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ONION CROP RESPONSE TO NITROGEN AND POTASSIUM FERTIGATION AND SOIL APPLICATION

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ABSTRACT: This work was about the response of onion *(Allium cepa L.)* crop to nitrogen and potassium fertigation compared to soil application frequencies at different levels of N and K_2O; i.e., 60 kg N + 75 kg K_2O, 80 kg N + 100 kg K_2O and 100 kg N + 125 kg K_2O/fed* under sandy soil conditions. This work was carried out during the two winter seasons of 2000/2001 and 2001/2002, at El-Khattara Experimental Farm, Fac. Agric., Zagazig University.

The results, generally, indicated that fertigation method significantly increased the dry weight of different parts of onion plant; i.e., roots, leaves, bulb and whole plant, chlorophylls and carotenoids concentration in leaves and uptake of N, P and K as well as yield and its components; i.e., total, marketable, exportable and grades (I and II) compared to soil application method.

Fertigation of the highest dose of combined N + K_2O (100 kg N + 125 kg K_2O/fed) being the best treatment which significantly increased all the above mentioned parameters; i.e., dry weight, chlorophyll and carotenoides, NPK uptake and yield and its components compared to low dose of fertilizers; i.e. 60 kg N + 75 kg K_2O/feddan.

Key words: Onion, fertigation, soil application, nitrogen and potassium fertilizers, dry weight, yield and its components.

INTRODUCTION

It has bean proved, particularly in recent time, that for reaching maximum utilization efficiency of fertilizer and further increases of yields of vegetable crops under sandy soil conditions, it can be achieved by possible means such as fertigation frequencies, suitable fertilizers and adequate quantity of irrigation water. The advantage of fertigation technique are reducing the amount of fertilizer and interval between application through this technique to maintain uniform level of nutrients and to control the nutrient supply in the soil in accordance with changing

* feddan = 4200 m^3

plant needs during the growth season (Sterling, 1983). He added that adding nutrients such as nitrogen and potassium are easily to be applied through drip irrigation, whereas, phosphorus is not usually recommended for application.

Application of fertilizers through drip irrigation system (Fertigation) reduced leaching of added fertilizer (Janings and Martin, 1990). Generally, the shorter the fertigation frequency, the greater the dry matter of tomato vegetative parts. However, this could not be generalized, data given showed that such behaviour, was to some extent, governed by the application timing as well as by quantity applied (Nader, 1991). Fertigation technique improved plant growth (Abd El-Razek, 1996 on peas; Chopade *et al.*, 1997 on onion) and increased yield of different parts (Hamdy, 1991 on tomato ; Abd-El-Razek, 1996 on peas; Badwi, 1999 on potato); and El-Haris and Abd El-Razek (1997) indicated that the growth characters and yield and its components of onion were improved with fertigation method compared to traditional soil fertilizer application.

High nitrogen rate (90 kg/ fed.) promoted total bulb yield, yield of culls and percentage of doubles, whereas, it suppressed percentage of singles and pickles of onion (Farag and Koriem, 1990). Application of 120 kg / N/fed. increased plant growth, bulb yield and yield components (El-Gamili *et al.*, 2000). Applied N significantly increased vegetative growth and yield parameters of garlic (El-Seifi *et al.*, 2004). Application of 80 kg K_2O/ha significantly increased onion average weight and diameter of bulb (Nagaich *et al.*, 1999). Nitrogen combined with potassium fertilizer increased the growth of different organs of onion plant (El-Gamili and Abd El-Hadi, 1996). Increasing K fertilizer (0-240 kg/ha) increased onion yield (Guo *et al.*, 1999).

In addition, the combination of N+ K_2O significantly increased total yield of onion bulb (El-Gamili and Abd El-Hadi, 1996; Gaviola *et al.*, 1998).

The object of this work was to study the effect of N and K_2O fertigation compared to soil application on onion growth, pigments, NPK uptake and yield and its components in sandy soil under drip irrigation system.

MATERIALS AND METHODS

Two field experiments were carried out in new reclaimed sandy soil at El-Khattara Experimental Farm, Fac. Agric., Zagazig University in 2000/2001 and 2001/2002 seasons, under drip irrigation system.

