-5 scale (0 : dormant eye, 1: hair formation on the bud, 2: shooting on primer bud , 3: 1-2 leaves, 4 : 3-4 leaves, 5: 5-6 leaves).

Shooted and rooted scions obtained from different gamma radiation doses were planted in plastics bags containing turf in order to acquire M_1V_2 phase.

Statistical analysis of the data was carried out using TARIST computer package programme (Açıkgöz *et al.*, 1994).

RESULTS AND DISCUSSION

Effects of four different gamma radiation doses applied to the one-eyed scions of the canes of Amasya grape variety on the shooting percentage, vigour, average shoot length, average number of nodes, average internode length and number of days up to 45 % shooting stage are shown in Table 1.

Table 1: Effects of Different Gamma Radiation Doses on the One-eyed Scions of Amasya Grape Variety

Doses (Gy)	Shooting (%)	Vigour (0-5)[1]	Average shoot height (cm)	Average number of nodes	Average internode length (cm)	Number of days up to 40% shooting
Control	100.0a	4.11a	3.51a	2.95a	1.19a	11.0c
20	82.47ab	2.03b	1.90b	2.09b	0.91b	22.0bc
25	71.84b	1.65b	1.39bc	1.68c	0.82b	29.25b
30	42.92c	1.05c	1.17c	1.34cd	0.87b	48.25a
35	22.20c	0.63c	0.88c	1.19d	0.73b	----
LSD	25.39**	0.55**	0.58**	0.34**	0.25**	11.82**

[1] The values of vigour (0-5) were obtained at the end of 8th week
** Significant at 0.01

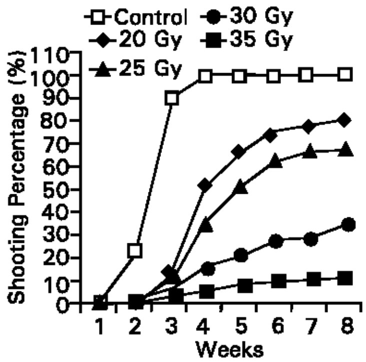

Fig. 1: Shooting percentage of Amasya variety between 1st and 8th weeks

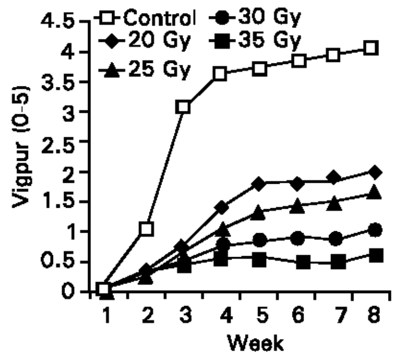

Fig. 2: Vigour of Amasya variety between 1st and 8th weeks (0-5)

Effects of various gamma radiation doses applied to Amasya grape variety on the shooting percentage and developmental ability of the scions at the end of 8 weeks later are presented in Fig. 1 and Fig. 2. 30 and 35 Gy gamma radiation doses decreased the shooting percentage and vigour of the scions significantly. All of the radiation doses increased shooting period of the scions compared to control (Fig. 1 and 2).

The effects of the canes of Amasya grape variety irradiated with different gamma radiation on the one-eyed scions uprooted were determined. Shooting percentage was 100 % at control, while shooting at the 20, 25, 30 and 35 Gy radiation doses decreased to 82.47, 71.84, 42.92 and 22.2%, respectively. Depending on increasing radiation doses, vigour values also decreased compared to control (4.11) and found to be 2.03, 1.65, 1.05 and 0.63, respectively (Table 1).

Because of increasing radiation doses, the rooting percentage and average number of roots in the one-eyed scions of Amasya grape variety decreased as well. The rooting percentage of control was 85.55 % while the percentages at 20 and 25 Gy decreased 19.97, 8.33%, respectively. Average number of roots in the controls was 6.64, whereas it was 4.1 at 20 Gy and 1.31 at 25 Gy. Rooting at 30 and 35 Gy radiation treatments did not occurred. At the 30 and 35 Gy gamma radiation treatments, spot-sclerosis was found on the leaves. Moreover, the folia become smaller and asymmetric development and deformations were observed. In addition, average shoot height, average number of nodes and average internode length decreased with increasing radiation doses (Table 1). Average shoot height in the control was 3.51 cm, but this declined to 1.90 cm, 1.39 cm, 1.17 cm and 0.88 cm with application of 20, 25, 30 and 35 Gy doses, respectively. In number of nodes, the control had 2.95 nodes whereas the scions exposed to 20, 25, 30 and 35 Gy doses had 2.09, 1.68, 1.34 and 1.19 nodes, respectively. Similarly, 1.19 cm average internode length of the control decreased to 0.91 cm, 0.82 cm, 0.87 cm and 0.73 cm with application of 20, 25, 30 and 35 Gy doses. According to statistical analyses, various radiation dose treatments applied on Amasya grape variety were highly significant for all the parameters as seen in Table 1 ($P<0,01$).

Number of days from planting to 40% shooting delayed 11 days at 20 Gy, 18 days at 25 Gy and 37 days at 30 Gy. It could not be determined for 35 Gy because only 22.2% shooting occurred (Table 1). The results obtained from this research were in accordance with a study indicating that shooting delayed with increasing radiation doses in a round seedless grape variety (Çoban, 1988). We also found that various gamma radiation doses affected the development of shooting of the scions at different levels. These results were also in line with other various studies (Einset and Pratt, 1975; Donini, 1978; Donini, 1993; Hadju *et al.*, 1995; Körosi *et al.*, 1995; Lima da Silva and Doazon, 1995).

According to the results, different gamma radiation doses applied had significant effects on the vegetative development parameters of the scions. Increased gamma radiation treatments resulted in decreases on shooting percentage and delays on shooting time of the scions. As a result, GR_{50} dose for the application of mutation breeding of Amasya grape variety was determined as 21.46 Gy. Ponnusswani *et al.* (1992) found GR_{50} dose to be 20-25 Gy on woody cuttings of Muscat grape variety, which agrees with our results.

It was determined that 20 and 25 Gy gamma radiation doses are suitable for Amasya grape variety whereas 30 and 35 Gy radiation doses have many negative effects on the plants. These results give some information in determining appropriate dose levels on mutation breeding studies in other grape varieties.

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