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GROWTH, YIELD AND STORABILITY OF ONION AS INFLUENCED BY POTASSIUM FERTILIZER APPLICATION TIME AND UREA AS FOLIAR SPRAY

Geries, L.S.M. ; R. A. Marey and M.G. Morsy
Onion Res. Dept., Field Crops Res. Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

This experiment was carried out for two seasons in 2007/2008 and 2008/2009 at the Experimental Farm of Sakha Agricultural Research Station, ARC, Kafr El-Sheikh, Gevernorate, Egypt. The objective of this experiment was to study the effect of four times of potassium application i.e., 100% before transplanting (BT), 50% BT + 50% at 30 days after transplanting (DAT), 50% K at BT + 50% K at 60 DAT and 50% K at 30 DAT + 50% K at 60 DAT. Three urea rates as foliar spray i.e. 2, 4, and 6 g/l on vegetative growth at 90 and 120 DAT, yield and yield components, quality and storability of onion.

The main important findings were as follows:

1- Plant height, bulbing ratio, plant fresh weight and plant dry weight recorded maximum mean values by adding 50% of potassium fertilizer at 30 DAT and 50% at 60 DAT at two growth stages in both seasons, except for plant height at 120 DAT in the first season and bulbing ratio at 90 DAT in both seasons.
2- Adding 50% of potassium at 30 DAT and 50% at 60 DAT attained the highest average of bulb weight, marketable yield/fed., culls yield/fed. and total yield/fed. While, adding 50% of potassium before transplanting and 50% at 60 DAT attained the lowest ones in both seasons.
3- Increasing urea rate as foliar spray from 2 to 4 or 6 g/l significantly increased mean values of plant height, plant fresh weight and plant dry weight at two growth stages, in both seasons.
4- Spraying onion plants with 6 g/l of urea attained of average bulb weight, marketable yield/fed., culls yield/fed. and total yield/fed. While spraying onion plants with 2 g/l gave lowest ones of all studied characters, except for culls yield/fed. in the second season.
5- Results showed that highest percentages of TSS% and dry matter% were obtained by adding 50% of potassium before transplanting and 50% at 60 DAT, while the smallest ones were obtained by adding 50% of potassium at 30 DAT and 50% at 60 DAT in both seasons.
6- Increasing urea as foliar spray rate from 2 g/l to 4 or 6 g/l decreased mean values of TSS% and dry matter % in both seasons.
7- Results indicated that highest average of bulb weight, marketable yield/fed. and total yield/fed. were achieved by adding 50% of potassium at 30 DAT and 50% at 60 DAT when plants were sprayed with 6 g/l of urea in both seasons.

It could be concluded that adding 50% of potassium at 30 DAT and 50% at 60 DAT and spraying onion plants with 6 g/l of urea.could be recommended for optimum onion yield per unit area.

INTRODUCTION

Onion (*Allium cepa*, L.) is one of the most important vegetable crops grown commercially in Egypt due to its multifarious use as local consumption, processing and exportation. The cultivated area for onion production in Egypt in 2010 season the area was 115, 295 feddans produced 1563,300 tons by

an average of 13.56 t/fed., as mentioned by the yearly book of Economics and Statistics of the Agric. Ministry, in Egypt. Increasing productivity of onion with good quality is an important target for the growers of onions. From several production inputs essential for onion, the nutritional requirement plays a key role on various growth traits. The enhanced yield of the crop is often associated with optimum nutrients.

Time of potassium application growth during the growing period of onion is important for plant growth. There are several evidences of fixation and leaching loss of potassium from the soil (Huq *et al.,* 1990). Islam *et al.*, (2008) cleared that significant improving in different growth parameters and yield of onion was observed in response to different application methods. Among the methods, highest bulb yield (11.85 t ha^{-1}) was obtained from three splits application of potassium and the lowest (11.49 t ha^{-1}) was obtained from application of basal doses of potassium. Satter and Haque (1975) reported that split application of nitrogen and potash gave higher weight of winter onion bulb than single application of the same dose. Sing and Verma (2001) showed that bulb yield of onion increased significantly with split application of K_2O, being the highest with 3 splits. Yaso and Moursy (2007) reported that the highest total bulb yields were obtained from the highest K-fertilizer rate (48 kg K_2O/fed.) applied 3-month after transplanting, while the highest marketable yields were obtained from applying high K-fertilizer rate either in two splits (2- and 3- month after transplanting) or late in the growing seasons (3-month after transplanting).

Nitrogenous fertilizers play a vital role in modern farm technology, however only 20- 50% of the soil applied nitrogen is recovered by the annual crops (Bajwa, 1992). Foliar spraying by each amino mix compound and or sugar as individually or together resulted plants more vigor and heavier bulbs yield (Shaheen *et al*.., 2010). Yildirim *et al.,* (2007) stated that the interest in foliar fertilizers arose due to the multiple advantages of foliar application methods such as rapid and efficient response to the plant needs, less product needed, and independence of soil conditions. A high penetration rate is one of the pre-requisites for efficient foliar nutrition. Urea, due to its intrinsic characteristics such as small molecular size, non-ionic nature and high solubility, is usually taken up rapidly through the leaf cuticle. Most plants absorbing urea as foliar spray rapidly and hydrolyze the urea in the cytosol (Witte *et al.,* 2002). Tiwari *et al.,* (2002) reported that the incorporation of foliar spray proved better than non-spray treatment for growth and yield traits (plant height, number of leaves per plant, neck diameter, bulb diameter and weight, total soluble solids, and specific gravity). Koota and Osinska (2001) applied (11 essential nutrients) as foliar spray in concentrations of 1.5% and 3.0% four times during the intensive period of plant growth at two week intervals, using 1000 L water solution per ha each time. They recorded that the maximum increase in marketable yield by using supplementary foliar fertilization was 10.8% in onion. Bahadur and Maurya (2001) reported that maximum bulb weight of onion (75.8 g) and 20% increase in yield(maximum yield) was obtained at foliar sprayed with 1% urea, compared to the control.

Therefore, the main objective of this research is to study the effect of potassium application times and the rate of urea as foliar spray on plant growth, yield and its component, quality and storability of onion bulbs.

MATERIALS AND METHODS

This study was carried out at the Experimental Farm of Sakha Agric. Res. Station, ARC, Kafr El-Sheikh , Governorate, Egypt, during the two successive winter seasons of 2007/2008 and 2008/2009. The experiments were conducted to evaluate the effect of potassium application methods and different rates of urea as foliar spray on vegetative growth, yield and yield components, quality and storability of onion (Giza red cultivar). Some physical and chemical analyses of the experimental sites in the two seasons are presented in Table (1).

Table 1: Some physical and chemical analysis of the experimental soil at (0-30 cm) deepth in 2007/2008 and 2008/2009 seasons.

Determination		Season	
		2007/2008	2008/2009
Mechanical analysis:	Sand%	44.90	41.50
	Silt%	37.00	38.50
	Clay%	18.10	20.00
	Textural class	Clay	Clay
Chemical analysis:	PH	8.11	8.10
	Total soluble salts %	0.26	0.22
	Calcium carbonate %	2.41	3.72
	Organic matter %	1.71	2.18
	Total nitrogen %	0.08	0.09
	Available N ppm	22.00	26.00
	Available P ppm	12.00	10.00
	Available K ppm	420.00	480.00

This experiment included 12 treatments, which were the combination between four potassium application times and three urea rates as foliar spray. These treatments were arranged in split plot design with three replications. The main plots were devoted to the methods of potassium application with rate of 24 K_2O/fed. as potassium sulfate (48% K_2O) as follows:

1- 100% of potassium rate at land preparation.
2- 50% of potassium rate before transplanting (BT) and 50%K at 30 days after transplanting (30 DAT).
3- 50% of potassium rate before transplanting (BT) and 50%K at 60 days after transplanting (60 DAT).
4- 50% of potassium rate at 30 days after transplanting (30 DAT) and 50% at 60 days after transplanting (60 DAT).