Table 1: The physical and chemical properties of the experimental soil field

Physical properties (%)	2000 /2001 season	2001 /2002 season	Chemical properties	2000 /2001 season	2001 /2002 season
Sand	94.86	93.41	Organic matter %	1.46	1.54
Silt	2.76	3.53	Available K (ppm)	55.39	52.73
Clay	2.38	3.06	Available P (ppm)	13.34	12.97
Water holding capacity	14.10	14.70	Available N (ppm)	11.21	11.87
Field capacity	7.90	7.50	Total N %	0.12	0.13
Wilting point	2.60	2.30	$CaCo_3$ %	0.24	0.28
Available water	4.8	4.8	pH	7.97	7.8
Texture	Sandy	Sandy	E.C.dsm^{-1}	2.21	2.21

Samples of the soil were obtained from 25 cm soil surface

Table 2: Analysis of irrigation water

Characters		Values
EC	dsm^{-1}	1.42
pH		8.02
Ca^{++}	(mol/L.)	1.21
Mg^{++}	(mol/L.)	1.08
Na^{+}	(mol/L.)	12.20
K^{+}	(mol/L.)	0.12
$SO4^{--}$	(mol/L.)	1.44
CO_3^{--}	(mol/L.)	0.00
Cl^{-}	(mol/L.)	5.79
HCO_3	(mol/L.)	7.38

The physical and chemical analysis of soil and chemical analysis of irrigation water are shown in Tables 1 and 2, respectively.

The experiment included six treatments which were the combinations of two methods of fertilizer application; i.e. soil application and fertigation and three rates of combined N + K fertilizers as follows:

1. 60 kg N + 75 K_2O/fed.
2. 80 kg N + 100 kg k_2O/fed.
3. 100 kg N + 125 kg k_2O/fed.

The split plot design with four replicates was followed. The application methods were arranged in main plots, while, rates of fertilizers were arranged in sub plots. The area of sub plot ($10.8m^2$) contains one dripper irrigation line with 18m length and 60cm in width. The dripper lines were with discharge of 2.5 l/hr for each dripper at one bar.

Seeds of onion *cv* Giza 20 were sown in nursery on Nov. 20^{th} and 5^{th} in the first and second season, respectively and transplanted at 10cm apart on both sides of the

dripper line on January 20th and 5th in 2000/2001 and 2001/2002 seasons, respectively.

Farmyard manure at a rate of 30 m^3/fed. was applied during soil preparation. Ammonium sulphate (20.6% N) and potassium sulphate (48.52% K_2O) were used as sources of N and K fertilizers, respectively. One fourth of mineral fertilizers (N and K) was added as soil application during soil preparation time in the center of rows and coved with sand. The rest amount of both nitrogen and potassium fertilizers were divided into 10 equal portions, and added as soil application or through irrigation water (fertigation) every 7 days by beginning 25 days after transplanting. In addition, phosporus fertilizer was added at a rate of 50 kg P_2O_5 per faddan as calcium super phosphate (15.5% P_2O_5); 50% of this amount was added preplanting, while the other amount (50%) was added as phosphoric acid (85% P_2O_5) and splitted in equal doses and added at the same time with N and K in irrigation water.

In addition, all standard cultural practices of planting onion were carried out as commonly used in the district.

At 120 days after transplanting, a random sample of 5 plants was taken from each sub plot and the following data were recorded:

1.Plant growth

Plant growth was determined as plant height, number of leaves, neck and bulb diameter, bulbing ratio and dry weight of different organs of plant; i.e., roots, leaves, bulb and whole plant.

2.Photosynthetic pigments

Chlorophyll a, b and total chlorophyll as well as carotenoids were determined colorimetrically according Wettestein method (1957).

3. Plant nutritional status

Total nitrogen, phosphorus and potassium in different plant parts were determined according to the methods described by Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1970), respectively.

4. Yield and its components

Plants were harvested when 75% of plant tops were down and bulbs were weighed and the following data were recorded:

1.Bulb grades, namely grade 1 (bulbs with diameter more than 6cm.), grade 2 (bulbs with diameter between 4.5 - 6 cm.), grade 3 (bulbs with diameter between 3.5 - 4.5cm.) and grade 4 (bulbs with diameter less than 3.5cm.) were recorded according to specification laid down by the Ministry of Economic for onion exportation (1963).

