Irrigation Regimes Effecting Drought Tolerance Of Grape Rootstocks Under Cold Arid Conditions

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Abstract: The drought tolerance is a very important property of grapevine rootstocks. For that reason the breeding and selection of new rootstock varieties is focused on the evaluation of their drought tolerance. In this experiment, 5 rootstocks of grape were compared and evaluated with local rootstock. The maximum height of shoot was observed at scheduling of irrigation at 0.3 bar (66.80cm) in Doddridge while as maximum average height of shoot (61.96cm) was recorded for 1103-P and minimum average height of shoot (41.89cm) for Local rootstock with different scheduling of irrigations. Maximum diameter of shoot (4.35cm) was observed by 1613-C with scheduling of irrigation at 0.3 bar, where as Doddridge attained the highest average diameter of shoot (3.50cm) with different scheduling of irrigations. The maximum number of shoots per vine (19.42) was observed in 1613-C at 0.3 bar where as Local rootstock showed the minimum average number of shoots per vine (8.96) while as maximum average number of shoots per vine was observed for 1103-P (14.80) .Regarding the length of internode, 1103-P recorded the maximum length (7.41cm) at 0.3 bar and maximum average length of internode (7.01cm). The maximum relative leaf water content at scheduling of irrigation at 0.3 bar (84.6%), at 0.5 bar (79.3%) and at 0.7 bar (75.6%) was observed in 1103-P followed by Doddridge and Salt Creek. Based on the effect of different irrigation regimes on grape rootstocks, the drought tolerance of grape rootstocks can be ranked as 1103-P>Doddridge>Salt Creek>1613-C>1616-C>Local.

Key words: Drought tolerance, Grape rootstocks, irrigation regimes, morphological characters, water use efficiency, Cold Arid conditions, Ladakh.

Introduction

In recent years, it is possible to observe global climatic changes. The numbers of warm years and longer periods of drought are increasing. In the course of its phylogenetic development, grapevine (Vitis vinifera) has developed various physiological and morphological mechanisms enabling plants to survive under conditions of water deficits (Kondouras et al., 2008). Water is the most important limiting resource for the vineyards of the Cold Arid region of India where water is supplied mostly by the scanty rainfall that poorly matches the water requirement of vineyards in the region. Rootstock utilization has been significantly increasing since the 1970s in the world. They vary in root distribution and affect scion responses in vigor, yield, fruit quality and other physiological parameters (Paranychianakis et al., 2004; Koundouras et al., 2008). In addition to their effect on yield, rootstocks also significantly affect fruit quality components such as total phenolic and anthocyanin content and vine productivity under different irrigation treatments (Hilal etal., 2000; Koundouras et al., 2008).

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Grape (*Vitis vinifera* L) is an important temperate crop but well acclimatized under sub-tropical regions of the world. In India, it is mainly grown in semi-arid regions and at a smaller scale in temperate regions where water is the main limiting factor for yield and quality of the grapes. The attitude of root system to develop and absorb minerals and water largely effects the growth and vigor of the scion especially in scarcity situation (Rives, 1971). The water stress has a dominant effect on the growth of the vine and it directly affects the growth and development which can be judged by the morphological signs such as height of shoot, diameter of shoot, number of shoots per vine and length of internode Although grapevine (Vitis vinifera L.) is considered to be a species that is relatively well adapted to drought stress, the combined effects of intensive illumination, high temperatures and low atmospheric water pressure tension could presumably act as major constraints for leaf photosynthesis, particularly under conditions of severe soil water deficits that are usually encountered by this crop (Flexas et al., 1998). Because of differences in the architecture of root system, the drought tolerance of plants is significantly influenced by rootstocks. The capability of grapevine to uptake water and nutrients from soil is dependent not only on the size of the root system but also on its horizontal and vertical arrangement (Smart et al., 2006), Comas, L.H. *et al, (*2010). A good resistance of grapevine to stress situations results from deep ofroot system and physiological mechanism of drought avoidance (Chaves et al., 2010).. In the light of above discussion, the present study was undertaken to investigate the relative drought tolerance of grape rootstocks under cold arid regions of Ladakh, India.