The sub plots were devoted to the foliar spray rates of urea i.e., 2, 4, and 6 g/l. Urea was sprayed at 60 and 80 days from transplanting .

Onion seeds of Giza red cultivar were sown in the nursery in the first week of October during the two successive seasons, while transplanting took place on December 18th and 9th in the first and second seasons, respectively. The preceding crop was maize in both seasons.

The experimental plot size was 10.5 m^2 (3.5 m length and 3 m in width) included five ridges with 60 cm a part between ridges. Uniformed seedlings were transplanted after hardening on both sides of ridges 7-10 cm apart. Nitrogen at rate 2of 90 kg N/fed. in the form of ammonium nitrate (33.5 % N) was applied in the two equal dose. The first dose was applied after thirty days from transplanting and the second one was added at thirty days later. Calcium super phosphate (15.5 % P_2O_5) was added during land preparation at the rate of 300 kg/fed.. Other cultural practices for growing onion were conducted as recommended for onion production at North Delta region.

Studied characters:

The following characters of onion plant in both seasons were estimated according to the recommended methods as follows:

A- Vegetative growth characters:

After 90 and 120 days after transplanting(DAT), 10 random plants were taken from each plot to measure the following characters:

1- Leaves characters: i.e., number of leaves/plant, leaf length (cm), neck diameter (cm), leaves fresh weight (g) and leaves dry weight(g).
2- Bulb characters: i.e., bulb diameter (cm), bulb fresh weight (g) and bulb dry weight (g).
3- Plant growth characters: i.e., plant height (cm), bulbing ratio, plant fresh weight (g) and plant dry weight (g). Where, Bulbing ratio = neck diameter (cm)/bulb diameter (cm), according to (Mann, 1952).

B- Bulb yield and its components:

At harvest time, all plants in the experimental plots were uprooted, and after the curing periods, the following data were recorded:

1- Average bulb weight (g): It was calculated by dividing weight of single bulbs by its number.
2- Marketable yield (t/fed.): It was determined as the weight of single bulbs yield for each experimental plot.
3- Culls yield (t/fed.): It includes bulbs of less than 3 cm diameter, doubles, bolters, off-color and scallions.
4- Total yield (t/fed.): It was calculated on basis of total yield for the experimental plot.

C- Bulb quality:

At harvest, 10 bulbs were randomly taken as a representative sample from each experimental plot and the following physical bulb characters were recorded :

1- Total soluble solids (T.S.S):

It was determined immediately after harvest by a hand refractometer in the same representative sample of the ten bulbs according to A.O.A.C. (1975).

2- Percentage of dry matter in bulbs (D.M.%):

It was determined by estimating the loss in sample of bulbs fresh weight after drying for four hours at 105^{o}C and then at 70^{o}C in a drying oven

with ventilator until it reaches constant weight, according to the following formula:

$$\text{D.M.\%} = \frac{\text{Sample dry weight}}{\text{Sample fresh weight}} x100$$

D- Bulbs storability:

After the curing period (15 days after harvesting), a random sample of 100 bulbs from a marketable grade were chosen from each plot in three replications and stored for five months at room condition. During storage period, bulbs were monthly inspected and stored to discard the rotted and sprouted bulbs, and remained bulbs (sound bulbs) were weighted. The percentage of total weight loss was calculated every month of storage according to following equation of Wills *et al.,* (1982):

$$\text{Weight loss \%} = \frac{\text{Initial weight - weight after storage}}{\text{Initial weight}} \text{ X } 100$$

Statistical analysis:

All collected data were subjected to analysis of variance according to Snedecor and Cochran (1980). Treatments means were compared by Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

A - Vegetative growth characters:

1- Leaves growth characters:

Results in Tables 2 and 3 indicate significant differences among the four potassium fertilizer treatments in respect to number of leaves/plant, leaf length, neck diameter, leaves fresh weight and leaves dry weight at the two sampling dates (90 and 120 DAT) in both seasons, except for number of leaves/plant at 120 DAT and neck diameter at 90 DAT, in the second season. Mean values of all these characters were maximum by adding 50% of potassium at 30 DAT and 50% at 60 DAT (K_4) at the two sampling dates in both seasons. The minimum mean values of all leaf growth characters were obtained by adding 50% of potassium before transplanting and 50% at 60 DAT (K_3). This result was true the two sampling dates in both seasons, except for number of leaves/plant at 120 in the second season, where the minimum value was obtained by adding 100% of potassium at land preparation. The superiority in most leaf growth characters under applying potassium on two equal portion (30 and 60 days after transplanting) may be attributed to the effective utilization of potassium under this treatment. These results mainly due to lesser losses of potassium during growing season as compared to other treatments. Similar results were obtained by Islam *et al.,* (2008) who recorded that at 30, 50, 70 and 90 DAT, the tallest leaf length and number of leaves per plant was found in the plots receiving three-splits of potash, while the shortest leaf length and number of leaves per plant was noted from the plots receiving single application of potash as basal dose at 70 DAT.

Table 2: Effect of potassium application date, foliar spray with urea and their interaction on number of leaves/plant, leaf length and neck diameter of onion at 90 and 120 DAT during 2007/2008 and 2008/2009 seasons.