2.Marketable yield of bulbs (ton/fed.); weight of grade 1+ grade 2 + grade 3.
3.Exportable yield of bulbs (ton/fed.); weight of grade 1 + grade 2.
4.Total yield of bulbs (ton/fed.): weight of grade 1+ grade 2 + grade 3 + grade 4.

Statistical analyses were done as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

I. Plant Growth

1.Effect of application method

Presented data in Table 3 show significant difference between the two application methods (fertigation and soil application) for all the studied items; i.e., plant height, number of leaves/ plant, both neck and bulb diameter as well as dry weight of different plant organs after 120 days from transplanting in both growing seasons. Whereas, the maximum values in this respect were more achieved by using fertigation method compared to soil application method.

The promoting effect of fertigation method on the vegetative growth characters of onion plant might be due to the following reasons: fertilizer availability is fitted to nutritional needs of the plant during its growth cycle; fertilizers elements already in solution become available to the plant roots faster than when placed dry in the soil, and to high uniformity of fertilizers distribution which improved the efficiency of fertilization, as apposed to the traditional method (Sterling, 1983 came to similar conclusion).

These results are in harmony with those reported by Bakker *et al.*(1984) on lettue, Nader (1991) on tomato, Abd El - Razek (1996) on peas and Chopade *et al.* (1997) on onion. They indicated that application of fertilizers through irrigation water (fertigation) in hanced plant growth.

2.Effect of N+K_2O fertilizers rate

The results in Table 3 show significant differences among the three levels of combined N and K fertilizers at 120 days after transplanting for all the studied characters, except for number of leaves and bulbing ratio in second season. Moreover, there were graduall and consistent increases with increasing the dose of the added combined N and K fertilizers up to the highest used level; i.e., 100 kg N+125 kg K_2O/ feddan, In spite of that, in most cases, there was no significant differences between the medium dose (80 kg N + 100 K_2O/ fed.) and the highest dose (100 kg N +125 kg K_2O / fed.).

Results suggested also that the application of the low and medium levels of combined N and K fertilizers; i.e. 60 kg N+75 K_2O

Table 3: Effect of application method, N + K_2O fertilizers rates and their interaction on the growth characters of onion plants

Treatments / Characters	Plant height (cm)	Number of leaves / plant	Diameter (cm) Neck	Diameter (cm) Bulb	Bulbing ratio	Dry weight / plant Root	Dry weight / plant Leaves	Dry weight / plant Bulb	Dry weight / plant Total	Plant height (cm)	Number of leaves / plant	Diameter (cm) Neck	Diameter (cm) Bulb	Bulbin ratio	Dry weight / plant Root	Dry weight / plant Leaves	Dry weight / plant Bulb	Dry weight / plant Total
Application methods X N+K2O rates (kg/fed	2000 - 2001 season									2001 - 2002 season								
Soil application 60+ 75	48.35	6.70	0.85	4.00	0.21	0.18	2.05	5.08	7.31	56.83	8.40	1.45	5.26	0.27	0.27	2.56	8.37	11.21
80+100	49.50	7.45	0.94	4.17	0.22	0.26	2.14	5.27	7.67	56.02	8.53	1.55	5.78	0.26	0.23	3.04	8.13	11.41
100+125	51.45	7.95	1.04	4.30	0.24	0.20	2.71	7.49	10.40	58.45	8.53	1.48	5.60	0.26	0.31	2.86	9.42	12.60
Mean	49.76	7.36	0.94	4.16	0.22	0.21	2.30	5.95	8.46	57.10	8.48	1.49	5.55	0.27	0.27	2.82	8.64	11.74
Fertigation 60+ 75	51.25	8.15	1.00	4.68	0.24	0.23	2.84	6.39	9.46	57.50	10.03	1.58	5.53	0.28	0.42	3.04	9.62	13.08
80+100	53.20	8.46	1.04	4.61	0.25	0.24	3.11	7.35	10.70	59.70	10.20	1.85	5.88	0.31	0.46	3.12	9.44	13.02
100+125	54.10	9.00	1.19	5.26	0.25	0.27	3.36	7.98	11.61	63.36	10.40	1.83	6.40	0.28	0.47	3.41	10.71	14.60
Mean	52.85	8.53	1.08	4.85	0.24	0.24	3.10	7.24	10.59	60.18	10.21	1.75	5.94	0.29	0.45	3.19	9.92	13.57
Mean values of N+K_2O rates																		
60+ 75	49.80	7.42	0.92	4.34	0.22	0.20	2.44	5.74	8.39	57.16	9.21	1.52	5.39	0.28	0.34	2.80	8.99	12.15
80+100	51.35	7.95	0.99	4.30	0.23	0.25	2.63	6.31	9.19	57.86	9.36	1.70	5.83	0.29	0.34	3.08	8.78	12.22
100+125	52.77	8.47	1.11	4.78	0.24	0.23	3.04	7.74	11.01	60.90	9.46	1.65	6.00	0.27	0.39	3.13	10.07	13.60
L.S.D at 0.5 level																		
Application methods	2.42	1.08	0.13	0.42	0.02	0.02	0.10	0.84	0.85	3.01	0.94	0.13	0.28	0.02	0.05	0.10	1.09	1.01
N + K_2O rates	2.73	1.05	0.19	0.41	0.02	0.03	0.45	1.45	1.90	2.89	N.S.	0.17	0.59	N.S.	N.S.	0.12	0.71	1.40
Interaction (methods X N + K_2O)	3.87	1.62	0.28	0.72	N.S.	0.04	0.64	2.07	2.71	4.09	0.80	0.24	0.85	0.03	0.10	0.17	1.00	2.00