Materials and Methods

The field experiment was carried out on an experimental Field of High Mountain Arid Agriculture Research Institute, SKUAST-K Leh India. Rootstock is defined as the root system of the grapevine to which is grafted the desired variety of grapes. The grape rootstocks viz. Doddridge, Salt Creek, 1613-C, 1616-C, 1103-C, Local rootstock and 3 levels of irrigation regimes at 0.3 bar, 0.5 bar and 0.7 bar were taken under study. Two rooted cuttings were planted in each pot in the month of October, 2010 and in each replication three pots were maintained in factorial completely randomized design. The transplanted rooted cuttings sprouted and the shoots were allowed to grow up to April, 2011. The recut of the sprouted shoots was undertaken in April, 2011 by retaining 2-3 matured buds on shoot. The recut was taken for uniform growth of shoot and equal foliage density. The treatments were commenced at the stage of 5th to 6th leaf stage based on standard curve of moisture tension v/s water content Ghildyal and Tripathi, (1986) and Fanizza *et al*.(1993).Total thirty irrigations were given during investigations. The height of the shoot and length of internodes were measured with the help of flexible tape and the diameter was measured with the help of Vernier caliper.

Results and Discussion

The maximum average shoots per vine (Table 1) were recorded for 1103-P (14.80) while as lowest in Local rootstock (8.96).The interaction effect between irrigation regimes and different grape rootstocks was also significant. Among the different irrigation regimes, the maximum number of shoots per vine (19.42) were produced by 1613-C followed by 1103-P (16.42), 1616-C (15.42), however it was at par with Doddridge (15.17) with scheduling of irrigation at 0.3 bar. However 1103-P observed the maximum number of shoots per vine with scheduling of irrigation at 0.5 bar (14.50) and at 0.7 bar (13.48) while as Local rootstock registering minimum number of shoots with scheduling of irrigation at 0.5 bar (8.62) and 0.7 bar (4.72).Similar results were obtained by Fanizza *et al,* (1993), Sikhamany *et al,*(1995) and Ramteke *et al,*(1999), Cifre J *et al,* (2005), De Herralde F *et al*, (2006) and Chaves M M *et al,* (2007). The maximum average height of shoots were produced by 1103-P (61.87 cm) while the minimum in Local rootstock (41.79 cm). The height of shoot of various rootstocks was significantly decreased with the increase in water stress. The interaction effect between irrigation regimes and different grape rootstocks was also significant. Among the different levels of irrigation, the maximum height of shoot (66.26 cm) was recorded for 1103-P with scheduling of irrigation at 0.3 bar and (61.42 cm) with scheduling of irrigation at 0.5 bar and (57.93 cm) at 0.7 bar. The lowest height of shoot (22.63 cm) was recorded by Local rootstock at 0.7 bar. Similar results were reported by Patil *et al* 1995, Ramteke *et al* 1999, Dry, P *et al* 2000,Stevens *et al* 2002, Ramteke, S.D. *et al* 2002, Satisha, J. *et al* 2002, Schmidt, J *et al,* 2002 The effect of irrigation regimes on length of internode of the rootstocks was significant. Among the different