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NITROGEN AND POTASSIUM UPTAKE AND UTILIZATION OF FOUR GRAPEVINE ROOTSTOCKS

Abdel-Mohsen, M. A. and A.A. Rashedy
Pomology Department, Faculty of Agriculture, Cairo University, Giza, Egypt.
Corresponding author email: **mohamed.abdulmohsen@agr.cu.edu.eg**

ABSTRACT

Two pot experiments were carried out during two seasons of 2014 and 2015 on four grapevine rootstocks namely, Salt creek, Freedom, 1103 Paulsen and Harmony under shad (siran) house at pomology department, Fac. of Agric., Cairo Univ., Egypt. This study aimed to investigate the efficiency of previous rootstocks in uptake nitrogen and potassium nutrients as their effect on growth parameters. Four nitrogen and potassium rates (0.0, 0.4, 0.8, and 1.2 g N or K_2O/pot) were added separately in the two separate experiments and each rate was divided into six equal doses which added weekly. Freedom rootstock recorded the highest growth vigor parameters with regard to shoot and root length and dry weight followed by Salt Creek rootstocks all along both experiments. Also, Freedom recorded the highest significant leaf area in the first season in both experiments. Moreover, Freedom rootstock contained the highest nitrogen and potassium content in shoot and root tissues. Furthermore, the highest nutrient dosages (0.8 and 1.2 g/pot) recorded the highest growth parameter, chlorophyll, nitrogen and potassium content. This study showed an additional advantage for Freedom rootstock in uptake and utilization of nitrogen and potassium nutrients.
Keywords:Grapevine, Rootstock, Nitrogen, Potassium, Growth, Uptake, Utilization.

INTRODUCTION

Selected rootstocks are just as important as the cultivars. The primary use of grapevine rootstocks is for pest resistance. However, rootstocks also influence vegetative growth, yield and fruit quality (Main, 2002). In addition rootstocks allow vines to uptake water and nutrients as well as to store nutrients and carbohydrates (Creasy and Creasy, 2009). Main choice of grape rootstocks in Egypt is for nematode resistance, which spread all over Egyptian lands. Selection of rootstocks with high nutrient uptake can reduce fertilization costs, ground water pollution and support organic farming.

Sandy soils which are commonly N deficient, since the application of N is essential for continued production of high-quality grapes (Spayd *et al.,* 1993). Nitrogen (N) is an important constituent of the protein makeup of plants and is part of the chlorophyll molecule’s structure. Photosynthesis process depends on function and coordination of many proteins and enzymes, which account for the majority of N in leaves (Chen and Cheng, 2003). So vine nitrogen status greatly influences both growth and yield parameters (Des Gachons *et al.,* 2005).

Efficient use of fertilizers in crop production is increasingly important. Low recovery of applied N by crops (low efficiency) may contribute to nitrate pollution to surface or groundwater, and necessitate the use of higher fertilizer rates to supply plants with sufficient N (Schaller, 1991). However, due to the detrimental impact of the overuse of N fertilizers on the biosphere such as the eutrophication of both marine and terrestrial ecosystems (Hirel *et al.,* 2007), the challenge for the next decades will be to accommodate the needs of the expanding world population by developing a highly productive agriculture, while at the same time preserving the quality of the environment (Dyson, 1999).

Potassium (K) is a very important element in protein and fat synthesis, enzyme activation and as an osmotic charge balancer. K helps in opening and closing of stomata and assists in osmoregulation of cell (Hsiao, 1973). Moreover, K creates immunity in plants body against drought, high temperature and diseases. K helps plant body to produce starches, enhance root growth, and shoot length (Maser *et al.,* 2002). The quantity removed with a moderate crop of grapevines is frequently greater than that of N (Winkler *et al.,* 1974). K is essential for vine growth and yield. Whereas, grape berries are strong sinks for K particularly during ripening. This idea originated from knowledge of K's role in the plants formation of sugars and starches (Mpelasoka *et al.,* 2003).

The content and concentration of K within grapevine can be regulated by selective use of rootstocks (Kodur *et al.,* 2010 and 2011). However, the mechanisms of K accumulation in the grapevine shoots are not well understood (Kodur *et al.,* 2010 and 2011). The results highlight that accumulation K in grapevine rootstocks shoot is regulated mainly by roots (Kodur *et al.,* 2011). In addition, such accumulation of K in rootstocks is positively affected by factors such as root traits (root length, root surface area, amount of fine roots), root pressure and/or growth and vigor, but not by transpiration rate or water use (Kodur *et al.* 2010), which showed that some grapevine rootstocks accumulate low concentrations of K in the shoot such as 140 Ruggeri but others accumulate high shoot concentrations such as 101-14 Millardet de Grasset.