and 80 kg N+ 100 kg K_2O/fed., respectively were not enough and unfavourable for growth of onion plants in sandy soil under drip irrigation.

These results are in agreement with those obtained by Vachhani and Patel (1996) who reported that plant height, number of leaves/ plant and bulb weight of onion were the highest with 150 kg N/ha. Also, Oukal (1999) found that the growth characters of onion plant were increased with increasing the application of nitrogen fertilizer up to the highest applied level (150 kg N/kg fed.) and application of 120 kg N/fed increased plant growth (El-Gamili *et al.*, 2000).

Vachhani and Patel (1996) reported that K application increased only the number of leaves/ plant and application of 80kg K_2O/ha significantly increased onion bulb weight and diameter (Nagaich *et al.*, 1999).

The effect of combined N and K fertilizers on plant growth are in agreement with those reported by El-Gamili and Abd El-Hadi (1996), who reported that the interaction between the NPK has no significant effect on growth of onion plant . Moreover, Oukal (1999) found that application of the relatively high level of N, P and K fertilizers (120 kg N + 60 kg P_2O_5+45 K_2O) increased the growth rate of onion plants.

From the aforementioned results, it could be recommended that the application of 100 kg N + 125 kg K_2O/fed. through irrigation water and under drip irrigation system is more favourable for the growth of onion plants grown in new reclaimed sandy soil.

II. Photosynthetic Pigments

I. Effect of application method

Concerning the effect of the used two methods of fertilizers application on chlorophyll and carotenoids content in onion leaves (Table 4). Obtained results indicate, except total carotenoids in second season, that there were significant differences between the effect of the two application methods on photosynthetic pigments. Whereas, fertigation method exerted significant and marked increase in chlorophyll a, b, and total and carotenoids content in onion leaves compared to traditional method.

2.Effect of N+K_2O fertilizers rate

With respect to the effect of combined N and K fertilizers on chlorophyll and carotenoids in onion leaves (Table 4), the listed results indicate that there was gradual and progresive significant increase in total chlorophyll with increasing of combined N and K fertilizers up to the highest used level; i.e., 100 kg N+125 kg K_2O/feddan.