Treatment		2007/2008						2008/2009					
		No. of leaves/plant		Leaf length (cm)		Neck diameter (cm)		No. of leaves/plant		Leaf length (cm)		Neck diameter (cm)	
		90 days	120 days	90 days	120 days	90 days	120 days	90 days	120 days	90 days	120 days	90 days	120 days
Potassium application date(A):													
K_1		8.27 a	9.11 b	49.27 b	55.56 b	1.43 a	2.10 b	7.82 b	8.67	59.74 a	63.68 a	1.39	2.06ab
K_2		8.26 a	8.99 b	47.14 c	53.80 c	1.39 ab	2.07 b	8.26 ab	9.20	54.69 b	62.87 a	1.38	1.93 bc
K_3		7.28 b	8.31 c	46.07 c	49.81 d	1.32 b	1.99 b	7.11 c	9.04	49.97 c	57.09 b	1.19	1.75 c
K_4		8.87 a	10.09 a	53.11 a	58.05 a	1.47 a	2.47 a	8.40 a	9.70	61.07 a	64.45 a	1.42	2.22 a
F – test		**	**	**	**	*	*	**	N.S	**	**	N.S	*
Urea spray rate (B):													
2 g/l		7.59 b	8.46 c	46.75 c	52.06 c	1.30 c	2.10 b	7.13 c	8.74 b	54.25 c	60.00 c	1.24 b	1.83 b
4 g/l		7.98 b	9.05 b	48.53 b	53.57 b	1.41 b	2.12 ab	7.63 b	9.22 ab	56.36 b	61.71 b	1.32 b	1.93 b
6 g/l		8.93 a	9.87 a	51.41 a	57.28 a	1.51 a	2.29 a	8.93 a	9.51 a	58.49 a	64.35 a	1.48 a	2.20 a
F – test		**	**	**	**	**	*	**	*	**	**	**	**
Interaction (A x B):													
K_1	2 g/l	7.80	8.07 df	46.36 c	52.73	1.33 ce	1.92	6.80	8.42	57.65	61.65	1.30	1.88
	4 g/l	8.00	9.27 bc	50.33 b	54.28	1.40 cd	1.99	7.33	8.73	59.20	63.85	1.36	2.02
	6 g/l	9.00	10.00 ab	51.11 b	59.67	1.55 ab	2.34	9.33	8.87	62.38	65.55	1.52	2.27
K_2	2 g/l	7.73	8.33 cf	44.30 c	51.93	1.36 ce	1.87	7.73	8.64	54.55	60.62	1.18	1.74
	4 g/l	8.08	9.00 be	45.78 c	53.31	1.39 cd	2.02	8.03	9.42	52.73	63.45	1.33	1.74
	6 g/l	9.00	9.63 ab	51.33 b	56.18	1.43 bd	2.33	9.00	9.53	56.78	64.54	1.62	2.31
K_3	2 g/l	6.77	7.83 f	45.12 c	48.27	1.22 e	1.84	6.27	8.85	46.81	54.79	1.11	1.67
	4 g/l	7.23	7.93 ef	46.75 c	49.63	1.36 ce	2.00	7.23	9.08	50.08	55.99	1.14	1.78
	6 g/l	7.83	9.17 bd	46.33 c	51.53	1.39 cd	2.13	7.83	9.20	53.02	60.48	1.32	1.80
K_4	2 g/l	8.07	9.60 ab	51.23 b	55.32	1.28 de	2.61	7.73	9.03	58.00	62.95	1.35	2.04
	4 g/l	8.67	10.00 ab	51.24 b	57.08	1.47 bc	2.45	7.93	9.65	63.44	63.57	1.45	2.19
	6 g/l	9.87	10.67 a	56.85 a	61.74	1.66 a	2.35	9.53	10.42	61.76	66.84	1.46	2.43
F – test		N.S	*	*	N.S	*	N.S	N.S	N.S	N.S	N.S	N.S	N.S

****, * and NS indicate p <0.05 , <0.01 and not significant , respectively. Means within the same column for each factor designated by the same letter are not significantly different at 5% level according to Duncans Multiple Range Test**

K_1: 100% at land preparation, K_2: 50% before transplanting +50% at 30 days after transplanting, K_3: 50% before transplanting +50% at 60 days after transplanting and K_4: 50% at 30 days after transplanting +50% at 60 days after transplanting.

It is obvious from results in Tables 2 and 3 that the differences among mean values of number of leaves/plant, leaf length, neck diameter, leaves fresh weight and leaves dry weight for the three urea foliar treatments were significant at the two sampling dates, in both seasons. At the two sampling dates it is clear that spraying with 6 g/l of urea attained the highest number of leaves/plant, leaf length, neck diameter, leaves fresh weight and leaves dry weight in both seasons. Whereas, spraying with 2 g/l of urea attained the lowest means of all these characters at the two sampling dates in both seasons, except for leaves dry weight at 90 and 120 DAT in the first season. These results were in harmony with those reported by Russel (1982), who reported that as the level of nitrogen supply increased compared with the lower rate, the extra protein produced allows the plant leaves to grow larger and

hence to have a larger surface available for photosynthesis proportional to the amounts of nitrogen supply.

Table 3: Effect of potassium application date, foliar spray with urea and their interaction on leaves fresh and dry weight leaves weight of onion at 90 and 120 DAT during 2007/2008 and 2008/2009 seasons.

Treatment		2007/2008				2008/2009			
		Leav. fresh wt. (g)		Leav. dry wt. (g)		Leav. fresh wt. (g)		Leav. Dry wt. (g)	
		90 days	120 days	90 days	120 days	90 days	120 days	90 days	120 days
Potassium application date (A):									
K_1		62.05 b	75.15 ab	2.98 b	4.83 ab	78.51 b	69.49 b	4.08 ab	6.27 a
K_2		61.80 b	73.16 b	2.77 b	4.49 b	82.57 ab	96.00 b	3.88 b	4.94 b
K_3		60.91 c	67.74 c	2.46 c	3.94 c	75.49 b	94.86 b	3.27 c	4.58 b
K_4		63.08 a	78.00 a	3.24 a	5.20 a	88.78 a	115.67 a	4.41 a	7.26 a
F – test		**	**	**	**	*	**	**	**
Urea spray rate (B):									
2 g/l		60.96 c	69.93 c	2.84 b	4.50 b	73.43 c	96.85 b	3.72 b	5.19 b
4 g/l		62.04 b	73.69 b	2.70 b	4.49 b	80.59 b	99.86 b	3.91 ab	5.67 ab
6 g/l		63.63 a	76.92 a	3.05 a	4.86 a	90.00 a	105.57 a	4.10 a	6.43 a
F – test		**	**	**	*	**	**	*	*
Interaction (A x B)									
K_1	2 g/l	61.63 c	72.25 c	2.89 cd	4.67	67.73 e	90.57 de	3.76	6.54
	4 g/l	61.75 c	75.64 bc	2.96 cd	4.73	81.63 d	98.65 c	4.09	5.61
	6 g/l	62.76 b	77.56 b	3.08 bc	5.09	86.19 bd	100.26 c	4.40	6.64
K_2	2 g/l	61.37 c	72.32 c	2.66 df	4.31	83.01 cd	89.83 de	3.62	4.22
	4 g/l	61.88 c	72.35 c	2.77 ce	4.39	83.56 cd	95.86 cd	3.97	5.14
	6 g/l	62.16 bc	74.82 bc	2.87 cd	4.77	81.14 d	102.33 c	4.06	5.48
K_3	2 g/l	59.30 d	63.77 e	2.40 ef	3.80	65.80 e	95.44 cd	3.18	3.94
	4 g/l	61.62 c	67.81 d	2.39 f	3.87	65.98 e	88.27 e	3.24	4.84
	6 g/l	61.81 c	71.65 cd	2.59 df	4.16	94.68 ab	100.88 c	3.37	4.96
K_4	2 g/l	61.53 c	71.38 cd	3.39 ab	5.22	77.19 d	111.57 b	4.30	6.06
	4 g/l	62.90 b	78.99 b	2.68 df	4.96	91.17 ac	116.64 ab	4.34	7.09
	6 g/l	67.80 a	83.63 a	3.67 a	5.41	97.99 a	118.80 a	4.58	8.62
F – test		**	*	**	N.S	**	*	N.S	N.S

****, * and NS indicate p <0.05 , <0.01 and not significant , respectively. Means within the same column for each factor designated by the same letter are not significantly different at 5% level according to Duncans Multiple Range Test**

K_1: 100% at land preparation, K_2: 50% before transplanting +50% at 30 days after transplanting, K_3: 50% before transplanting +50% at 60 days after transplanting and K_4: 50% at 30 days after transplanting +50% at 60 days after transplanting.

Data in Tables 2 and 3 show the interaction between potassium fertilizer treatment and urea spray rate at the two growth stage in both seasons. In the first season, the significant interactions were obtained for number of leaves/plant at 120 DAT; leaf length, neck diameter and leaves dry weight at 90 DAT; and leaves fresh weight at the two sampling dates. While, in the second seasons, the significant interactions were obtained for only leaves fresh weight, at the two sampling dates. The best leaves performance in items of number of leaves/plant, leaf length, neck diameter, leaves fresh weight and leaves dry weight were attained by applying 50% of potassium at 30 DAT and 50% at 60 DAT (K_4), when sprayed with 6 g/l of urea. These results were true at the two sampling

dates in both seasons, except for neck diameter at 120 DAT in the first season as well as for leaf length and neck diameter at 90 DAT in the second season.

