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RESPONSE OF GROWTH AND YIELD OF ONION PLANTS TO POTASSIUM FERTILIZER AND HUMIC ACID.

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ABSTRACT

Two field experiments were carried out during the two successive seasons of 2001/2002 and 2002/2003 at the Experimental Station of National Research Centre at Shalkan, Kalubia Governorate to study the response of growth and yield of onion to potassium sulphate fertilizer at rates of 0, 150 and 300 kg/fed, as well as potassium humate at rate of 0, 3, 6 and 12 L/fed.

The important obtained results were as follows:-

1. Increasing the potassium addition level up to 150 kg/fed had a significant effect on the growth characters, i.e. plant height, number of leaves / plant, fresh and dry weight of whole plant as well as total yield and its components (bulb weight as g / bulb and bulb dimension. Also, gave the highest percentage of TSS, N, P, K, Fe, Mn, Zn and Cu. Increasing the potassium addition from 150 up to 300 kg/fed caused a reduction in growth characters, yield and chemical characters, (TSS, N, P, K and Fe, but increased Mn, Zn and Cu).
2. Foliar application of potassium humate at different levels, i.e. 0, 3, 6 and 12 L/fed. had a significant effect on growth characters and total yield and its components as well as chemical characters all of them resulted its highest values only with that onion plants, which sprayed with humic acid at 6 L/fed, but that onion plants, which sprayed with humic acid at levels of 12 L/fed resulted less plant growth as well as yield and its components, in addition caused an increment in TSS, N, P, K, Fe, Mn and Zn in bulb tissues.

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important vegetable crop grown in Egypt. Increasing productivity of onion with good quality is an important target by the growers for local market and exportation.

In the natural soil, a balance exits between the metal ions that occur in the solution phase (free ions/or soluble chalet complexes) and in insoluble mineral and organic forms. The quantity of micronutrients available to plants at any one time is affected not only by the synthesis and destruction of biochemical chelating substances, but on transformations carried out by micro-organisms (Stevenson 1982). Therefore, humic acid is particularly used to decrease the negative effects of chemical fertilizers and could have beneficial effect on nutrition of plants (Martinez *et al*., 1983).

The commercial humic acids improved growth, yield production, quality and significant increase in the accumulation of P, K, Ca, Mg, Fe, Zn and Mn in tissues of tomato as well as increased accumulation of N, Ca, Fe, Zn and in roots (Chen and Aviod, 1990, David *et al*., 1994, Padem and Ocal 1999 and Erik *et al*., 2000). In the same respect, Padem *et al*. (1997) studied that the effect of humic acid addicted foliar fertilizer on eggplant and pepper.

They found that seedling stem diameter; number of leaves, shoot and dry matter were significantly influenced by foliar applications in both vegetables.

A combination of 120 kg N and 50 kg K_2O increased growth, yield and quality, i.e. bulb weight, bulb diameter and TSS in tissues of onion (Singht *et al*., 1991 and Vachihani and Patel, 1996). Rizk (1989) reported that the increasing of NPK rate increased vegetative growth, yield and quality of bulb onion. Yield and quality increased significant with K fertilization (Bhande *et al*., 1998; Jiang *et al*., 1998; Gue *et al*., 1999 and Sing and Mohanty, 2000).

The aim of the present study was to investigate the effect of different rates of potassium fertilizer and humic acid on growth, yield and some physical and chemical properties of onion bulbs.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Station of the National Research Centre at Shalakon (Kalubia governorate), during the seasons of 2000/2001 and 2001/2002 to investigate the effect of potassium sulphate at 0, 150 and 300 kg/fed with humic acid at 0, 3, 6 and 12 L/fed. on the productivity and some chemical constituents of onion. Chemical analysis and physical properties of the experimental soil are shown in Table (1) while the chemical analysis of humic acid is given in Table (2).

Table (1): Physical and chemical analysis of the experimental soil.