These results hold true in the two growing seasons. On the other

Table 4: Effect of application method, N+ K_2O fertilizers rates and their interaction on the photosynthetic pigments (mg/gm. dry weight of leaves) of onion plant at 120 days after transplanting

Characters / Treatment			Chlorophyll a	Chlorophyll b	Chlorophyll Total (a + b)	Total carotenoids	Chlorophyll a	Chlorophyll b	Chlorophyll Total (a + b)	Total carotenoids
Application methods	**X**	**N+K_2O rates (kg/fed.)**	**2000 - 2001 season**				**2001 - 2002 season**			
Soil application		**60 + 75**	**2.72**	**1.60**	**4.32**	**2.20**	**2.50**	**1.77**	**4.27**	**2.26**
		80 + 100	**2.87**	**1.90**	**4.77**	**2.43**	**2.62**	**2.06**	**4.68**	**2.54**
		100 + 125	**3.05**	**2.46**	**5.51**	**2.70**	**3.00**	**2.10**	**5.10**	**2.52**
	Mean		**2.88**	**1.99**	**4.87**	**2.44**	**2.70**	**1.98**	**4.69**	**2.44**
Fertigation		**60 + 75**	**3.35**	**2.82**	**6.17**	**2.75**	**2.95**	**2.59**	**5.54**	**2.47**
		80 + 100	**2.90**	**3.24**	**6.14**	**2.80**	**3.00**	**2.67**	**5.67**	**2.51**
		100 + 125	**3.52**	**3.67**	**7.19**	**2.98**	**3.10**	**2.79**	**5.89**	**2.61**
	Mean		**3.25**	**3.24**	**6.50**	**2.84**	**3.01**	**2.68**	**5.70**	**2.53**
Mean values of N + K_2O rates										
		60 + 75	**3.03**	**2.21**	**5.25**	**2.47**	**2.72**	**2.18**	**4.91**	**2.36**
		80 + 100	**2.88**	**2.57**	**5.45**	**2.62**	**2.81**	**2.36**	**5.18**	**2.52**
		100 + 125	**3.28**	**3.07**	**6.35**	**2.84**	**3.05**	**2.44**	**5.49**	**2.56**
L.S.D. at 0.05 level										
Application methods			**0.23**	**0.54**	**0.93**	**0.39**	**0.31**	**0.10**	**0.42**	**N.S.**
N + K_2O rates			**N.S.**	**0.30**	**0.57**	**0.33**	**0.32**	**N.S.**	**0.54**	**N.S.**
Interaction (Methods X N + K_2O)			**0.64**	**0.43**	**0.81**	**0.47**	**0.45**	**N.S.**	**0.76**	**0.39**

hand, the contents of chlorophyll a and b as well as total carotenoids were fluctuated and did not show clear trend.

These results seemed to be true for total chlorophyll since nitrogen is considered as limiting constituent part of chlorophyll molecule.

In addition, the favourable effect of K on total chlorophyll is due to the role of K which plays an important and great role in promoting the assimilating rate of CO_2 and photosynthetic capacity.

Similarly, El-Tabbakh *et al.* (1979c) found that the concentration of total chlorophyll and chlorophyll a increased with adding nitrogen up to the highest used level; i.e., 60 kg N/fed., whereas the concentration of chlorophyll b and total carotenoids increased by adding nitrogen up to the highest level. In this respect El-Oksh *et al.* (1993) found also that significant increase in total chlorophyll was recorded as nitrogen rate increased to 7.02 g/ pot, but with higher rate of N, the increment was not significant. They reported that high nitrogen and potassium promoted the accumulation of chlorophyll in onion leaves.

III.Plant Nutritional Status

1.Effect of application method

It is quite clear from data in Table 5 that, generally, N, P and uptake in different organs of onion plant as well as total minerals uptake significantly affected by the method of fertilizers application. Whereas, the highest values were recorded by fertigation method compared to the traditional method. These results hold true in the two growing seasons, except, for the uptake of P in leaves, and total P uptake which did not reflect any significant difference between the two methods.

The favourable effect of fertigation method on minerals uptake might be attributed to the solubility of fertilizers in solution which become more available to roots and absorption.

2.Effect of N + K fertilizers rates

Data presented in Table 5, generally, indicate significant differences among the combined N and K fertilizers levels for N, P and K uptake of onion plants, Moreover, there was gradual and progressive increase in N, P and K uptake in different organs of plant as well as its total uptake with increasing the dose of combined N and K fertilizers up to the highest used level; i.e., 100 kg N + 125 kg K_2O/fed.

