SHORT COMMUNICATION

SCREENING OF GRAPE ROOTSTOCKS FOR SULPHATE SALINITY

M.R. DESHMUKH AND S.G. PATIL*

Agharkar Research Institute, Agarkar Road, Pune-411 004

Received on 16 Nov., 2007, Revised on 8 Feb., 2010

Effect of Sodium sulphate ($Na_2 SO_4$) was recorded on various biochemical parameters of grape genotypes like Dogridge, Degrasset, Jawahar, H-516 and H-1204. Various concentrations of Sodium sulphate *viz.* Control, 2, 4, 6, 8, 10, and 12 dS m^{-1} had a significant effect on the reduction in shoot and root growth which can be considered as the criteria for relative salt tolerance. Based on these criteria H-516 and Dogridge recorded the lowest reduction in growth attributes. It indicated that they were relatively salt tolerant to growth of rootstocks. Overall such salinity tolerant genotypes have special significance in grape improvement programme, as rootstock can be used for grafting of seedless/wine grape varieties for their cultivation under sulphate salinity soils.

Key words: **Grape, growth, rootstocks, sodium sulphate**

Use of sulphate containing fertilizer in grape cultivation is increasing day by day. Sulphate salinity has become one of the serious environmental problems limiting productivity and quality. The excess soluble salts of sodium in the root zone cause the toxicity. They adversely affect the grape vines by direct injury to roots rendering water unavailable to plant by accumulation of toxic ion like sulphate (SO_4), hindrance in growth causing deficiency of essential elements like potassium and phosphorus (Bernstein 1965). Under such situation growing any commercial varieties on their own roots adversely affect the yield and quality of grapes. The most practical alternative is the use of salt tolerant rootstocks of grape. It is an established fact that rootstocks provide a different root system to the scion. The selective absorption of nutrients by the scion due to changed root system can be profitably employed in eliminating the absorption of toxic elements. Some attempts were made earlier for the selection of rootstock for salinity by Divate (1974), Gupta and Nauriyal (1973), Joolka *et al.* (1977) and Pandey and Divate (1976 a,b). The work on sulphate salinity is very meager hence attempts have been made to study the effect of sodium sulphate on growth of shoot and roots of the five grape roots.

An experiment was conducted under control conditions during 2002-03. Six months old uniform rooted cuttings of five rootstocks viz. Dogridge (*Vitis champini*), Degrasset (*V. champini*), Jawahar (*V. vinifera*) and hybrids- H-516 (*V. labrusca x V. vinifera*) and H-1204 (*V. vinifera x V. lanata*) were obtained from the germplasm maintained at Agharkar Research Institute. Earthen pots were filled with 5 kg of soil and were used for the experiment. To evaluate the grape rootstocks for salt tolerance at various levels of Sodium sulphate salinity, the experiment was carried out in Factorial Completely Randomized Design (FCRD) with 2 replications and seven levels of treatments. Electrical Conductivity (EC) levels of irrigation water were Control, 2, 4, 6, 8, 10 and 12 dS m^{-1}. To prevent the leaching of salts, inner sides of the pots were lined with 400 gauge impervious polythene sheets. The pots

*Corresponding author, E-mail: sgpatil@india.com

were filled with soil mixed with well-rotted Farm Yard Manure (FYM) in 3:1 proportion and 100 gm of single super phosphate for each pot and irrigated immediately. The experiment was carried out as per the method adopted by Pandey and Divate (1976) with certain modification.

Data recorded on various growth parameters of shoot and root for five rootstocks revealed that genotypes, sources of sodium salts and EC levels had a significant influence on shoot and root growth. The mean values showed that the rootstock recorded the lowest shoot and root growth under sulphate salinity (Table 1). The reduction in shoot and root growth due to EC levels with Na_2SO_4 in different genotypes as compared to the corresponding control

Effect on shoot growth: The results showed that more reduction in shoot height was found in Jawahar and the least in Dogridge. The reduction might be due to the physiological scarcity of water caused by high concentration of salts because of osmotic effect on plant, toxic effect of accumulated ions in plant tissue, specific effects of constituent ions or combination of all these. Such reduction in shoot height due to salinity has been reported by Bernstein (1965), Joolka (1972), Obbink and Alexander (1973), Alsaidi *et al* (1985, 1988) and Samra (1986) in grape vines**.**

The reduction in growth under saline conditions appeared due to low carbohydrates and protein synthesis. The low carbohydrates were due to lesser number of leaves and reduced chlorophyll content under salinity conditions. Nitrogen , which is initial element in protein synthesis steadily decreased due to salinity. This resulted in reduction in cell division and cell extension (Hewitt 1963). It is possible that stomatal resistance increased thereby reducing transpiration rate resulting into thicker leaves with higher water conent. Pandey (1982) is of the opinion that growth was retarded in grapes due to diversion of nutrients towards respiring tissue damaged by salts. He recorded damage to root tips and leaf cells within 30 days of salinization.