Physical properties	**2001/2002**	**2002/2003**
Soil texture	Clay	Clay
Clay (%)	45.83	48.20
Silt (%)	29.71	27.51
Fine sand (%)	20.53	21.14
Coarse sand (%)	2.48	2.82
Chemical analysis		
Available K (mg/100 g soil)	0.61	0.58
Available P (mg/100g soil)	5.72	4.81
Total N (mg/100g soil)	128.04	151.80
Cl (meq/L)	1.82	1.65
CO_3 (meq/L)	4.34	5.13
Na_2CO_3 (meq/L)	3.65	3.82
$CaCO_3$ (meq/L)	1.76	1.65
Organic matter (%)	1.82	1.87
SO_4 (ppm)	76.03	95.41
EC (mmhos/cm/25°C)	2.48	2.35
pH	7.52	7.70

Table (2): Chemical analysis of humic acid.

Chemical analysis	**value**
Density	1.4 g/cm^3
Humic acid	23.0 g/L
Folic acid	0.5 g/L
Phosphorus	0.5 g/L
Nitrogen	5.0 g/L
Potassium	15.0 g/L

Onion seedlings cv. Giza 20 were transplanted on 20th and 13th of December for 2001/2002 and 2002/2003 seasons, respectively. The experimental design was split plot with three replicates, where the three application rates of potassium sulphate, i.e. 0, 150 and 300 kg/fed. were arranged within the main plots, but the 4 levels of humic acid (0, 3, 6 and 12 L/fed.) were distributed in the sub-plots. Each experiment included 12 treatments with 3 replicates. The plot area was 14.0 m^2 (4 ridges, 70 cm interval, 5 meter in length). Potassium sulphate was added at two equal amounts, the first half was one month after transplanting and the second one 60 days late, but humic acid added with the irrigation water at transplanting time. The normal cultural practices of onion production commonly used as in the growing area.The following data were recorded:-

1. Plant growth:

After 150 days from transplanting, samples of onion plants were taken and number of leaves per plant, plant length (cm), fresh and dry weight of leaves, neck and bulb (g/plant) were recorded.

2. Bulb yield and its physical properties:

At harvest time (180 days old), the total weights of bulbs resulting from each experimental plot of 3 replicates were recorded and the yield of bulbs as ton/fed. was calculated. Samples of 10 bulbs from each experimental plot were taken and average weight (g), length and diameter of bulb as well as TSS were recorded.

3. Nutritional elements:

At harvesting time, onion bulb samples from each experimental plot were taken for elemental analysis, where N, P and K elements in the dry matter of bulb tissue were determined according to the methods described by Pregl (1945), Troug and Mayer (1939) and Brown and Lilleland (1946), respectively for N, P and K. But, Fe, Mn, Zn and Cu concentration were determined using flame ionization atomic absorption spectrophotometer model 1100 B (Perkin Elmer) according to the method of Chapman and Pratt (1978). Reading of TSS was taken using hand refractmeter calibrated as percent sucrose.

All obtained data were subjected to the statistical analysis and means were compared according to LSD at 5% level test described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A. Vegetative growth characters:

1. Effect of potassium fertilizer:

Tables (3) and (4) show clearly that addition of potassium fertilizer as dressing at different levels caused a significant effect on the vegetative plant growth characters of onion plant in both two seasons. However, increasing the potassium addition levels up to 150 kg/fed. of potassium sulphate resulted in the heightest plants (1st season only), which had the highest number of leaves (two seasons) as well as the heaviest fresh and dry weight of whole plant and its different organs (two seasons).

Moreover, the increasing of potassium sulphate addition from 150 to 300 kg/fed. caused a depression in all values of plant growth characters. These results are good in both seasons with exception of height of plant in 2nd season, where the highest onion plant recorded with that plant, which received the highest potassium sulphate level, i.e. 300 kg/fed.

The obtained results are in good accordance with these which obtained by Singht *et al*. (1991), Vachihani and Patel (1996) and Rizk (1989). It known that potassium is important to plant growth. It addition is necessary for carbohydrate manufacture, and its deficiency seems to make plant develop, abnormal leaf color, stems and underdeveloped roots Denizen (1979).