2- Bulb growth characters:

Results presented in Table 4 indicate significant differences among the studied potassium treatments on bulb diameter at 120 DAT, and bulb fresh weight and bulb dry weight at the two sampling dates. These results were true in both seasons.

Table 4: Effect of potassium application date, foliar spray with urea and their interaction on bulb diameter, bulb fresh weight and bulb dry weight of onion at 90 and 120 DAT during 2007/2008 and 2008/2009 seasons.

Treatment		2007/2008						2008/2009					
		Bulb diameter (cm)		Bulb fresh weight (g)		Bulb dry weight (g)		Bulb diameter (cm)		Bulb fresh weight (g)		Bulb dry weight (g)	
		90 days	120 days	90 days	120 days	90 days	120 days	90 days	120 days	90 days	120 days	90 days	120 days
Potassium application date(A):													
K_1		2.70	4.69 a	45.16 b	83.69 b	6.77 b	15.80 ab	2.84	4.70 b	27.27 b	68.50 b	4.37 a	12.76 b
K_2		2.52	4.69 a	43.67 b	81.47 b	6.61 bc	15.31 b	2.87	4.67 b	28.52 b	63.69 c	4.33 a	12.69 b
K_3		2.40	4.16 b	34.49 c	75.73 c	6.44 c	13.20 c	2.68	4.62 b	24.60 b	62.12 c	3.79 b	12.49 b
K_4		2.83	4.91 a	58.00 a	87.58 a	7.02 a	15.95 a	3.22	4.98 a	34.58 a	87.89 a	4.56 a	13.21 a
F – test		N.S	*	**	**	**	**	N.S	*	**	**	*	*
Urea spray rate(B):													
2 g/l		2.40 c	4.44 b	39.15 c	78.08 c	6.54 b	14.77 b	2.68 b	4.59 b	25.69 c	58.89 c	4.10 b	12.58 b
4 g/l		2.61 b	4.57 ab	44.86 b	82.24 b	6.73 ab	14.96 b	2.89 b	4.73 ab	28.96 b	70.47 b	4.19 b	12.75 ab
6 g/l		2.84 a	4.83 a	51.98 a	86.05 a	6.87 a	15.47 a	3.15 a	4.90 a	31.58 a	82.30 a	4.49 a	13.04 a
F – test		**	*	**	**	*	**	**	*	**	**	**	*
Interaction (A x B)													
K_1	2 g/l	2.55	4.57	36.98 f	80.38 d	6.60	15.69	2.68	4.56	21.69 f	55.94 f	4.01	12.37
	4 g/l	2.72	4.72	42.60 e	83.89 cd	6.81	15.75	2.73	4.67	28.80 ce	74.94 d	4.51	12.85
	6 g/l	2.83	4.77	55.88 bc	86.82 bc	6.91	15.94	3.12	4.86	31.32 bc	74.62 d	4.59	13.08
K_2	2 g/l	2.07	4.62	35.49 fg	80.19 d	6.54	15.07	2.42	4.64	26.43 de	47.87 h	4.29	12.46
	4 g/l	2.59	4.58	44.86 e	80.73 d	6.47	15.33	2.94	4.64	27.36 ce	64.72 e	4.20	12.61
	6 g/l	2.91	4.88	50.66 d	83.48 cd	6.81	15.33	3.26	4.74	31.77 bc	78.48 cd	4.51	13.00
K_3	2 g/l	2.27	4.02	32.22 g	71.31 f	6.31	12.75	2.51	4.56	24.48 ef	50.19 gh	3.77	12.35
	4 g/l	2.38	4.16	33.65 fg	75.94 e	6.48	13.01	2.67	4.72	24.33 ef	54.03 fg	3.55	12.29
	6 g/l	2.57	4.29	37.58 f	79.96 d	6.54	13.84	2.86	4.56	25.00 ef	82.13 c	4.06	12.85
K_4	2 g/l	2.70	4.55	51.90 cd	80.42 d	6.70	15.55	3.10	4.59	30.19 cd	81.54 c	4.34	13.15
	4 g/l	2.77	4.81	58.31 b	88.39 b	7.15	15.73	3.20	4.90	35.34 ab	88.18 b	4.53	13.25
	6 g/l	3.03	5.37	63.80 a	93.93 a	7.21	15.56	3.36	5.45	38.22 a	93.94 a	4.80	13.22
F – test		N.S	N.S	**	**	N.S	N.S	N.S	N.S	*	**	N.S	N.S

****, * and NS indicate p <0.05 , <0.01 and not significant , respectively. Means within the same column for each factor designated by the same letter are not significantly different at 5% level according to Duncans Multiple Range Test**

K_1: 100% at land preparation, K_2: 50% before transplanting +50% at 30 days after transplanting, K_3: 50% before transplanting +50% at 60 days after transplanting and K_4: 50% at 30 days after transplanting +50% at 60 days after transplanting.

Adding 50% of potassium at 30 DAT and 50% at 60 DAT (K_4) had the superiority for obtaining the highest means of bulb diameter, bulb fresh weight and bulb dry weight, While, adding 50% of potassium before transplanting and

50% at 60 DAT (K_3) attained the lowest ones. These results were true at the two sampling dates in both seasons. The increase in bulb growth characters when splitting potassium at two equal doses (30 and 60 days after transplanting) may be due to that this treatment reduced the losses of potassium through fixation and leaching as compared to other methods of application. These results were in a good accordance with those recorded by Satter and Haque (1975) who reported that split doses of nitrogen and potash gave higher weight of winter onion bulb than single dose of same treatment.

As shown in Table 4, bulb diameter, bulb fresh weight and bulb dry weight appeared significant increase by increasing urea spray rate from 2 to 6 mg/liter at the two sampling dates in both seasons. These increments in different bulb characters under higher urea foliar rate may be attributed to the effects of nitrogen fertilization in activation of onion growing. These results reflects the role of nitrogen in enhancing plant capacity in protein synthesis, which lead to an increase in building up carbohydrates and this in turn resulted in increases in plant growth characters. Similar conclusion was reported by Aisha *et al.,* (2007), Shaheen *et al.,* (2007) and Shaheen *et al.,* (2010).

The interaction between the two factors under study had a significant effect on bulb fresh weight at the two sampling dates, while the effect of interaction did not reach the level of significant on bulb diameter or bulb dry weight at any sampling date. These results were true in both seasons (Table 4). The combination between adding 50% of potassium at 30 DAT and 50% at 60 DAT (K_4) and spraying with 6 g/l of urea resulted in the highest means for these three characters at the two sampling dates, except for bulb dry weight at 120 DAT in both seasons.