Thus, this study aimed to assess the growth and N and K uptake of 'Salt Creek' (Ramsey), 'Freedom,' 'Harmony,' and 'Paulsen' grapevine rootstocks.

MATERIALS AND METHODS

The present study was carried out under black siran shade house in the nursery of the Pomology depart. Fac. of Agric. Cairo Univ. during 2014 and 2015 seasons. Uniform wood cuttings with 3 buds and 1 cm in diameter of Freedom (1613Couderc X *V. champinii*), Salt Creek (Ramsey) (*V. champinii*), Harmony (1613 C x *V. champinii*), and 1103Paulsen (*V. berlandieri x V. rupestris*) grapevine rootstocks were planted in plastic pots filled with 9 kg washed sand at the beginning of February during each seasons. After One month of planting, 120 successive cutlings of each rootstock were chosen and equally shared to two experiments to assess the growth and N and K-uptake efficiency of these rootstocks. Four treatments of

N or K, each was replicated three times and every replicate was represented by five cutlings. Chemical analysis of soil and water was presented in Table 1.

Table 1: Chemical analysis of soil and water

			Soluble anion (meq/ l)				Soluble cation (meq/ l)				
	pH	EC ds/m	CO3	HCO3	Cl	SO4	Ca	Mg	Na	K	N
soil	8.4	1. 12	-	3.8	11.6	4.6	11.1	7.53	7.73	0.37	2.07
water	6.9	0.46	-	1.32	0.75	2.76	1.76	2.05	0.82	0.19	1.25

Treatments

Nitrogen or potassium experiments were carried out separately including four rates for each one. The rates were 0.0, 0.4, 0.8 and 1.2 g N or K_2O_5/pot by using ammonium nitrate (33.5 % N) as a nitrogen source or potassium sulphate (48.5%) as potassium source. Each rate was fractioned into equal six does added at weekly intervals starting from 1st April up to15th May for each season. The cutlings were irrigated with tap water two times a week and one of them received ¼ strength of standard Hoagland solution (Hoagland and Arnon, 1939) minus nitrogen or minus potassium for nitrogen and potassium experiments, respectively.

Measurements

After six weeks of starting fertilizer application, cutling were removed from plastic pots to determine the following parameters: Shoot length (cm), average leaf area (cm^2) using leaf area meter (model LI-3000), fresh and dry weight (g) of shoot and root, total root length (m) and root fineness (m/g).

Whereas, root length and root fineness was estimate according the following formulas:-

Root length = 11/14 x number of intercepts x Grid unit. By using the grid intersection method according to Tennant (1975)

Root fineness = root length (m) / root fresh weight (g), according to Ryser and lambers (1995).

Chlorophyll concentration was determined by using Spad meter 502, concentration of colorimetric for 3 fresh leaves /cutling. Root and shoot nitrogen content was determined according to Novozamsky *et al.* (1974) using spectrophotometer (6300 Jenway 6300 Visible spectrophotometer), while determination of potassium was assessed according to Temminghoff and Houba (2004) through flame apparatus.

Experimental design and Statistical analysis

Cutlings of each experiment in this study were arranged in a split plot design with three replicates in each treatment. Significant differences among treatments means were separated using LSD at 0.05 using M-Stat-C (ver. 2.10) according to Snedecor and Cochran (1989).

RESULTS

Impact of nitrogen dosage on accumulation and subsequent growth

Shoot Length: With respect to the effect of rootstock on shoot length, it was clear that shoot length of Freedom rootstock recorded significantly the longest magnitude in both seasons. Regarding the effect of N treatments, it was shown that cutlings fertilized with 0.8 or 1.2 g nitrogen rates produced significantly the longest shoots in first season. In second one all nitrogen dosages produced longer shoots than control. Concerning to interaction between rootstock and nitrogen dosages, Freedom cutlings fertilized with 0.8 in the first and the second season or 0.4 up to 1.2 g N/ pot in the second season showed the largest shoot. In the contrast, cutling of Harmony and Paulsen irrigated by tap water only without N fertilization produced the shortest shoots (Table, 2).

Shoot Dry Weight: On the average, shoot dry weight of Freedom cutlings were the heaviest compared with rest others rootstock with significant deference in the second season only. Also, Salt Creek came in the second place. Increments in shoot weight were associated with increased in N rate. With regard to the interaction, Freedom and Salt Creek under 0.4 and 0.8 gave significantly the highest dry weight in the first season compared to control while Freedom only under 0.8 or 1.2 g N/ pot in the second one recorded the highest values (Table, 2).