2. Effect of potassium humate (humic acid):

The application of potassium humate (humic acid) with irrigation water at different levels, i.e. 0, 3, 6 and 12 L/fed. had a statistical significant effect on the parameters of onion plant growth in two seasons of 2001/2002 and 2002/2003. However, the vigor plants, i.e. the highest leaves number, heaviest fresh and dry weight of whole plant and its different parts, all of them resulted only with that onion plants, which treated with humic acid at 6 L/fed. These findings are true in both seasons. From other side, the obtained data reveals that the onion plants, which sprayed with humic acid at levels of 12 L/fed. resulted less vigor of plant growth if compared with that plants which treated with humic acid at 6 L/fed. The application of humic acid resulted the vigor plant growth expressed as plant length, fresh and dry weight of whole plant and its different organs. Also had a similar trend of results which obtained in this respect (Erik *et al*., 2000).

3. Effect of potassium fertilizer x humic acid:

The interaction effect of potassium fertilizer as potassium sulphate at levels of 0, 150 and 300 kg/fed. with the treatments of humic acid as addition to ingestion water at levels of 0, 3, 6 and 12 L/fed. are presented in Table (3). The recording data showed that the highest values of plant length, number of leaves, total fresh and dry weight of onion plant as well as its leaves, bulb and neck, all of these criteria's were obtained with that plants, which fertilized with potassium sulphate at 150 kg/fed. with adding humic acid at 6 L/fed. These results were similar in the two experimental seasons, with exception of plant length in 2nd season. The statistical analysis of the obtained data showed that the differences within the different interaction treatments were great enough to reach the level of significant at 5%, except fresh weight of neck in two seasons and its dry weight in 1st season only.

B. Total bulb yield and its some physical properties:

1. Effect of potassium fertilizers:

Total onion bulb yield as ton/fed. recorded its heaviest values (11.73 and 9.7 ton/fed. for 1st and 2nd seasons, respectively with addition of potassium fertilizer at rate of 150 kg as potassium sulphate per feddan (Table 5).

Increasing the potassium addition from 150 up to 300 kg caused a reduction in total bulb yield amounted by 14.77 and 10.98%, respectively in 1st and 2nd seasons. The response of average bulb weight as g/bulb and bulb dimension (length and diameter) followed the same pattern of change like that mentioned above.

The statistical analysis of the obtained data showed that the differences within different treatments of potassium fertilizers were great enough to reach the 5% levels. The obtained results in both two seasons were similar.

It could be concluded that the heaviest bulbs yield and its best values of some physical properties, which resulted may be attributed to the best vigor of plant growth characters which obtained by addition of 150 kg of potassium sulphate per fed. (Tables 3 and 4).The trend of obtained results are in good accordance of the previos investigators such as Bhande et al. (1998), Jiang et al. (1998), Gue et al. (1999) and Sing and Mohanty (2000).

There is no doubt that K as an important nutritional element plays its part in regulation many physical criterias in plant which in turn effect on the resulted total yield. The previous references of current knowledge about K, may reflect the interest of many workers in studying its mode of action and its role in the production of onion. However, one fact must be put in mind is that the provide K to the plant or the soil depends largely on the available reservation of this element in the soil. So, the negative or the positive results may be due to this quantity of K stored in the soil.

The trend of obtained results are in good accordance with that of the previous investigators such as Bhande *et al*. (1998), Jiang *et al*. (1998), Gue *et al*. (1999) and Sing and Mohanty (2000).

2. Effect of humic acid:

Table (5) shows clearly that the application of humic acid (potassium humate) had a significant effect on the total bulb yield as ton/fed. as well as its some physical characters (average weight, length and diameter of bulb) in both two experimental seasons. Whereas, supplying onion plants by humic acid at level of 6 L/fed. resulted the heaviest total yield as ton/fed. (12.1 and 10.11 in 1st and 2nd seasons, respectively). However, the yield of onion decreased when the application rate raised up to 300 kg/ fed. These decrements amounted by 15.7% and 17.8% for 1st and 2nd season, respectively. Some physical properties of onion bulb responded completely like that of total bulb yield as ton/fed. These were true in both seasons.

It could be summarized that humic acid caused an increment in total bulb yield and caused an enhancement in some physical properties if treated at rate of 6 L/fed.

The trend of these results are supported by that of Chen and Aviod (1990), David *et al*. (1994), Padem *et al*. (1997) and Erik *et al*. (2000).