3- Plant growth characters:

Results listed in Table 5 showe that plant height, plant fresh weight and plant dry weight were significantly affected by potassium application treatments at the two sampling dates in both seasons. While bulbing ratio was significantly affected by potassium application treatments only at 90 DAT in the second season. Mean values of plant height, bulbing ratio, plant fresh weight and plant dry weight were the maximum by adding 50% of potassium at 30 DAT and 50% at 60 DAT (K_4). These results were true at the two sampling dates in both seasons, except for plant height at 120 DAT in the first season and bulbing ratio at 90 DAT in both seasons. These results may be explained in view of that adding of potassium at two equal doses (at 30 and 60 days after transplanting) increased the availability of potassium for onion plants, and this increased plant growth rate, as compared to other application methods of potassium. These results were in agreement with that fund by Rizk *et al.,* (1997) who found that adding the different levels of NPK at equal time, i.e. 30 and 60 days after transplanting gave a superiority in total fresh and dry weight of onion plants as compared to other treatments when adding with other method, i.e. before and 30 days after transplanting at two equal portion. Data also reveal that the maximum mean values of plant height at 120 DAT in the first season were obtained by adding 100% of potassium fertilizer at land preparation (K_1). While, the highest mean values of bulbing ratio at 90 DAT were obtained by adding 50% of potassium before transplanting and 50% at 30 DAT (K_2) in the first season and by K_1 or K_2 potassium treatments in the second season with the same value.

Table 5: Effect of potassium application date, foliar spray with urea and their interaction on plant height, bulbing ratio, plant fresh weight and plant dry weight of onion at 90 and 120 DAT during 2007/2008 and 2008/2009 seasons.

Treatment		2007/2008							
		Plant height (cm)		Bulbing ratio		Plant fresh weight (g)		Plant dry weight (g)	
		90 days	120 days	90 days	120 days	90 days	120 days	90 days	120 days
Potassium application date(A):									
K_1		54.52 b	69.32 a	0.53	0.45	107.20 b	158.84 ab	9.75 b	20.62 a
K_2		52.59 bc	67.60 b	0.59	0.45	105.47 b	154.63 b	9.37 c	19.80 b
K_3		51.89 c	61.23 c	0.55	0.48	95.39 c	143.48 c	8.90 d	17.14 c
K_4		57.07 a	69.25 a	0.52	0.51	122.08 a	165.58 a	10.27 a	21.15 a
F – test		*	**	N.S	N.S	**	**	**	**
Urea spray rate(B):									
2 g/l		51.48 c	64.91 c	0.55	0.47	100.11 c	148.01 c	9.37 b	19.27 b
4 g/l		54.11 b	66.89 b	0.55	0.47	106.89 b	155.93 b	9.43 b	19.44 b
6 g/l		56.45 a	68.76 a	0.54	0.48	115.61a	162.96 a	9.92 a	20.33 a
F – test		*	**	N.S	N.S	**	**	**	**
Interaction (A x B):									
K_1	2 g/l	50.60	67.60 e	0.52 bc	0.42	98.61 e	152.63 d	9.49	20.36
	4 g/l	54.56	69.47 cd	0.52 bc	0.42	104.40 d	159.52 bd	9.77	20.48
	6 g/l	58.39	70.90 ab	0.55 bc	0.49	118.60 b	164.37 bc	9.99	21.03
K_2	2 g/l	52.11	64.93 f	0.68 a	0.41	96.86 e	152.52 d	9.20	19.39
	4 g/l	52.00	67.90 e	0.56 bc	0.45	106.70 d	153.08 d	9.24	19.72
	6 g/l	53.66	69.97 bc	0.54 bc	0.48	112.80 c	158.29 cd	9.68	20.30
K_3	2 g/l	49.33	59.47 h	0.54 bc	0.46	91.53 f	135.08 f	8.71	16.54
	4 g/l	52.89	61.73 g	0.58 b	0.48	95.28 ef	143.75 e	8.87	16.88
	6 g/l	53.45	62.50 g	0.55 bc	0.50	99.39 e	151.61 de	9.13	18.00
K_4	2 g/l	53.89	67.64 e	0.47 c	0.58	113.40 c	151.80 de	10.09	20.77
	4 g/l	57.00	68.45 de	0.53 bc	0.51	121.20 b	167.38 b	9.83	20.69
	6 g/l	60.32	71.67 a	0.55 bc	0.44	131.60 a	177.57 a	10.88	21.97
F – test		N.S	*	**	N.S	*	*	N.S	N.S
		2008/2009							
Potassium application date (A)									
K_1		68.62 ab	71.81 ab	0.49	0.44 a	105.79 bc	164.99 b	8.45 a	19.03 b
K_2		67.02 b	69.84 bc	0.49	0.42 a	111.09 b	159.69 c	8.22 a	17.63 c
K_3		62.18 c	67.13 c	0.45	0.34 b	100.09 c	156.98 c	7.06 b	17.08 c
K_4		71.60 a	74.60 a	0.44	0.45 a	123.37 a	203.56 a	8.96 a	20.46 a
F – test		**	*	N.S	*	**	**	**	**
Urea spray rate (A)									
2 g/l		62.41 c	66.24 c	0.46	0.40	99.13 c	155.74 c	7.82 b	17.77 b
4 g/l		67.30 b	71.22 b	0.47	0.41	109.54 b	170.32 b	8.11 b	18.42 b
6 g/l		72.36 a	74.68 a	0.48	0.42	121.58 a	187.86 a	8.59 a	19.46 a
F – test		**	**	N.S	N.S	**	**	**	**
Interaction (A x B)									
K_1	2 g/l	65.03 e	69.00 ef	0.48	0.41	89.41 f	146.51 e	7.77	18.91
	4 g/l	68.33 cd	70.27 df	0.50	0.43	110.43 de	173.59 c	8.59	18.46
	6 g/l	72.50 b	76.17 ab	0.50	0.47	117.51 cd	174.88 c	8.99	19.72
K_2	2 g/l	63.33 ef	63.40 h	0.49	0.38	109.43 e	137.69 e	7.91	16.68
	4 g/l	68.00 cd	72.13 ce	0.47	0.38	110.92 de	160.57 d	8.17	17.75
	6 g/l	69.73 bc	74.00 bd	0.53	0.49	112.91 ce	180.81 c	8.57	18.48
K_3	2 g/l	55.07 g	64.53 gh	0.44	0.37	90.28 f	145.63 e	6.95	16.29
	4 g/l	61.07 f	67.60 fg	0.43	0.38	90.31 f	142.30 e	6.79	17.13
	6 g/l	70.40 bc	69.27 ef	0.47	0.27	119.68 c	183.02 c	7.43	17.81
K_4	2 g/l	66.20 de	68.03 fg	0.44	0.44	107.38 e	193.11 b	8.63	19.21
	4 g/l	71.80 b	74.87 bc	0.45	0.45	126.51 b	204.82 a	8.87	20.34
	6 g/l	76.80 a	79.27 a	0.44	0.45	136.21 a	212.74 a	9.38	21.84
F – test		**	*	N.S	N.S	**	**	N.S	N.S

****, * and NS indicate p <0.05 , <0.01 and not significant , respectively. Means within the same column for each factor designated by the same letter are not significantly different at 5% level according to Duncans Multiple Range Test**

K_1: 100% at land preparation, K_2: 50% before transplanting +50% at 30 days after transplanting, K_3: 50% before transplanting +50% at 60 days after transplanting and K_4: 50% at 30 days after transplanting +50% at 60 days after transplanting.

As shown in Table (5), plant height, plant fresh weight and plant dry weight were significantly affected by urea foliar treatments, while bulbing ratio was insignificantly affected by these treatments. These results were true at the two sampling dates in both seasons. Increasing urea spray rates from 2 to 4 and 6 mg/liter increased means of plant height, plant fresh weight and plant dry weight at the two sampling dates in both seasons. The increases in plant growth characters by increasing urea spray rate may be attributed to its vital contribution to several biochemical processes (chlorophyll, enzymes and proteins synthesis) related to vegetative growth in the plants and to its active role on assimilating the photosynthetic reactions (Marschner, 1994 and El-Desuki *et al.,* 2006).