Average Leaf Area: Concerning the effect of rootstock on the average leaf area, Freedom only and accompanied with Salt Creek produced the highest significant leaf area in the first and second seasons respectively. Regarding the effect of nitrogen rates, all nitrogen dosage increased leaf area compared with control through two seasons (Table, 2). Concerning the effect of interaction, the presented data indicated that Freedom under all N rates produced largest significant leaf area in the first season compared to other rest rootstocks. In second season Freedom and Salt Creek recorded largest area under all N rates and this was true with Harmony and Paulsen under higher N rate (0.8 and 1.2 g N / pot).

Table 2: Response of shoot and leaf of four grapevine rootstocks to different nitrogen fertilization rates.

Rootstocks	Nitrogen rates g N/pot	Shoot length (cm)		Shoot dry weight (g)		Leaf area (cm^2)	
		2014	2015	2014	2015	2014	2015
Salt Creek	0.0	55.78	49.00	1.44	2.91	32.51	40.24
	0.4	61.44	70.33	2.15	4.11	43.43	57.54
	0.8	62.67	78.45	2.24	4.23	51.19	61.19
	1.2	61.11	76.55	1.85	4.38	46.39	62.29
Freedom	0.0	54.67	58.89	1.43	3.38	50.36	52.80
	0.4	64.44	86.89	2.50	5.47	63.92	61.99
	0.8	78.22	90.78	2.60	5.68	65.61	63.57
	1.2	69.34	89.89	1.81	6.75	61.71	63.07
Harmony	0.0	28.33	32.68	0.49	2.31	35.35	35.26
	0.4	42.89	65.55	1.78	3.23	39.66	47.76
	0.8	44.00	68.55	1.87	3.97	38.55	57.25
	1.2	45.67	80.28	1.41	4.36	42.07	58.74
Paulsen	0.0	32.33	26.10	0.68	1.65	30.71	35.79
	0.4	42.56	71.12	0.86	3.14	32.67	50.15
	0.8	46.89	76.59	1.16	3.37	42.57	58.72
	1.2	46.56	74.04	1.19	3.93	36.29	59.64
LSD at 0.5		5.019	10.31	0.5981	1.206	9.346	6.729
Rootstocks Mean	Salt Creek	60.25	68.58	1.92	3.91	43.38	55.31
	Freedom	66.67	81.58	2.09	5.32	60.40	60.36
	Harmony	40.22	61.70	1.39	3.47	38.90	49.75
	Paulsen	42.08	61.98	0.97	3.02	35.56	51.08
LSD at 0.5		5.951	9.097	n.s	1.74	10.80	8.312
Nitrogen rates Mean	0.0	42.78	41.68	1.01	2.56	37.23	41.02
	0.4	52.83	73.44	1.82	3.99	44.92	54.36
	0.8	57.94	78.52	1.97	4.31	49.48	60.18
	1.2	55.67	80.19	1.56	4.86	46.61	60.94
LSD at 0.5		5.019	10.31	0.5981	1.206	9.346	6.729

*** Values shown are average and standard deviation, within each column.**

Root Dry Weight: Root dry weight was affected significantly by grapevines rootstocks. In this respect, the data reveal that Salt Creek and Freedom recorded the highest significant dry weight in the 1st season and Freedom in 2nd one while Paulsen recoded the lowest significant weight during both seasons. Also, the data showed significant difference in root dry weight as a result of applying N-rates during both seasons. The highest root dry weight was recorded under N application at 0.8 g N/pot. In addition such increment was pronounced when the interaction between N-rate and grapevines rootstocks was considered, the highest root dry weight was observed under 0.8 g N/pot with Salt Creek and Freedom with significant differences when compared with the other treatments in the first and second seasons, respectively (Table, 3).

Root Length: Data in Table 3 clearly indicate that, Freedom recorded the significant longest root in comparison with other rootstock. However, root length was increased by applying N fertilizer in comparison with control. Under 0.80 g N/pot in both seasons, Freedom recorded significantly the longest root. The lowest value recorded with Paulsen in first season and in second with Paulsen and Harmony under control treatment (Table, 3).

Root Fineness: Regarding the effect of rootstock, there no difference recorded between rootstocks. Under nitrogen fertilization, no significant difference was occurred in first season, while in second one cutlings of control has the thickness root (Table, 3).

Table 3: Responses of four grape rootstocks roots to different nitrogen fertilization rates.