levels of irrigations the maximum length of internode was observed for 1103-P (7.41 cm) with scheduling of irrigation at 0.3 bar and the lowest length of internode was noticed by Local rootstock (2.74 cm) at 0.7 bar. Similar trend was observed for highest average Length of Internodes with highest length recorded for 1103-P (7.01 cm) and lowest for Local rootstock (4.39 cm).It shows that irrigation regimes resulted for more reduction of internode length in Local rootstock and vice versa. These findings are supported by Patil *et al*. 1995, Ranteke *et al* 1999, Mhetre 1999, Calo A *et al* 1997, Patil, S.G *et al,* (2003), Stevens, D.P. *et al* (2003), Patil, S.G *et al,* (2005), Pire, R. *et al,* (2005), The effect of irrigation regimes on diameter of shoot of the rootstocks showed also significant results. Among the different irrigation regimes, the maximum average diameter of shoot (3.50 mm) was recorded for Doddridge followed by 1613-P (3.30 mm) while as minimum average diameter of shoot (1.40 mm) for Local rootstock. The minimum reduction in diameter of shoot was recorded by 1103-P which was followed by Doddridge and Salt Creek rootstocks. The local rootstocks registered the maximum decrease in shoot diameter by losing the turgidity of cells indicating thereby that the diameter was significantly reduced due to water stress. In 1103-P, the lowest reduction in the shoot diameter might be because of minimum reduction in turgidity of cells. These findings are in conformity with those reported by Hsaio (1973), Padgett-Johnson *et al,* (2004), Cregg, B. *et al,* (2004), Pellegrino, A., E. *et al,* (2005), Sakellariou-Makrantonaki *et al* (2006), Cramer, G.R. *et al* (2007), Among the different levels of irrigations, the maximum relative leaf water content was observed by 1103-P (84.52%) with scheduling of irrigation at 0.3bar and minimum for Local rootstocks (55.0%). The maximum average relative leaf water content was recorded for 1103-P (79.9%) and minimum for Local rootstocks (63.9%). In drought tolerant rootstocks the maximum RLWC may be due to maintenance of the cell turgidity while in drought susceptible rootstocks, cell turgidity was lost readily. These results are found similar with the findings of El-Borkouki *et al*, (1979), Yuejin, W *et al* (2004), Koundouras, S. *et al* (2008), The relative leaf water content of leaves increased as available water increased. The maximum value of relative water content was obtained from control treatments (100% available water) in contrast lowest value obtained at 12.5% available water. Similar results were obtained by El- Barkouki *et al*, (1979), Ghidyal *et al*, (1985), Prakash and Bhat (1999), Gomez-Del-Campo, M *et al*, (2002)and Chaves, M.M. *et al*, (2010). They showed that imposition of water stress strongly decreased the relative leaf water content of leaves in all rootstocks by end of stress cycle. From this experimental study it is concluded that the rootstocks of grape can be ranked as 1103-P> Doddridge> Salt Creek> 1613-C> 1616-C> Local rootstocks.

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Graph 1. Graphical representation for Effect of irrigation regimes on Grape rootstocks