Results presented in Table 5, plant height and plant fresh weight were significantly affected by the interaction between potassium application treatment and urea spraying rate at the two sampling dates in both seasons, except for plant height at 90 DAT in first seasons. Bulbing ratio was significantly affected by the interaction between the two factors only at 90 DAT in the first season, while plant dry weight was insignificantly affected by this interaction at the two sampling dates in both seasons. The highest means of plant height, plant fresh weight and plant dry weight were obtained by applying 50% of potassium at 30 DAT and 50% at 60 DAT (K_4) and spraying with 6 g/l of urea. These results were true at the two sampling dates in both seasons. Bulbing ratio appeared the highest means by the combination between K_2 potassium treatment and spraying with 2 g/l of urea at 90 DAT; and between K_4 potassium treatment and spraying with 2 g/l of urea at 120 DAT in the first season. While in the second season, the highest means were obtained by the combination between K_2 potassium treatment and spraying with 6 g/l of urea at two growth stages. Also, it was observed that the combination between K_3 potassium treatment and spraying with 2 g/l of urea attained the lowest means of plant height, plant fresh weight and plant dry weight at the two sampling dates in the first season. While in the second season, this interaction attained the lowest means for plant height at 90 DAT and plant dry weight at 120 DAT.

B- Bulb yield and its components:

Data presented in Table 6 showe that the tested potassium application treatments exhibited significant differences in mean values of average bulb weight, marketable yield/fed., culls yield/fed. and total yield/fed. in both seasons. Adding 50% of potassium at 30 DAT and 50% at 60 DAT (K_4) attained the highest mean values of average bulb weight (87.90 and 104.18 g), marketable yield/fed. (12.88 and 13.79 t/fed.), culls yield/fed. (1.36 and 1.95 t/fed.) and total yield/fed. (14.24 and 15.75 t/fed.), in the first and second seasons, respectively. While, Adding 50% of potassium before transplanting and 50% at 60 DAT (K_3) attained the lowest mean values of bulb weight (75.46 and 94.13 g), marketable yield/fed. (11.32 and 11.90 t/fed.), culls yield/fed. (0.91 and 1.40 t/fed.) and total yield/fed. (12.23 and 13.30 t/fed.), in the first and second seasons, respectively.

From these results, it can be concluded that an increases in yield and its components due to adding K-fertilizer at two equal doses(30 and 60 days after transplanting) indicated that the uptake of potassium at vegetative as well as bulb formation stage was much better under this method of potassium application as compared to other application methods. Similar results were reported by Satter and Haque, 1975, Sing and Verma, 2001, and Islam *et al.,* 2008.

It is clear from results in Table 6 that the differences among mean values of average bulb weight, marketable yield/fed., culls yield/fed. and total yield/fed. for the three urea spray treatments were significant in both seasons. Spraying onion plants with 6 g/l of urea attained the highest means of average bulb weight (89.89 and 102.10 g), marketable yield/fed. (12.58 and 13.48 t/fed.), culls yield/fed. (1.32 and 1.82 t/fed.) and total yield/fed. (13.90 and 15.30 t/fed.), while spraying with 2 g/l of urea attained the lowest mean values of average bulb weight (76.24 and 95.72 g), marketable yield/fed. (11.51 and 11.88 t/fed.) and total yield/fed. (13.90 and 15.30 t t/fed.), in the first and second seasons, respectively. The lowest values of culls yield/fed. were obtained by spraying with 2 g/l of urea (0.99 t/fed.) in the first season, and by spraying with 4 g/l (1.59 t) in the second season. The increments in marketable yield/fed. under the highest urea spray rates were 5 and 9 % in the first season, 6 and 13 % in the second season, while these increments in total yield/fed. were 6 and 11 % in the first season; 7 and 14 % in the second season over the middle and the lowest urea spray rates, respectively. These results may be explained in view the explanation of Khalil *et al.,* (1988), who cleared that N application enhanced metabolic activities within the plant, improved vegetative growth and thereby encouraged much more metabolites to be stored in the bulbs as storage organs. These results were in harmony with those reported with Patel and Patel (1990), Rana and Sharma (1994), El-Desuki *et al.,*(2006) and Yaso *et al.,* (2007) who revealed that the total onion bulbs yield and its components were improved as a results of increasing the level of mineral N-fertilizer. However, Koota and Osinska (2001) illustrated that the maximum increase in marketable yield in onion using supplementary foliar fertilization was 10.8%.

The interaction between potassium application treatment and urea spray rate had significant effects on average bulb weight, culls yield/fed. and total yield/fed. in the second season, and on marketable yield/fed. in both seasons (Table 6). Mean values of average bulb weight, marketable yield/fed., culls yield/fed. and total yield/fed. were reached the maximum by adding 50% of potassium at 30 DAT and 50% at 60 DAT (K_4) when onion plants sprayed with 6 g/l of urea in both seasons, except for culls yield/fed. in the second season. While these characters recorded the minimum mean values by adding 50% of potassium before transplanting and 50% at 60 DAT (K_3) when onion plants sprayed with 2 g/l of urea in both seasons, except for average bulb weight in the first season and culls yield/fed. in the second season.

C- Bulb quality:

Results in Table (6) indicate that potassium application treatment had significant effect on total soluble solids percentage (TSS%) and dry matter%,

in both seasons. The highest mean values of TSS% (13.55 and 14.26%) and dry matter% (14.16 and 21.34%) were obtained by adding 50% of potassium before transplanting and 50% at 60 DAT (K_3), while the least values of TSS% (12.47 and 13.28%) and dry matter% (13.69 and 20.12%) were obtained by adding of 50% of potassium at 30 DAT and 50% at 60 DAT (K_4) in the first and second seasons, respectively. These results revealed that TSS% and dry matter% were reduced by increasing bulb size and weight of onion under optimum potassium treatment (K4) and this may be attributed to the high moisture content in these bulbs.

Results in Table (6) clearly indicated that urea spray rates had significant effect on TSS% in the second season and on dry matter % in both seasons. Increasing urea spray rate from 2 g/l to 4 or 6 g/l decreased mean values of TSS% and dry matter % in both seasons. These results reflect the adverse effect of the excessive N-application on TSS% and dry matter% and thus may be attributed to the high moisture content in bulbs of onion. Thes results were in agreement with those of Haggag *et al.,* (1986) and Hanna-alla *et al.,* (1991), who cleared that application of 120-150 kg N/fed. decreased percentage of TSS% content.

Results also indicated that the interaction between K-fertilization treatment and urea spray rate had a significant effect on dry matter% only in the second season, while it failed to exert any significant effect on TSS% in first or second seasons (Table 6). The maximum mean values of TSS% and dry matter were obtained by the combination between K_3 potassium treatment and spraying onion plants with 2 g/l of urea n both seasons. While the minimum means of TSS% in both seasons and dry matter% in the second season were obtained by the combination between K_4 potassium treatment and spraying onion plants with 6 g/l of urea.

D- Bulbs storability:

Results in Table 7 indicate significant differences among the studied potassium application treatments on weight loss% of onion bulbs during the five storage periods in both seasons, except for weight loss% at 120 days in the first season and at 30 days in the second season. Adding 50% of potassium before transplanting and 50% at 60 DAT (K_3) gave the lowest mean values of weight loss% at all storage periods in both seasons, except for weight loss% at 120 storage period in the first season and at 30 days in the second season. While, adding 50% of potassium at 30 DAT and 50% at 60 DAT (K_4) gave the highest mean values of weight loss% at all storage periods in both seasons. It could be concluded that the weight loss% of onion bulbs during storage periods appeared the same trend of plant growth as well as yield and its components of onion in response to K-fertilization treatments.