Rootstocks	Nitrogen rates g N/pot	Root dry weight (g)		Root length (m)		Root fineness m/g	
		2014	2015	2014	2015	2014	2015
Salt Creek	0.0	1.04	1.50	26.72	28.45	6.68	4.64
	0.4	1.31	1.86	29.53	38.85	5.68	5.14
	0.8	2.19	1.90	33.21	47.33	3.91	6.11
	1.2	1.36	1.78	38.86	36.43	7.96	5.02
Freedom	0.0	0.98	1.64	33.43	30.58	8.58	4.56
	0.4	1.45	2.42	42.57	62.34	7.44	6.37
	0.8	1.51	2.69	53.29	71.67	8.94	6.64
	1.2	1.38	1.84	40.76	52.33	7.44	7.01
Harmony	0.0	0.63	1.25	23.51	23.42	9.18	4.62
	0.4	0.73	1.49	29.03	39.51	10.34	4.62
	0.8	0.91	1.66	34.05	44.67	9.33	6.59
	1.2	1.12	1.67	31.44	42.33	7.06	6.21
Paulsen	0.0	0.41	1.01	14.41	22.92	8.45	5.52
	0.4	0.51	1.31	19.79	31.94	9.49	6.01
	0.8	0.66	1.57	23.76	38.33	9.52	5.99
	1.2	0.51	1.57	24.04	40.00	10.66	6.24
LSD at 0.5		0.285	0.1410	7.983	5.240	2.401	0.9622
Rootstocks Mean	Salt Creek	1.48	1.76	32.08	37.77	6.06	5.23
	Freedom	1.33	2.15	42.51	54.23	8.10	6.15
	Harmony	0.85	1.52	29.51	37.48	8.98	5.97
	Paulsen	0.52	1.36	20.50	33.30	9.53	5.94
LSD at 0.5		0.509	0.2895	7.844	5.718	n.s	n.s
Nitrogen rates Mean	0.0	0.77	1.35	24.52	26.34	8.22	4.83
	0.4	1.00	1.77	30.23	43.16	8.24	6.00
	0.8	1.32	1.96	36.08	50.50	7.93	6.33
	1.2	1.09	1.72	33.78	42.48	8.28	6.12
LSD at 0.5		0.285	0.1410	7.983	5.240	n.s	0.9622

*** Values shown are average and standard deviation, within each column.**

Leaf Chlorophyll Concentration: The data in Table 4 disclosed that, there was non-significant difference in average leaf chlorophyll concentration between four rootstocks. Significant effect appeared due N treatments. Furthermore, nitrogen fertilization from 0.4 up to 1.2 or from 80 up to 1.2 g/pot in two seasons respectively showed the highest concentration of chlorophyll in leaf tissues. During both seasons all rootstocks appeared statistically the highest leaf chlorophyll content under 0.8 to 1.2 N rate except Harmony under 120 N rate.

Root and Shoot Nitrogen Content: As for the average root nitrogen content (Table, 4), no significant differences between four rootstocks were attained during both seasons. While Freedom and Salt Creek contained significantly the highest shoots N content. Increasing in N rate was accompanied with increasing root and shoot nitrogen content. Moreover, the highest N rates 0.8 or 1.2 g N/ pot gave the highest content of N in both organs. With regard to the interaction between rootstocks and N-dosages, shoot nitrogen content of Freedom with 1.2 g N in first season and Freedom as well as with Salt Creek in the second season gave the highest significant shoot nitrogen content under 0.8 and 1.2 g/pot.

Table 4: Responses of four grape rootstocks chlorophyll concentration and nitrogen content to different nitrogen fertilization rates.

Rootstocks	Nitrogen rates g N/pot	Leaf chlorophyll concentration (spad)		Shoot nitrogen content (%)		Root nitrogen content (%)	
		2014	2015	2014	2015	2014	2015
Salt Creek	0.0	26.10	24.67	2.63	2.67	2.59	2.65
	0.4	28.00	33.38	3.33	3.40	3.29	3.35
	0.8	30.43	33.83	3.53	3.83	3.57	3.87
	1.2	31.80	34.18	3.53	3.90	3.52	3.87
Freedom	0.0	28.47	25.21	2.79	2.81	2.70	2.75
	0.4	28.87	29.55	3.36	3.62	3.24	3.59
	0.8	32.97	31.14	3.73	3.87	3.65	3.80
	1.2	32.00	33.27	3.94	3.96	3.80	3.88
Harmony	0.0	28.20	22.25	2.31	2.36	2.75	2.54
	0.4	29.83	30.06	3.20	3.32	3.58	3.60
	0.8	27.30	32.89	3.49	3.55	3.83	3.77
	1.2	30.37	33.45	3.56	3.65	4.02	3.87
Paulsen	0.0	28.63	22.15	2.46	2.45	2.85	2.66
	0.4	27.53	31.13	3.11	3.22	3.23	3.47
	0.8	30.87	31.67	3.47	3.43	3.79	3.72
	1.2	31.23	32.39	3.58	3.64	3.77	3.80
LSD at 0.5		2.979	1.875	0.1994	0.1767	0.25	0.1846
Rootstocks means	Salt Creek	29.08	31.51	3.26	3.45	3.25	3.40
	Freedom	30.58	29.79	3.45	3.57	3.35	3.50
	Harmony	28.92	29.66	3.14	3.22	3.55	3.45
	Paulsen	29.57	29.34	3.14	3.18	3.41	3.41
LSD at 0.5		n.s	n.s	0.3030	0.2447	n.s	n.s
Nitrogen rates mean	0.0	27.85	23.57	2.55	2.57	2.72	2.65
	0.4	28.56	31.03	3.25	3.39	3.34	3.50
	0.8	30.39	32.38	3.56	3.67	3.71	3.77
	1.2	31.35	33.32	3.65	3.79	3.78	3.86
LSD at 0.5		2.979	1.875	0.1994	0.1767	0.25	0.1846