3. Effect of potassium fertilizer with humic acid:

The resulted data of Table (5) reveals that addition of potassium sulphate as soil fertilizer at rate of 150 kg/fed. and supplying that plants with humic acid at level of 6 L/fed gave the heaviest total bulb yield (13.08 and 10.97 ton/fed, respectively in 1st and 2nd season). Also, that interaction

treatment resulted the best physical bulb properties. The statistical analysis of the obtained data recorded a significant difference within different interaction treatments. These were true for total bulb yield and its physical properties in both two seasons, except that of bulb length in 1st season, which no significant responded by interaction treatments.

C. Total soluble solids and chemical nutrition values:

1. Effect of potassium fertilizers:

Data recorded in Table (6) shows clearly that the highest values of TSS, N and Fe in onion bulb tissues were determined in bulbs of that plants which fertilized by potassium sulphate at rate of 150 kg/fed. However, concerning to the values of potassium, manganese, zinc and cupper in bulb tissues, the obtained data cleared that with increasing potassium fertilizer level, their contents in onion bulb tissues raised to reach the highest values with addition the highest potassium sulphate rate, i.e. 300 kg/fed. These findings are in good accordance with the two experimental seasons. The statistical analysis of the obtained data reveals that the differences within different potassium levels were great enough to be significantly in two seasons, with the exception of P in two seasons and TSS values and Mn only in 2nd season. However, it is known that increasing the levels of K in soil extract raised the availability of nutrient elements which favored to enhancement their absorption and hence increased its concentration in storage organs.

The trend of obtained results are in good accordance of the previous investigators such as Bhande *et al*. (1998), Jiang *et al*. (1998), Gue *et al*. (1999) and Sing and Mohanty (2000).

2. Effect of humic acid:

The application of humic acid (potassium humate) had a great effect on the value of TSS and some nutritional elements of onion bulb tissues in the two studied seasons. Whereas, increasing rates of the application caused an increment in TSS, N, P, K, Fe, Mn and Zn. However, using humic acid at rate of 6 L/fed. resulted the highest values of TSS, N and K in two seasons, and Zn in 1st season only. Also, obtained data showed that the highest content of Fe, Mn and Cu in two seasons, and Zn in 1st season only were with that plants received 12 L. / fed. with no significant difference bythat treatment of applying 6 L. / fed.

The statistical analysis of the obtained data show that the differences within different potassium humate levels with regard to the studied chemical properties were great to reach the 5% level of significant in two seasons, with exception of phosphorus content in two seasons. Similar results were obtained by Chen and Aviod (1990), David *et al*. (1994), Padem *et al*. (1997) and Erik *et al*. (2000).

3. Effect of potassium fertilizer with humic acid:

The interaction between 3 levels of potassium fertilizer and 4 levels of humic acid had a slow great effect on the several of some chemical nutritional composition of onion bulb tissues. Whereas, that onion plants which received 150 kg of potassium sulphate and 6 L/fed. of humic acid resulted the highest N values in two seasons and TSS in 1st season only.

However, when onion plants which were fertilized by 150 kg/fed of potassium sulphate and supplied by potassium humate at 12 L/fed, it, resulted the highest levels of Fe in two seasons. Concerning to Mn, Zn and Cu, the highest levels in onion bulb tissues were found when plants which applied by 300 kg/fed. of potassium sulphate and 12 L/fed. of humic acid in two experimental seasons.

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إستجابة نمو ومحصول البصل للتسميد البوتاسى والمعاملة بهيومات البوتاسيوم (حمض الهيوميك).

فاتن سمير عبد العـال ، محمد رضا شفـيق ، أحمد عبد النبى احمد و عبد المعطى محمد شاهين .

قسم بحوث الخضر – المركز القومى للبحوث – الدقى- القاهرة

أجريت تجربتان حقليتان بمزرعة المركز القومى للبحوث بشلقان ، محافظة القليوبية فى عامين متتالين ٢٠٠٢/٢٠٠١ ، ٢٠٠٣/٢٠٠٢ لدراسة تأثير التسميد البوتاسى بمعدل صفر ، ١٥٠ ، ٣٠٠ كجم/فدان والمعاملة بهيومات البوتاسيوم (حمض الهيوميك) بمعدلات صفر ، ٣ ، ٦ ، ١٢ لتر/فدان على صفات النمو والمحصول والجودة والمحتوى الكيماوى لمحصول البصل.