Effect on root growth: The data regarding length of roots revealed that the genotypes, salts and EC levels had significant influence on the root length. It indicated that Jawahar had the maximum root length (70.17 cm) which was significantly superior to H-516 (54.51 cm), Dogridge (47.23 cm) and H-1204 (46.14 cm), while the

Table 1. Mean values of growth parameters due to sodium sulphate.

Characters	Dogridge	Degrasset	Jawahar	H-516	H-1204	Mean
			Shoot growth			
Shoot height (cm)	69.89	62.76	26.81	57.45	57.81	56.14±15.56
Shoots vine^{-1}	6.14	8.35	3.29	10.89	6.19	6.97±2.53
Leaves vine^{-1}	63.49	40.28	28.42	32.85	51.96	43.40±12.82
Leaf area (cm^2)	69.73	78.93	71.75	49.23	63.25	66.28±10.02
Shoot dry wt (g)	11.63	10.16	5.32	8.64	3.85	7.92±2.92
Mean S.D.	41.16 ±28.95	40.10±28.02	27.00±24.42	31.81±19.67	36.43±29.87	26.11±22.39
			Root growth			
Length of root (cm)	47.23	26.00	70.17	54.51	46.14	48.81±14.27
Primary roots vine^{-1}	18.26	3.3	20.98	25.69	16	16.85±7.50
Secondary roots vine^{-1}	24.3	7.3	24.35	25.16	25.69	23.35±8.81
Tertiary roots vine^{-1}	142.89	80.25	132.32	201.76	137.98	139.03±36.61
Root volume (cc)	23.67	8.89	21.87	18.75	18.71	18.38±5.11
Dry wt of roots (g)	6.04	0.90	8.13	7.06	2.73	4.98±2.72
Mean	43.93±45.99	20.97±27.75	46.30±43.10	55.48±66.96	40.88±48.36	41.59±45.40

least root lenth was recorded in Degrasset (26.0 cm). The reduction in root length due to salinity, because of saline water application (osmotic effect) was reduced or caused specific toxicities (ion effect). It has also been shown that no differences exit between salt and water stress in affecting NH4-N uptake. NO_3 uptake was restricted more by water stress than by salinity, suggesting that nutrient mobility should be considered since a mobile nutrient such as NO_3 can be supplied to plant roots by water movement, which was reported by Taylor and Greenway (1987).

Increasing salt concentration in the soil solution significantly decreased the root length and number of roots per vine. However, the maximum reduction in root length was observed in Degrasset under Na_2SO_4 (26%) salinity. The findings are in confirmation with Alsaidi *et al.* (1988) who while studying the root growth of grape vines, reported that it was reduced as the concentration of salt in soil increased. It is probable that salinity caused decrease in plant harmone content (auxins and gibberellins) and increased the inhibitor level, which restricted the growth and subsequent rooting (Sinel nikova *et al.* 1972). The root growth made by the vines was influenced by the nature of salts present in the soil.

The reduction in number of primary roots, secondary and tertiary roots due to Na_2SO_4 salinity was observed. Reduction in root density due to soil salinity has been reported by Pearson *et al.* (1957) and Bernstein (1965) who observed that increasing salinity caused severe reduction in the mass of the root formed. The reduction in root mass might be due to effect of salinity on growth and development process in plants

Alsiadi *et al.* (1988) who explained that increasing the salt concentration in the root medium caused disorders in the physiological processes, which decreased growth and yield of grapes for Black rose, Cardinal, Thompson seedless and Perlette cultivars. They pointed out that growth suppression in saline soil might be due to osmotic effect on plant roots and toxic effect accumulated in plant tissue. They also showed that the increasing salt concentration caused destructive changes in the cellular structures and organnels such as chloroplast which decreased the physiological processes concerning the growth. Similarly, it is also supported by Sinelnikova *et al.* (1972) who stated that salinity decreased the content of plant harmones and increased the level of inhibitors which restrict the growth. They explained that the salinity caused decrease in DNA synthesis in grapes. The lowest reduction in number of tertiary roots was observed in H-516 and Dogridge have a better tolerance irrespective of the salts than the other genotypes.