*** Values shown are average and standard deviation, within each column.**

Impact of potassium dosage on accumulation and subsequent growth

Shoot Length: In general, Freedom cutlings produced significantly the longest shoots in both seasons. Zero applied K produced the shortest shoot while the shoot length was enhanced by increasing K rates. However, under

K application from 0.4 up to 1.2 g/pot Freedom recorded significantly the longest shoot (Table, 5).

Shoot Dry Weight: generally, Freedom rootstock produced the heaviest shoot dry weight in comparison with rest other rootstocks. But the effect of K dosages was insignificant. Further the interaction effect showed that, Freedom under the highest rates of K (0.8 or 1.2 g/pot) recorded the heaviest dry weight with significant differences with Paulsen only in both seasons (Table, 5).

Leaf Area: Freedom cutlings had significantly showed the largest leaves. As comparison with control, potassium fertilization had significant effect on leaf area. The highest K dose produced the largest leaf. The interaction effect revealed that, Freedom under 0.4 up to 1.2 g K gave the largest leaf. The same results obtained with Salt Creek under the highest K rate in the second season with significant differences compared to Paulsen rootstock in both seasons. However, Paulsen and Harmony produced the lowest leaf area under zero K fertilizer rate (Table, 5).

Table 5: Response of shoot and leaf of four grapevine rootstocks to different potassium fertilization rates.

Rootstocks	Potassium rates g K_2O/pot	Shoot height (cm)		Shoot dry weight (g)		Leaf area (cm^2)	
		2014	2015	2014	2015	2014	2015
Salt Creek	0.0	57.22	58.44	1.73	2.49	49.13	48.16
	0.4	61.94	74.33	1.93	2.98	52.56	54.39
	0.8	65.00	74.56	1.97	2.94	54.07	53.23
	1.2	68.00	83.78	1.96	2.95	58.76	56.74
Freedom	0.0	63.22	78.44	2.10	3.10	56.42	51.55
	0.4	70.78	92.56	2.31	3.75	63.38	55.09
	0.8	75.33	94.00	2.83	3.83	63.95	58.88
	1.2	75.57	93.33	2.31	3.85	67.83	62.37
Harmony	0.0	47.14	64.45	1.52	2.43	30.21	43.13
	0.4	55.00	68.78	1.82	2.66	33.38	45.90
	0.8	60.11	71.33	1.83	2.74	34.74	45.49
	1.2	62.86	72.33	1.84	2.73	37.25	51.25
Paulsen	0.0	43.55	59.44	0.80	1.14	27.96	39.56
	0.4	49.11	64.56	1.05	1.49	30.25	42.63
	0.8	54.21	67.67	1.09	1.64	34.06	43.96
	1.2	55.67	68.56	0.90	1.63	39.28	46.30
LSD at 0.5		10.32	8.660	0.3806	0.6005	8.467	7.367
Rootstocks Mean	Salt Creek	63.04	72.78	1.90	2.84	53.63	53.13
	Freedom	71.23	89.58	2.39	3.73	52.90	56.97
	Harmony	56.28	69.22	1.75	2.64	33.89	46.44
	Paulsen	50.64	65.06	0.98	1.47	32.89	43.11
LSD at 0.5		6.594	13.78	0.346	1.135	8.384	10.67
Potassium rates mean	0.0	52.78	65.19	1.56	2.29	40.93	45.60
	0.4	59.21	75.06	1.78	2.72	44.89	49.50
	0.8	63.66	76.89	1.93	2.79	46.70	50.39
	1.2	65.52	79.50	1.75	2.79	50.78	54.17
LSD at 0.5		10.32	8.660	n.s	n.s	8.467	7.367

*** Values shown are average and standard deviation, within each column.**

Root Dry Weight: As for the average root dry weight, Freedom and Salt creek rootstocks recorded the heaviest root weight while Paulsen produced the lightest weight. All K rates were insignificantly deferent in this parameter with slight increase in root weight by adding K in comparison with zero rate (control). As well as shoot dry weight, Freedom under highest K rate disclosed the highest root dry weight with a significant differences compared to Harmony and Paulsen rootstocks under all K rates in both seasons (Table, 6).