وتتلخص أهم نتائج الدراسة فيما يلى:-

١- زيادة التسميد البوتاسى ادى الى زيادة معنوية على صفات النموالخضرى والمحصول والمحتوى الكيماوى حتى معدل ١٥٠ كجم/فدان ، أما زيادة المعدل من ١٥٠ إلى ٣٠٠ كجم/فدان يؤدى إلى نقص فى صفات النمو والمحصول والمحتوى الكيماوى من نسبة المواد الصلبة الكلية ، النتروجين ، الفوسفور ، البوتاسيوم ، الحديد ، الزنك ، المنجنيز والنحاس.

٢- اضافة هيومات البوتاسيوم الى ماء الرى بمعدلات صفر ، ٣ ، ٦ ، ١٢ لتر/فدان ادى الى زيادة فى قيم صفات النمو الخضرى والمحصول وجودة الأبصال الناتجة والمحتوى الكيميائى للأبصال من مواد صلبة كلية ، نتروجين ، فوسفور ، بوتاسيوم ، حديد ، منجنيز ، زنك ونحاس وكان افضل معدل هو الرى مع ٦ لتر / فدان.

Table (3): Effect of potassium sulphate and potassium humate on growth characters of onion plant during 2001/2002 season.

Treatments		2001/2002									
K-sulphate (kg/fed)	K-Humate (L/fed)	Plant length (cm)	No. of leaves plant	Fresh weight (g/plant)			Total (g/plant)	Dry weight (g/plant)			Total (g/plant)
				Leaves	Bulb	Neck		Leaves	Bulb	Neck	
	0	62.10	8.62	36.92	59.53	33.20	129.65	12.48	21.28	6.24	40.00
	3	66.93	11.31	48.33	62.04	34.83	145.20	16.39	22.04	6.66	45.09
0	6	70.97	11.82	50.62	88.42	35.60	174.64	16.88	30.14	6.92	53.94
	12	70.33	10.27	43.41	80.64	33.03	157.08	14.48	28.37	6.34	49.19
Mean		67.58	10.51	44.82	72.66	34.17	151.65	15.06	25.46	6.54	47.06
	0	66.70	9.83	40.82	83.83	36.47	161.12	13.60	29.92	7.11	50.63
	3	71.80	11.13	49.12	89.76	37.73	176.61	16.62	33.09	7.27	56.98
150	6	75.07	11.91	51.15	96.34	38.30	185.79	17.12	34.32	7.50	58.94
	12	72.40	11.35	48.17	92.41	36.27	176.85	16.07	32.24	7.01	55.32
Mean		71.49	11.05	47.32	90.59	37.19	175.10	15.85	32.39	7.22	55.46
	0	65.75	9.35	39.98	83.18	30.02	153.18	13.32	29.09	6.04	48.45
	3	70.41	10.82	46.43	87.08	31.41	164.92	15.44	30.60	6.28	52.32
300	6	70.87	10.93	46.88	93.71	31.71	172.30	15.61	33.46	6.31	55.38
	12	69.20	10.82	46.56	91.02	30.26	167.84	15.30	32.20	6.43	53.93
Mean		69.06	10.48	44.96	88.75	30.85	164.56	14.92	31.34	6.27	52.53
Average	0	64.85	9.27	39.24	75.51	33.23	147.98	13.13	26.76	6.46	46.35
K-	3	69.71	11.09	47.96	79.63	34.66	162.25	16.15	28.58	6.74	51.47
Humate	6	72.30	11.55	49.55	92.83	35.20	177.58	16.54	32.64	6.91	56.09
	12	70.64	10.81	46.05	88.03	33.19	167.27	15.28	30.94	6.59	52.81
LSD at	K-sulphate	0.24	0.07	0.07	0.13	0.35	0.55	0.28	1.01	0.30	1.59
5% level	K-Humate	0.28	0.09	0.10	0.07	0.42	0.59	0.16	0.76	0.19	1.11
	Interaction	0.48	0.16	0.17	0.12	NS	0.29	0.28	1.32	NS	1.60

Table (4): Effect of potassium sulphate and potassium humate on growth characters of onion plant during 2002/2003 season.