These results are in confirmity with those found by El-Gamili and Abd El- Hadi (1996) who reported that N - addition at the highest used rate positively affected NPK in leaves and bulb. Moreover, Koriem (1987) indicated that N

Table 5: Effect of application method, N + K_2O fertilizers rates and their interaction on uptake of different organs of onion plant at 120 days after transplanting during 2001- 2002 season

Treatment	Characters	Minerals uptake (mg. / gm dry weight)									Total uptake (mg/plant)		
		Leaves			Bulb			Root					
		N	P	K	N	P	K	N	P	K	N	P	K
Application methods X N+K_2O rates (kg/fed.)													
Soil application	**60 + 75**	**65.57**	**7.18**	**88.58**	**110.53**	**37.56**	**180.54**	**3.29**	**0.47**	**2.34**	**179.40**	**45.22**	**271.75**
	80 + 100	**83.57**	**7.61**	**103.66**	**115.04**	**41.62**	**182.53**	**3.54**	**0.46**	**2.21**	**202.16**	**49.69**	**288.61**
	100 + 125	**96.65**	**6.87**	**94.67**	**124.99**	**43.07**	**201.91**	**4.79**	**0.63**	**3.63**	**226.43**	**50.58**	**300.47**
	Means	**81.93**	**7.22**	**95.64**	**116.85**	**40.75**	**188.33**	**3.87**	**0.52**	**2.73**	**202.66**	**48.50**	**286.94**
Fertigation	**60 + 75**	**82.10**	**6.99**	**106.70**	**139.44**	**49.97**	**250.99**	**5.88**	**0.62**	**4.87**	**227.42**	**57.58**	**362.56**
	80 + 100	**94.60**	**6.56**	**101.09**	**151.01**	**52.62**	**251.68**	**5.67**	**0.69**	**5.36**	**251.28**	**59.87**	**358.13**
	100 + 125	**96.41**	**8.01**	**121.06**	**212.26**	**62.28**	**313.94**	**6.82**	**0.88**	**5.48**	**315.49**	**71.17**	**440.48**
	Mean	**91.04**	**7.19**	**109.62**	**167.57**	**54.96**	**272.20**	**6.12**	**0.73**	**5.24**	**264.73**	**62.87**	**387.06**
Mean values of N + K_2O rats													
	60 + 75	**73.84**	**7.08**	**97.64**	**124.99**	**43.77**	**215.77**	**4.58**	**0.55**	**3.61**	**203.41**	**51.40**	**317.15**
	80 + 100	**89.09**	**7.08**	**102.38**	**133.03**	**47.12**	**217.11**	**4.61**	**0.57**	**3.78**	**226.72**	**54.78**	**323.37**
	100 + 125	**96.53**	**7.44**	**107.87**	**168.63**	**52.68**	**257.93**	**5.80**	**0.76**	**4.56**	**270.96**	**60.88**	**370.48**
L.S.D. at 0.05 level													
Application methods		**9.00**	**N.S.**	**10.70**	**23.48**	**5.21**	**39.44**	**0.50**	**0.18**	**0.12**	**31.36**	**N.S.**	**37.80**
N + K_2O rates		**5.76**	**N.S.**	**9.41**	**36.69**	**5.66**	**41.01**	**1.09**	**0.19**	**0.95**	**21.83**	**7.07**	**50.13**
Interaction (Methods X N + K_2O)		**8.14**	**0.98**	**13.14**	**52.41**	**N.S.**	**58.58**	**1.82**	**0.27**	**1.35**	**30.87**	**10.10**	**71.61**

contents of onion bulb and foliage were significantly increased by increasing N application rates up to 90 kg/fed., while K contents were not affected. Rizk (1997) reported also that application of N, P and K fertilizers increased the N% and total uptake by onion plant. Similarly, Oukal (1999) found that application of 120 kg N +60 kg P_2O_5 + 45 K_2O kg/fed. recorded the maximum values of N, P and K percentages and their total uptake of different onion plant parts. With regard to the interaction effect, the results showed, in general, that application of the relatively high rate of combined N and K fertilizers; i.e., 100 kg N + 125 kg K_2O / fed. through irrigation water (fertigation) being the most effective and favourable treatment for N, P and K uptake of onion plants. In spite of that there was insignificant effect of the interaction on P uptake in onion bulb.