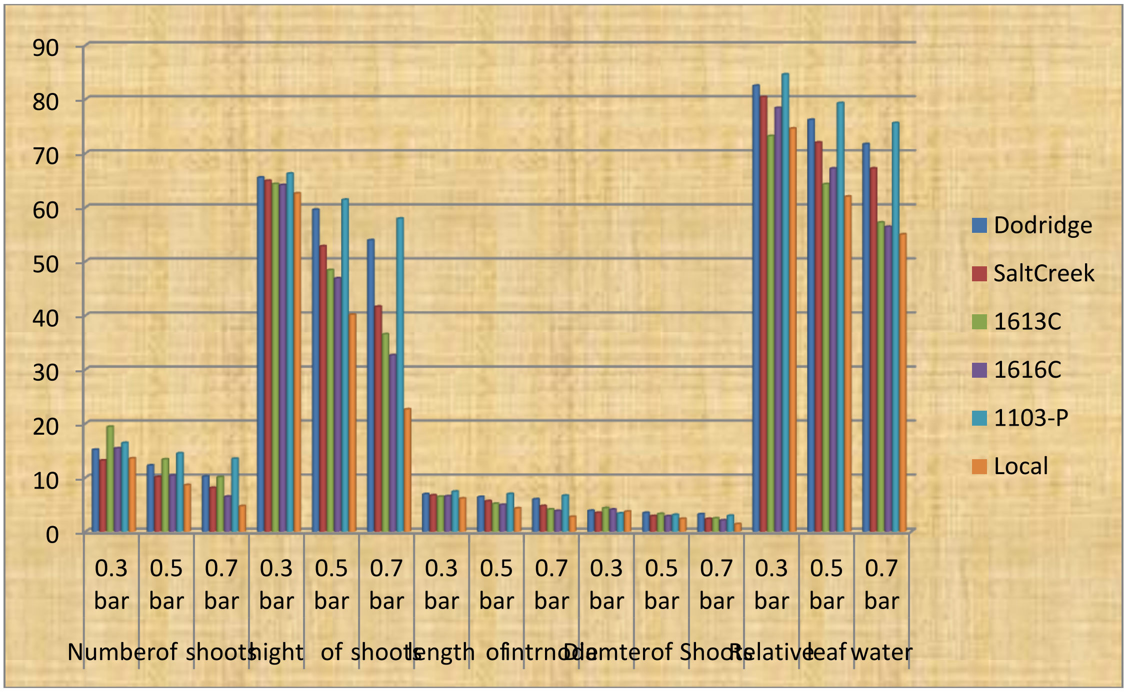

Table 1. Effect of irrigation regimes on Grape rootstocks.

Irrigation Regimes/ Rootstock	Number of Shoots				Height of shoots (cm)				Length of internodes (cm)				Diameter of shoots (cm)				Relative leaf water content (%)			
	0.3 bar	0.5 bar	0.7 bar	Mean	0.3 bar	0.5 bar	0.7 bar	Mean	0.3 bar	0.5 bar	0.7 bar	Mean	0.3 bar	0.5 bar	0.7 bar	Mean	0.3 bar	0.5 bar	0.7 bar	Mean
Doddridge	15.17	12.25	10.22	12.54	65.53	59.57	53.92	59.67	6.94	6.42	6.00	6.45	3.86	3.47	3.23	3.5	82.5	76.2	71.7	76.8
Salt Creek	13.17	10.12	8.10	10.46	64.92	52.81	41.63	53.12	6.72	5.64	4.75	5.70	3.49	2.88	2.36	2.9	80.4	72.0	67.2	73.2
1613-C	19.42	13.38	10.10	14.30	64.34	48.4	36.53	49.75	6.47	5.17	4.11	5.25	4.35	3.29	2.47	3.3	73.2	64.3	57.2	64.9
1616-C	15.42	10.38	6.48	10.76	64.14	46.88	32.64	47.88	6.55	4.96	3.84	5.11	4.09	2.86	2.09	3.0	78.4	67.2	56.4	67.3
1103-P	16.42	14.50	13.48	14.80	66.26	61.42	57.93	61.87	7.41	6.98	6.66	7.01	3.39	3.11	2.95	3.1	84.6	79.3	75.6	79.9
Local	13.55	8.62	4.72	8.96	62.59	40.15	22.63	41.79	6.13	4.31	2.74	4.39	3.71	2.38	1.4	2.4	74.6	62.0	55.0	63.9
Mean	15.52	11.54	8.85		64.63	51.53	40.88		6.70	5.58	4.68	5.65	3.81	2.99	2.41		79.0	70.2	63.8	

	SE±_ mean	CD at 5%	SE± mean	CD at 5%	SE± mean	CD at 5%	SE± mean	CD at 5%	SE± mean	CD at 5%
Rootstocks	0.07123	0.1978	0.1432	0.3968	0.0220	0.06059	0.01300	0.0431	0.1403	0.4397
Irrigation regimes	0.49563	0.1380	0.1064	0.2857	0.0174	0.0500	0.0087	0.0202	0.1094	0.3081
Interaction	0.13506	0.3315	0.2300	0.6705	0.0423	0.1200	0.0210	0.0605	0.3203	0.7500