In root volume, Dogridge (23.67 cc) recorded the highest root volume followed by Jawahar (21.87 cc) indicating that these genotypes had higher relative salt tolerance irrespective of root volume than the other genotypes. The reduction in root growth ultimately affect the root volume. The results are in agreement with Bernstein (1965) who reported that it might be due to the effect of salinity on growth and development of the roots. It might also be due to reduction in uptake of phosphorus affecting root growth because of less production of energy carrying ATP and reduction in protein synthesis rate due to low nitrogen content (Hewitt 1963).

Dry weight of roots decreased due to reduced number of leaves and also chlorophyll content resulting in lower rates of photosynthesis. It might be due to reduction in phosphorus uptake affecting the energy carrying ATP and reduction in protein synthesis rate due to low nitrogen content (Hewitt 1963). The CO_2 fixation in leaves was progressively inhibited with increase in leaf chloride content suggesting that the stunted appearance of vine growing under saline conditions resulted in reducing the rate of photosynthesis affecting the growth of the vine and also dry matter. Obbink and Alexander (1973), Alsaidi *et al.* (1985) and Samra (1986) who observed that physiological process due to high salt concentration was disturbed resulting into inhibition of vegetative growth and thus reduced dry weight of root supported it. Another reason might be the presence of excessive sulphate level, which has been reported to cause reduction in fresh and dry weight of plants. The maximum dry weight of root was recorded in Jawahar (8.13 g) followed by H-516 (7.06 g). The least dry weight of root was recorded in Degrasset (0.90 g), which showed relatively less salt tolerance than the rest of the genotypes irrespective of dry weight of root.

ACKNOWLEDGEMENTS

This work has been carried out under the "All India Co-ordinated Research Project on Sub-tropical Fruits-Grapes", sponsored by Indian Council of Agricultural Research, New Delhi.

REFERENCES

Alsaidi, J.H., Shakir, I.A., Dawood, Z.A. and Alawai, B.J. (1985). Effect of saline conditions on growth and mineral content in different parts of grapevine. Deiss Aniz cv. (*Vitis vinifera* L). *Annals of Agric. Sci.* **30:** 1495-1512.

Alsaidi, I.H., Shakir, I.A. and Hussein, A.J. (1988). Rooting of some grapevine cuttings as affected by salinity. *Annal Agric. Sci.* **33:** 479-499.

Bernstein, L. (1965). Salt tolerance of fruit crops. U.S. Dept. *Agric. Info. Bull*. No. 8, Washington.

Divate, M.R. (1974). Physiological basis of salt tolerance in grapes. Ph.D. thesis submitted to IARI, New Delhi.

Gupta, O.P. and Nauriyal, J.P. (1973). Studies on salt tolerance on grape II. Effect of high levels chloride, sulphate and carbonates. *Haryana J. Hort. Sci.* **2:** 14-22.

Hewitt, E.J. (1963). The essential nutrient element requirement and interaction in plants. Plant Physiology Vol III. Inorganic nutrition of plant.

Joolka, N.K. (1972). Salt tolerance studies in grape. M.Sc. (Agri.) thesis submitted to HAU, Hissar.

Joolka, N.K., Singh, J.P. and Khera, A.P. (1977). Growth of grapevines as affected by NaCl and Na_2SO_4 salts. *Haryana J. Hort. Sci.* **5:** 181-188.

Obbink, J.G. and Alexander, D.M. (1973). Response of six grape vine cultivars to a range of chloride concentrations. *Amer. J. Enol. Viticult.* **24:** 65-68.

Pandey, R.M. (1982). Physiological studies on salt tolerance of grape variety Perlette. Research Report. ICAR. Fruit Res. Workshop (Nagpur) pp. 414-416.

Pandey, R.M. and Divate, M.R. (1976a). Salt tolerance in grape I. Effect of salinity on the morphological characters of plants. *Indian J. Plant Physiol.* **19:** 108-117.

Pandey, R.M. and Divate, M.R. (1976b). Salt tolerance in grape I. Effect of sodium salt singly and in combination on some morphological characters of grape varieties. *Indian J. Plant Physiol*. **19:** 230-239.

Pearson, G.A., Goss, J.A. and Hayward, H.E. (1957). The influence of salinity and water table on growth and mineral composition of young grape fruit trees. *Proc. Am. Soc. Hort. Sci*. **69:** 197-203.

Samra, J.S. (1986). Effect of soil sodicity on growth of four cultivars of grape. *Indian J. Hort.* **43:** 60-65.

Sinelnikova, V.N., Romanova, L.V. and Udovenko, G.V. (1972). Effect of salinization and physiological active substances on growth and level of endogenous growth regulators in potato. *Sov. Plant Physiol.* **19:** 50-55.

Taylor, T.M. and Greenway, H. (1987). Mineral Nutrition of Plants. Oxford and IBH Publishing Co.