Root Length: In comparison with the rest of the rootstocks, Freedom cutling had significant longest roots in the two seasons flowed by Salt Creek. In general K application had no significant effect on this parameter in first season while in second one the highest rates 0.8 and 1.2 produced the longest significant roots. Freedom recorder the longest root under 0.4 in the first season and with 0.8 g K_2O/ pot in second one (Table, 6).

Root fineness: Paulsen recorded the highest root fineness then other rootstocks came in the second place in first season. In second one, no significant differences were occurred between rootstocks. As for the impact of K fertilization rates, it had no significant effect showed in both seasons. Paulsen cutlings under K dosages at 0.4 and 0.8 in first season recoded the significant highest root fineness. In second one Freedom and Paulsen recorded the significant value with 0.4 up to 1.2 potassium dosages and Harmony with 0.8 and 1.2 dosages (Table, 6).

Table 6: Responses of four grape rootstocks roots to different potassium fertilization rates.

Rootstocks	Potassium rates g K_2O/pot	Root dry weight (g)		Root length (m)		Root fineness (m/g)	
		2014	**2015**	**2014**	**2015**	**2014**	**2015**
Salt Creek	0.0	0.55	1.74	17.44	26.28	7.10	3.82
	0.4	0.87	1.92	19.21	28.81	6.10	4.02
	0.8	0.86	2.01	19.33	33.94	5.81	4.18
	1.2	0.85	1.97	19.07	35.81	5.89	4.67
Freedom	0.0	0.81	1.71	22.47	38.87	7.22	5.24
	0.4	0.83	2.17	29.15	44.98	6.73	5.40
	0.8	1.12	2.19	22.66	53.92	7.20	6.35
	1.2	0.93	2.41	23.62	46.46	6.66	5.87
Harmony	0.0	0.53	1.11	15.06	23.29	6.07	4.14
	0.4	0.54	1.23	16.46	25.01	8.70	5.22
	0.8	0.54	1.28	17.68	31.92	8.44	6.61
	1.2	0.60	1.52	16.38	24.45	7.30	5.29
Paulsen	0.0	0.24	0.80	8.45	13.14	9.28	4.11
	0.4	0.29	0.89	8.98	22.96	11.85	6.55
	0.8	0.31	1.05	9.89	23.20	10.36	5.62
	1.2	0.34	1.14	10.14	25.67	8.64	5.81
LSD at 0.5		0.226	0.6461	2.733	4.892	1.963	1.342
Rootstocks Mean	Salt Creek	0.78	1.91	18.76	31.21	6.22	4.17
	Freedom	0.93	2.12	24.48	46.06	6.95	5.71
	Harmony	0.55	1.29	16.39	26.17	7.63	5.32
	Paulsen	0.29	0.97	9.36	21.24	10.03	5.52
LSD at 0.5		0.155	0.9828	2.555	4.899	1.810	n.s
Potassium rates Mean	0.0	0.53	1.34	15.86	25.39	7.42	4.33
	0.4	0.63	1.55	18.45	30.44	8.34	5.30
	0.8	0.71	1.63	17.39	35.74	7.95	5.69
	1.2	0.68	1.76	17.30	33.10	7.12	5.41
LSD at 0.5		n.s	n.s	n.s	4.892	n.s	n.s

*** Values shown are average and standard deviation, within each column.**

Leaf Chlorophyll Concentration: As for the leaf chlorophyll concentration, it was not significantly altered due to the rootstocks or K treatment (Table, 7).

Root and Shoot Potassium Content: In general Freedom rootstock flowed by Harmony recorded the highest value of shoot and root potassium content while Paulsen recorded the lowest K-content with significant difference in both seasons. With regard to the effect of K treatments, shoot and root content increased significantly by increasing K rate. Furthers the highest K rate (1.2g/pot) recorded the highest K shoot content while that is true with 0.8 and 1.2 in root. Freedom and Harmony recorded the highest significant shoot or root K content under the highest K dosages. In contrast Salt Creek and Paulsen rootstock recorded the lowest content especially under zero K application (Table, 7).

Table 7: Responses of four grape rootstocks chlorophyll concentration and potassium content to different potassium fertilization rates.