IV.Yield and Its Components

1-Effect of application method

Data in Table 6 indicate that fertilizers application method exerted a marked and significant effect on weight of both grades 1 and 2 as well as weight of exportable, marketable and total bulb yield. Whereas, fertigation method recorded the highest values compared to the traditional one. In spite of that, methods of application did not significantly affect the weight of both grades 1 and 4. Moreover, the fertigation method increased total bulbs yield of onion over the yield of soil application by 34.42% (average of the two seasons). The increase in total yield by fertigation method might be mainly due to the increase in average weight of bulb and owing also to the vigorous vegetative growth and more dry weight of onion plants (Table 3). In this connection, some workers came to similar conclusion (Farag and Koriem, 1990; Hamdy, 1991 on tomato; Abd El-Razek, 1996 on peas; El-Haris and Abdel Razik , 1997 on onion Badwi, 1999 on potato). They reported that fertigation increased yield comparing with traditional method of fertilizer application.

2.Effect of N+K_2O fertilizers rate

Data recorded in Table 6 indicate that increasing the rate of combined NK fertilizers significantly caused gradual and continous increase in weight of grades 1 and 2 as well as exportable, maketable and total yield. Whereas, the maximum values were recorded by the highest tested level; i.e.,100 kg N+125 kg K_2O/fed. In spite of that, both grades 3 and 4 were not affect by NK fertilizers. However, in most cases, there were no significant differences between medium and high level of N+K_2O fertilizers. Application of both medium and high levels showed

Table 6: Effect of application method, N + K_2O fertilizers rates and their interaction on the yield and its components of onion plants

Characters / Treatments		Yield and its components (Ton/ fed.)															
		Grade 1	Grade 2	Grade 3	Grade 4	Total yield	Relative yield	Exportable	Marketable	Grade 1	Grade 2	Grade 3	Grade 4	Total yield	Relative yield	Exportable	Marketable
Application methods X	N+K_2O rates kg/fed.)	2000-2001 season								2001- 2002 season							
Soil application	60 + 75	2.390	1.665	2.645	0.320	7.020	100	4.055	6.700	4.620	2.898	1.278	1.117	9.913	100	7.518	8.795
	80+100	3.185	1.880	2.645	0.120	7.830	111	5.065	7.710	5.045	3.153	1.230	0.932	10.360	105	8.198	9.428
	100+125	3.675	2.208	2.165	0.147	8.195	117	5.883	8.048	5.245	3.098	1.240	1.055	10.638	107	8.342	9.582
	Mean	3.083	1.918	2.485	0.196	7.681	100	5.001	7.486	4.970	3.049	1.249	1.035	10.303	100	8.019	9.268
Fertigation	60 + 75	4.162	2.297	2.270	0.356	9.085	100	6.459	8.729	5.835	4.127	1.650	1.423	13.035	100	9.962	11.612
	80+100	4.520	2.680	2.323	0.192	9.715	107	7.200	9.523	6.325	4.515	1.720	1.260	13.820	106	10.842	12.560
	100+125	5.120	3.385	2.122	0.131	10.758	118	8.505	10.627	7.300	4.675	1.475	1.135	14.585	112	11.975	13.450
	Mean	4.601	2.787	2.238	0.226	9.852	128	7.388	9.626	6.487	4.439	1.615	1.272	13.813	134	10.926	12.541
Mean values of (N + K_2O rats)																	
	60 + 75	3.276	1.981	2.458	0.338	8.053	100	5.257	7.715	5.228	3.513	1.464	1.270	11.474	100	8.740	10.204
	80+100	3.853	2.280	2.484	0.156	8.773	109	6.133	8.617	5.685	3.834	1.475	1.096	12.090	105	9.519	10.994
	100+125	4.398	2.797	2.144	0.139	9.477	118	7.194	9.338	6.273	3.887	1.358	1.095	12.612	110	10.159	11.516
L.S.D. at 0.5 level																	
Application methods		0.715	0.441	N.S.	N.S.	0.820	-	0.931	0.531	0.470	0.342	N.S.	N.S.	1.060	-	0.901	0.754
N +_ K_2O rates		0.634	0.432	0.301	0.160	1.054	-	0.810	1.939	0.485	0.376	N.S.	N.S.	0.848	-	0.882	0.916
Interaction (method X N + K_2O		0.756	0.610	0.845	0.228	1.522	-	1.146	1.470	0.686	0.565	N.S.	0.207	1.199	-	1.247	1.296