The results indicated that weight loss% was significantly increased by raising urea spray rate from 2 to 6 g/l at all storage periods in both seasons, except for weight loss% at 90 and 120 storage periods in the first season (Table 7). From this result, it can be concluded that onion bulbs grown under high nitrogen dose tended to rot and sprout early during storage than those grown under lower doses. These results were in harmony with those found by Brewster (1994), who showed that excessive N-application contributes to

increased storage losses and Batal *et al.,* (1995), who reported that high levels of nitrogen fertilization promote sprouting and decay of onions.

The interaction between K-fertilization treatment and urea spray rate had a positive effect on weight loss% only at 30 and 60 storage periods in the first season (Table 7). Adding 50% of potassium before transplanting and 50% at 60 DAT (K_3) and spraying onion plants with 2 g/l of urea attained the lowest means of weight loss% at 60, 90 and 150 as well as at 60, 120 and 150 storage periods, in the first and second seasons, respectively. While, adding 50% of potassium at 30 DAT and 50% at 60 DAT (K_4) and spraying with 6 g/l of urea attained the highest mean values of weight loss% at all storage periods in both seasons, except for that at 120 storage period in the first season (Table 7).

Table 7: Total weight loss of onion bulbs as affected by potassium application date, foliar spray with urea and their interaction during five months after harvesting in 2007/2008 and 2008/2009 seasons.

Treatment		2007/2008					2008/2009				
		Jun.	Jul.	Aug.	Sept.	Oct.	Jun.	Jul.	Aug.	Sept.	Oct.
Potassium application date (A):											
K_1		3.90 a	3.59 a	3.10 a	2.93	8.19 a	2.73	3.61 b	3.45 b	6.98 a	9.89 b
K_2		3.50 b	3.40 b	2.88 ab	2.66	7.13 b	2.52	3.07 bc	3.29 b	6.07 b	9.26 c
K_3		3.50 b	3.14 c	2.81 b	2.72	5.88 c	2.53	2.51 c	3.25 b	4.87 c	7.89 d
K_4		4.00 a	3.64 a	3.13 a	3.02	8.67 a	2.90	4.77 a	4.13 a	7.46 a	10.92 a
F – test		**	**	*	N.S	**	N.S	**	*	**	**
Urea spray rate (B):											
2 g/l		3.52 c	3.25 c	2.88	2.91	6.35 c	2.53 b	2.51 c	3.06 b	5.53 c	8.19 b
4 g/l		3.63 b	3.40 b	2.98	2.75	7.60 b	2.64 b	3.39 b	3.47 ab	6.30 b	9.86 a
6 g/l		4.03 a	3.68 a	3.08	2.84	8.45 a	2.85 a	4.57 a	4.07 a	7.21 a	10.43 a
F – test		**	**	N.S	N.S	**	**	**	**	**	**
Interaction (A x B):											
K_1	2 g/l	3.93 c	3.47 ce	3.00	2.77	7.11	2.47	2.77	2.49	6.40	8.64
	4 g/l	3.63 df	3.53 bd	3.10	2.83	8.33	2.77	3.43	3.72	6.71	10.08
	6 g/l	4.13 b	3.77 b	3.20	3.20	9.14	2.97	4.63	4.13	7.83	10.95
K_2	2 g/l	3.20 g	3.27 de	2.80	2.83	6.13	2.40	2.44	2.89	5.00	7.95
	4 g/l	3.50 f	3.37 ce	2.83	2.60	6.84	2.57	2.70	3.04	6.09	9.73
	6 g/l	3.80 cd	3.57 bc	3.00	2.53	8.43	2.60	4.06	3.93	7.13	10.11
K_3	2 g/l	3.23 g	2.97 f	2.73	3.13	4.43	2.43	1.34	3.06	3.88	6.31
	4 g/l	3.57 ef	3.20 ef	2.83	2.50	6.35	2.33	2.52	3.28	5.07	8.57
	6 g/l	3.70 de	3.27 de	2.87	2.53	6.86	2.83	3.68	3.42	5.67	8.81
K_4	2 g/l	3.70 de	3.30 ce	3.00	2.90	7.72	2.80	3.50	3.79	6.85	9.85
	4 g/l	3.80 cd	3.50 bd	3.13	3.07	8.90	2.90	4.90	3.82	7.31	11.08
	6 g/l	4.50 a	4.13 a	3.27	3.10	9.39	3.00	5.91	4.79	8.22	11.84
F – test		**	*	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

****, * and NS indicate p <0.05 , <0.01 and not significant , respectively. Means within the same column for each factor designated by the same letter are not significantly different at 5% level according to Duncans Multiple Range Test**

K_1: 100% at land preparation, K_2: 50% before transplanting +50% at 30 days after transplanting, K_3: 50% before transplanting +50% at 60 days after transplanting and K_4: 50% at 30 days after transplanting +50% at 60 days after transplanting.

Conclusion:

This study showed that, under the environmental conditions of this research, adding 50% of potassium at 30 DAT and 50% at 60 DAT and spraying onion plants with 6 g/l of urea attained the highest means for most plant growth characters and for yield and its components. So, this study recommended onion growers at North Delta to using this combination to attained optimum onion yield per unit area.

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النمو والمحصول و القدرة التخزينية للبصل وتأثرهم بمواعيد اضافة السماد البوتاسى والرش الورقى باليوريا.

لبيب صبحى ميخائيل جريس ورفعت علام مرعى ومحمد جمعه مرسى
قسم بحوث البصل - معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية - الجيزة- مصر

أقيمت تجربتان حقليتان خلال موسمى 2008/2007 و 2009/2008 بالمزرعة البحثية بمحطة البحوث الزراعية بسخا ـ محافظة كفر الشيخ ـ مصر. وكان الهدف من هذه التجربة هو دراسة تأثير أربع مواعيد لإضافة البوتاسيوم (100% قبل الشتل، و50% قبل الشتل + 50% بعد 30 يوم من الشتل، و 50% قبل الشتل + 50% بعد 60 يوم من الشتل، و50% بعد 30 يوم من الشتل + 50% بعد 60 يوم من الشتل)، وثلاثة معدلات للرش باليوريا (2 و4 و6 جرام/لتر)، على الصفات الخضرية (عند عمر 90 و120 يوم من الشتل) والمحصول ومكوناته وصفات الجودة والتخزين فى البصل.

وقد كانت أهم النتائج المتحصل عليها كما يلى:

1- أظهرت النتائج ان صفات طول النبات ومعدل التبصيل والوزن الغض للنبات والوزن الجاف للنبات أعلى القيم عند إضافة 50% من البوتاسيوم بعد 30 يوم من الشتل و 50% بعد 60 يوم من الشتل، وذلك فى كلا مرحلتى النمو، فى كلا الموسمين، فيما عدا طول النبات عند 120 يوم من الشتل فى الموسم الأول ومعدل التبصيل عند 90 يوم من الشتل فى كلا الموسمين.

2- اوضحت النتائج ان طريقة إضافة 50% من البوتاسيوم بعد 30 يوم من الشتل و 50% بعد 60 يوم من الشتل الى تحقيق اعلى القيم من وزن البصلة ومحصول الابصال القابلة للتسويق للفدان ومحصول النقضة للفدان والمحصول الكلى للفدان. فى حين أدت اضافة 50% من البوتاسيوم قبل الشتل و 50% بعد 60 يوم من الشتل الى تحقيق اقل القيم من تلك الصفات. وذلك فى كلا الموسمين.