Rootstocks	Potassium rates g K_2O/pot	Chlorophyll (spad)		Shoot potassium content (%)		Root potassium content (%)	
		2014	2015	2014	2015	2014	2015
Salt Creek	0.0	28.87	32.60	0.87	0.90	0.51	0.76
	0.4	29.1	33.32	1.77	1.80	0.89	1.22
	0.8	30.27	32.05	2.02	2.14	1.04	1.47
	1.2	29.87	32.83	2.65	2.44	1.21	1.60
Freedom	0.0	29.37	31.96	1.75	1.84	0.87	1.48
	0.4	30.33	33.49	2.06	2.23	1.44	1.78
	0.8	29.9	32.91	2.39	2.46	1.49	1.92
	1.2	31.00	31.37	2.57	2.60	1.68	2.12
Harmony	0.0	28.07	31.39	1.61	1.68	0.74	0.96
	0.4	30.13	33.53	1.78	1.74	1.21	1.44
	0.8	28.87	31.91	2.00	2.07	1.34	1.65
	1.2	29.63	32.57	2.46	2.50	1.59	1.85
Paulsen	0.0	28.17	30.59	1.12	1.16	0.41	0.63
	0.4	30.17	31.22	1.33	1.43	0.73	0.77
	0.8	30.8	31.72	1.53	1.54	0.88	1.12
	1.2	30.53	31.35	1.92	2.03	1.57	1.37
LSD at 0.5		2.250	2.698	0.282	0.3197	0.373	0.250
Rootstocks Mean	Salt Creek	29.52	32.70	1.83	1.82	0.91	1.26
	Freedom	30.15	32.43	2.19	2.28	1.38	1.83
	Harmony	29.17	32.35	1.96	2.00	1.22	1.48
	Paulsen	29.92	31.22	1.48	1.54	0.89	0.97
LSD at 0.5		n.s	n.s	0.3791	0.3684	0.475	0.3791
Potassium rates Mean	0	28.62	31.64	1.34	1.40	0.64	0.96
	0.4	29.93	32.89	1.74	1.80	1.07	1.30
	0.8	29.96	32.15	1.99	2.05	1.19	1.54
	1.2	30.26	32.03	2.40	2.39	1.51	1.74
LSD at 0.5		n.s	n.s	0.282	0.3197	0.373	0.250

*** Values shown are average and standard deviation, within each column.**

DISCUSSION

As general trend, under nitrogen or potassium experimental treatments, Freedom grapevine rootstock flowed by Salt Creek recorded the highest value of vegetative parameters while Paulsen came in the least. This result is due to the vigration effect of these rootstocks. However, grapevines varieties or rootstocks differ in it vigor, whereas Sourial et al. (2004), cleared that transplants of Dograide grape had longer shoot length than Thompson Seedless transplant. Also, Nikos *et al.* (2004) and Fallahi *et al*. (2005) noted that area of leaf was different between grape genotype and it could be attributed to the differences of vigor between cultivars.

Furthermore, the results appeared that root parameters of rootstocks varied and Freedom followed by Salt Creek produced the heaviest root dry weight as well as the longest roots. In this regard, it was found that grapevines varied in total root length (Sourial *et al.,* 2004; Salem *et al.,* 2007). Moreover Sourial *et al.* (2004) and El-Shahat *et al.* (2006), showed that root weight of ARG1 were higher than other grape rootstocks evaluated. Also, Freedom and 101-14 rootstocks had significantly higher total root length compared with that of Ramsey (Salt Creek) and Schwarzmann, while Freedom also had significantly higher total root surface area than did Ramsey (Kodur *et al.,* 2010). Further the superiority of Freedom in vegetative parameters was associated with its superiority in root dray weight and length. That helped in enhanced water and nutrient absorption which produced the highest vegetative parameters. Also, roots are the main site of cytokinin-like compound synthesis (Short and Torrey, 1972) which in turn reflects in its vigor.

Under nitrogen experiment, shoot and root parameters were enhanced with increasing N rate. Generally, shoot growth was increased by increasing N application (Bavaresco *et al.,* 2001). In addition increased N fertilization resulted in the greatest shoot length and dry weight of grapevines transplant (Shawky *et al.,* 2004; Salem *et al.,* 2007). Furthermore, increasing N application rate from 0 to 150 mg/pot increased root weight (Ali *et al.,* 1999). Also root length of grapevines was enhanced by nitrogen application (Salem *et al.,* 2007). That was due to the role of nitrogen in plants since nitrogen is an important constituent of the protein of all plant parts and is part of the chlorophyll molecule’s structure. Photosynthesis depends on the function and coordination of many proteins and enzymes, which account for the majority of N in leaves (Chen and Cheng, 2003).

All rootstocks under this study appeared similar statically their roots nitrogen content. While Freedom and Salt creek contain significantly the highest shoots N content. This may be that, all rootstock have the same efficiency of uptake N from soil but Freedom and Salt creek were more efficiency for transport N to upper ports (shoots) of cutling. That is in line with Christensen and Peacock (2000). They reported that Freedom rootstock is known to increase the N status of grafted varieties. The highest of N content which recorded in Freedom then in Salt Creek associated with them had a large root system. Roots are the main part producing cytokinins (Short and Torrey, 1972). Also, the elevated concentrations of exudate-cytokinins was associated with high levels of total nitrogen content (Sattelmacher and Marschner, 1978)

However, the highest nitrogen content was in grape varieties grafted onto ‘Salt Creek’ compared to those grafted into Harmony’ and un-grafted one (Ibacache and Sierra, 2009; Desouky *et al.,* 2015). Also, vigorous grapevines rootstocks are more able of finding the nutrients from the surrounding soil (Singh, 2006). However the mineral content of the grape scion varieties which grafted is the combined result of the ability of rootstock root system’s to absorb nutrients and the scion’s ability to translocate and accumulate those (Shaffer *et al.,* 2004). A vine grafted onto the vigorous nematode-resistant rootstocks Freedom, Salt Creek, and Harmony had lower requirements for N. That is due to their more vigorous root systems.