increase in total yield of onion by 7% for medium level and by 14% for high level (average of the two seasons) over the lowest applied dose of fertilizer (60 kg N+75 kg K_2O). Similar findings were also reported by Koriem *et al.* (1990), who found that high nitrogen rate (90 kg/fed.) promoted total bulb yield, yield of culls and percentage of doubles, whereas, it suppressed percentage of singles and pickles of onion. Application of 120kg N/fed increased yield and yield components (El-Gamili *et al.*, 2000). El-Seifi *et al.* (2004) on garlic came to similar results. Application of K fertilizer (0-240 kg/h) increased onion yield (Guo *et al.*, 1999).In addition, its combination ($N+K_2O$) significantly increased total yield of onion bulb (El- Gamili and Abd El Hadi,1996;Gaviola *et al.*, 1998).

Regarding the interaction effect, the results indicated, generally, that the heaviest increments of both grades 1 and 2 as well as exportable, marketable and total yields were recorded by NK fertigation at the highest level; i.e., 100 kg N + 125 kg K_2O/fed. In spite of that grade 3 was not affected by NK fertilizers. Consequently, it could be recommended, from the present work, that application of relatively high level of NK fertilizers (100 kg $N+125K_2O$/fed.) through irrigation water (fertigation) and under drip irrigation system in new reclaimed sandy soil are favourable and beneficial for onion production. This superiority is according to the stimulative effect of fertigation on vegetative growth, dry weight, chlorophyll and plant nutritional status.

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إستجابة محصول البصل للتسميد النتروجينى والبوتاسيى مع ماء الرى والإضافة الأرضية

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يهدف هذا العمل إلى دراسة استجابة محصول البصل لإضافة السماد النتروجينى والبوتاسى مع الرى مقارنة بالإضافة الأرضية لمستويات النتروجين والبوتاسيوم وهى ٦٠كجم ن + ٧٥ كجم بو ٢أ، ٨٠ كجم ن + ١٠٠ كجم بو ٢أ، ١٠٠ كجم ن + ١٢٥ كجم بو ٢أ تحت ظروف الأرض الرملية.

وقد أجرى هذا البحث خلال شتاء موسمى ٢٠٠٠/٢٠٠١، ٢٠٠١، ٢٠٠٢ فى مزرعة التجارب الزراعية بالخطارة التابعة لكلية الزراعة - جامعة الزقازيق.

وبصفة عامة أوضحت النتائج المتحصل عليها أن استخدام طريقة التسميد مع ماء الرى أدى إلى زيادة معنوية فى الوزن الجاف لمختلف أجزاء نبات البصل وهى الجذور والأوراق والبصلة والنبات الكامل، وتركيز الكلوروفيللات والكاروتينيدات فى أوراق النبات، وعلاوة على ذلك الممتص من النتروجين والفوسفور والبوتاسيوم، وكذلك المحصول ومكوناته وهى (المحصول القابل للتسويق والقابل للتصدير والدرجة الأولى والثانية للمحصول) مقارنة بطريقة الإضافة الأرضية للتسميد النتروجينى والبوتاسى.

ومن ناحية أخرى كان أعلى معدل من السماد النتروجينى والبوتاسى (١٠٠ كجم ن + ١٢٥ كجم بو ٢أ) هو أفضل معدل حيث أدى إلى زيادة معنوية فى جميع الصفات السابق ذكرها مقارنة بالمعدل المنخفض (٦٠ كجم ن + ٧٥ كجم بو ٢أ)

وبالنسبة للتفاعل فقد كانت أفضل معاملة هى إضافة ١٠٠ كجم ن + ١٢٥ كجم بو ٢أ تحت نظام التسميد مع ماء الرى بالتنقيط تحت ظروف الأرض الرملية.