3- أشارت النتائج الى ان أعلى القيم من النسبة المئوية للمواد الصلبة الذائبة الكلية و النسبة المئوية للمادة الجافة بالبصلة عند إضافة 50% من البوتاسيوم قبل الشتل و50% بعد 60 يوم من الشتل. فى حين تم الحصول على اقل القيم عند إضافة 50% من البوتاسيوم بعد 30 يوم من الشتل و 50% بعد 60 يوم من الشتل، وذلك فى كلا الموسمين.

4- اشارت النتائج الى ان الزيادة فى معدل الرش باليوريا من 2 الى 4 أو 6 جرام/لتر الى زيادة فى متوسطات طول النبات و الوزن الغض للنبات والوزن الجاف للنبات فى كلا مرحلتى النمو، وفى كلا الموسمين.

5- أظهرت النتائج ان الزيادة فى معدل الرش باليوريا من 2 الى 4 أو 6 جرام/لتر نقصاً فى كلاً من النسبة المئوية للمواد الصلبة الذائبة الكلية و النسبة المئوية للمادة الجافة بالبصلة، وذلك فى كلا الموسمين.

6- حققت معاملة الرش باليوريا بمعدل 6 جرام/لتر اعلى القيم من وزن البصلة ومحصول الابصال القابلة للتسويق للفدان ومحصول النقضة للفدان والمحصول الكلى للفدان، فى حين ادى الرش باليوريا بمعدل 2 جم/لتر الى إعطاء اقل القيم من جميع هذه الصفات فيما عدا محصول النقضة للفدان فى الموسم الثانى.

7- أشارت النتائج الى أن اعلى القيم للتفاعل بين عاملى الدراسة لكل من وزن البصلة ومحصول الأبصال القابلة للتسويق للفدان والمحصول الكلى للفدان من خلال إضافة 50% من البوتاسيوم بعد 30 يوم من الشتل و50% بعد 60 يوم من الشتل مع الرش باليوريا بمعدل 6 جرام/لتر. وذلك فى كلا الموسمين.

وتحت ظروف هذه الدراسة يمكن أن نستنتج أن إضافة 50% من البوتاسيوم بعد 30 يوم من الشتل و50% بعد 60 يوم من الشتل مع رش نباتات البصل باليوريا بمعدل 6 جرام/لتر يمكن أن ينصح بة للحصول على أعلى محصول من البصل فى وحدة المساحة0

قام بتحكيم البحث

أ.د / احمد ابو النجا قنديل	**كلية الزراعة – جامعة المنصورة**
أ.د / عبد الواحد عبد الحميد السيد	**كلية الزراعة – جامعة كفر الشيخ**

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Table 6: Effect of potassium application date, foliar spray with urea and their interaction on bulb yield and its components and bulb quality of onion during 2007/2008 and 2008/2009 seasons.

Treatment		2007/2008						2008/2009					
		Average bulb weight (g)	Market. Yield (t/fed.)	Culls yield (t/fed.)	Total yield (t/fed.)	T.S.S %	D.M. %	Average bulb weight (g)	Market. Yield (t/fed.)	Culls yield (t/fed.)	Total yield (t/fed.)	T.S.S %	D.M. %
Potassium application date(A):													
K_1		84.44 b	12.07 b	1.26 ab	13.33 b	12.70 b	13.99 ab	95.90 bc	13.05 a	1.82 ab	14.87 b	13.67 b	20.42 c
K_2		81.20 c	11.80 c	1.05 bc	12.85 c	13.49 a	13.80 bc	100.32ab	12.05 b	1.51 bc	13.55 c	13.39 c	20.77 b
K_3		75.46 d	11.32 d	0.91 c	12.23 d	13.55 a	14.16 a	94.13 c	11.90 b	1.40 c	13.30 c	14.26 a	21.34 a
K_4		87.90 a	12.88 a	1.36 a	14.24 a	12.47 b	13.69 c	104.18 a	13.79 a	1.95 a	15.75 a	13.28 c	20.12 d
F - test		**	**	*	**	*	**	**	**	*	**	**	**
Urea spray rate(B):													
2 g/l		76.24 c	11.51 c	0.99 b	12.50 c	13.20	14.23 a	95.72 b	11.88 c	1.60 b	13.48 c	13.96 a	21.05 a
4 g/l		80.62 b	11.97 b	1.12 ab	13.09 b	13.02	13.83 b	98.08 b	12.73 b	1.59 b	14.32 b	13.67 b	20.55 b
6 g/l		89.89 a	12.58 a	1.32 a	13.90 a	12.94	13.69 b	102.10 a	13.48 a	1.82 a	15.30 a	13.32 c	20.38 b
F - test		**	**	*	**	N.S	**	**	**	*	**	**	**
Interaction (A x B):													
K_1	2 g/l	75.82	11.84 cd	1.01	12.85	12.83	14.33	96.91 bc	12.45 d	1.51 cd	13.96 ce	13.83	20.63 cd
	4 g/l	86.83	12.14 bc	1.24	13.38	12.71	13.94	97.88 bc	12.80 c	1.52 cd	14.33 bd	13.67	20.40 de
	6 g/l	90.69	12.24 bc	1.54	13.77	12.56	13.72	92.91 cd	13.91 b	2.42 a	16.33 a	13.50	20.23 e
K_2	2 g/l	76.48	11.44 d	0.92	12.36	13.56	14.23	101.67 b	11.19 f	1.54 cd	12.74 de	13.67	21.07 b
	4 g/l	81.14	11.78 cd	1.02	12.79	13.47	13.64	98.72 bc	12.41 d	1.50 cd	13.91 ce	13.33	20.64 cd
	6 g/l	85.99	12.18 bc	1.20	13.38	13.44	13.54	100.56bc	12.55 cd	1.47 cd	14.02 ce	13.17	20.60 cd
K_3	2 g/l	71.03	10.41 e	0.87	11.28	13.73	14.39	88.74 d	11.10 f	1.54 cd	12.64 e	14.67	22.18 a
	4 g/l	70.01	11.47 d	0.93	12.40	13.48	14.14	95.51 bd	12.02 e	1.24 d	13.26 ce	14.17	20.97 bc
	6 g/l	85.33	12.07 bc	0.93	13.01	13.44	13.95	98.13 bc	12.57 cd	1.44 d	14.00 ce	13.93	20.87 bc
K_4	2 g/l	81.65	12.33 b	1.17	13.49	12.67	13.95	95.57 bd	12.78 c	1.82 bc	14.60 bc	13.67	20.34 de
	4 g/l	84.50	12.48 b	1.30	13.78	12.42	13.58	100.19bc	13.70 b	2.08 b	15.78 ab	13.50	20.19 e
	6 g/l	97.56	13.84 a	1.60	15.44	12.32	13.55	116.79 a	14.91 a	1.95 b	16.86 a	12.67	19.83 f
F - test		N.S	**	N.S	N.S	N.S	N.S	**	**	**	**	N.S	**

****, * and NS indicate p <0.05 , <0.01 and not significant , respectively. Means within the same column for each factor designated by the same letter are not significantly different at 5% level according to Duncans Multiple Range Test**

K_1: 100% at land preparation, K_2: 50% before transplanting +50% at 30 days after transplanting, K_3: 50% before transplanting +50% at 60 days after transplanting and K_4: 50% at 30 days after transplanting +50% at 60 days after transplanting.