Under potassium experiment, the results concluded that the highest value of shoot and root potassium content recorded by Freedom flowed by Harmony. This cam in line with Rühl (1989) and Kodur *et al.* (2010) they noticed that, K uptake and accumulation into the roots and shoots of grapevine depends on the type of rootstock. Uptake of K differs among rootstocks and these variations could be caused by differences in the capacity of absorption of the roots and/or differences in the incorporation of K into the xylem and their translocation from the roots up to shoots (Mpelasoka *et al.,* 2003). Kodur *et al.* (2010) suggest that Freedom takes up K more efficiently from the soil and accumulates more K in the shoot. Furthermore, Rizk-Alla *et al.,* (2011) found that Salt Creek had an intermediate performance for the K uptake, while Freedom ranked among the highest efficient stocks in potassium uptake as compared to own-rooted vines. Also, Freedom had highest total K uptake in comparison with Schwarzmann, Salt Creek, 1103 Paulsen, 110 Richter, 140 Ruggeri and 101-14grape rootstocks. While vines grafted on Salt Creek had lower K content in comparison with vines grafted onto Harmony' and '1613C'. Further, Freedom showed a higher content of K in the shoot compared with that in 1103 P and Ramsey. In addition Freedom showed higher content of K in roots than did 1103 P (Kodur *et al.,* 2010). Recently El-Gendy (2013) found that Flame Seedless grafted into Freedom rootstock ranked the highest efficient stocks in potassium uptake compared to Salt Creek rootstocks.

In conclusion, nutrients uptake were increased with total root length and root surface area (Kodur *et al.,* 2010). The current study highlights the positive impact of root based factors in the uptake and accumulation of N and K. Whereas, Freedom rootstock superiority in root parameter especially root weight and length lead to superiority in plant N and K content.

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الامتصاص والاستفادة من النتروجين والبوتاسيوم لأربعة أصول من العنب

محمد عبد العزيز عبد المحسنوأحمد عبد الهادى رشيدى
قسم بساتين الفاكهة – كلية الزراعة – جامعة القاهرة

اجريت هذه الدراسة خلال موسمى ٢٠١٤، و ٢٠١٥ فى تجربتين من الأصص على أربعة أصول من العنب وهى سولت كريك، وفريدم، وبولسن، و هارمونى،(Salt creek, Freedom, Paulsen, Harmony) مزروعة بالصوبة السيران التابعة لقسم بساتين الفاكهة، كلية الزراعة، جامعة القاهرة- مصر. وذلك لدراسة كفاءة تلك الاصول على إمتصاص النتروجين والبوتاسيوم، وأثر ذلك على نموها. وقد تم استخدام أربعة معدلات وهى (صفر، 0.4، 0.8، 1.2 جم/اصيص) لكل من النتروجين والبوتاسيوم فى تجربتين منفصلتين حيث تم اضافة المعدلات على ٦ دفعات متساوية اسبوعيا.

وقد أوضحت النتائج أن أصل العنب الفريدم حقق أفضل مقايس نمو فيما يتعلق بطول النبات، والوزن الجاف للجذور وطولها، تلاه الأصل السولت كريك، وذلك خلال موسمى التجربة.علاوة على ذلك فقد سجل الاصل الفريدم اعلى قيم معنوية لكل من طول النبات والجذور خلال التجربتين والموسمين مقارنة بباقى الاصول تحت الدراسة، كما سجل ايضا أعلى قيم معنوية لمساحة الورقة خلال الموسم الأول فى كلا التجربتين. علاوة على ذلك فقد احتوى الأصل الفريدم على أعلى محتوى للنتروجين والبوتاسيوم. وفيما يتعلق بمعدلات الاضافة فإن استخدام معدلى ٨٠، ١٢٠ ملجم/كجم تربة سجل أعلى قيم للنمو، وتركيز الكلوروفيل، والمحتوى من النتروجين والبوتاسيوم.

هذه الدراسة تلقى مزيدا من الضوء على ميزة إضافية لأصل العنب الفريدم فى امتصاص النتروجين والبوتاسيوم اضافة لمقاومته للنيماتودا.