Treatments		2002/2003									
K-sulphate (kg/fed)	K-Humate (L/fed)	Plant length (cm)	No. of leaves plant	Fresh weight (g/plant)			Total (g/ plant	Dry weight (g/plant)			Total (g/ plant
				Leaves	Bulb	Neck		Leaves	Bulb	Neck	
	0	57.93	6.01	26.00	68.79	35.39	130.18	9.08	22.36	7.04	38.48
	3	68.26	8.40	34.98	82.41	40.86	158.25	11.97	27.66	8.18	47.81
0	6	73.16	11.16	46.58	96.26	43.97	186.81	16.03	33.17	8.79	57.99
	12	70.13	8.70	36.53	80.11	41.36	158.00	12.45	30.14	8.42	51.01
Mean		**67.37**	**8.57**	**36.01**	**81.89**	**40.39**	**158.29**	**12.38**	**28.33**	**8.10**	**48.81**
	0	63.36	9.20	39.12	64.90	39.39	143.31	13.37	23.72	7.64	44.73
	3	74.03	11.70	49.27	80.17	43.75	173.19	17.01	28.40	8.75	54.16
150	6	77.10	14.70	61.18	96.23	47.15	204.56	20.97	33.17	9.42	63.56
	12	73.60	12.73	53.90	87.20	44.10	185.20	18.58	27.63	8.82	55.03
Mean		**72.03**	**12.01**	**50.87**	**82.12**	**43.35**	**176.34**	**17.48**	**28.23**	**8.66**	**54.37**
	0	67.93	9.00	37.74	73.14	35.58	146.46	13.01	23.72	7.34	44.07
	3	78.26	11.10	46.20	78.87	41.45	166.52	15.90	27.19	8.40	51.49
300	6	81.46	13.40	56.05	87.72	43.92	187.69	19.34	32.01	9.07	60.42
	12	79.13	10.66	43.67	75.03	39.58	158.28	15.01	25.61	7.91	48.53
Mean		**76.70**	**11.04**	**45.91**	**77.94**	**40.13**	**163.98**	**15.81**	**27.13**	**8.18**	**51.12**
	0	63.07	8.07	43.28	68.94	36.45	148.67	11.82	23.26	7.34	42.42
Average	3	73.52	10.40	43.48	80.48	42.02	165.98	14.96	27.75	8.44	51.15
K-	6	77.24	12.90	54.60	93.40	45.01	193.01	18.78	32.79	9.09	60.66
Humate	12	74.30	10.70	44.70	80.78	41.68	167.16	15.35	27.79	8.38	51.52
LSD at	K-sulphate	**0.53**	**0.11**	**0.23**	**2.24**	**1.52**	**3.99**	**0.08**	**0.51**	**0.15**	**0.74**
5% level	K-Humate	**0.41**	**0.02**	**0.49**	**1.84**	**0.72**	**3.05**	**0.05**	**0.66**	**0.10**	**0.81**
	Interaction	**0.72**	**0.31**	**0.85**	**3.19**	**NS**	**4.04**	**0.10**	**1.14**	**0.18**	**1.42**

Table (5): Effect of potassium sulphate and potassium humate on total yield of onion plant during 2001/2002 and 2002/2003 season.

Treatments		2001/2002				2002/2003			
K-sulphate (kg/fed)	**K-Humate (L/fed)**	**Bulb weight (g)**	**Bulb length (cm)**	**Bulb diameter (cm)**	**Total yield (ton/fed.)**	**Bulb weight (g)**	**Bulb length (cm)**	**Bulb diameter (cm)**	**Total yield (ton/fed.)**
0	0	68.40	6.91	7.10	7.63	59.77	4.87	6.00	7.08
	3	79.40	10.96	8.81	10.53	70.86	8.90	7.70	8.06
	6	88.23	13.80	9.12	11.33	77.36	10.97	7.73	9.10
	12	82.27	10.71	8.41	10.39	71.18	9.06	8.13	7.57
Mean		**79.58**	**10.60**	**8.36**	**9.97**	**69.79**	**8.45**	**7.39**	**7.95**
150	0	80.06	9.14	8.71	10.44	70.63	6.16	6.68	8.27
	3	91.57	12.17	10.41	12.48	81.06	9.26	8.42	9.93
	6	100.27	13.03	10.99	13.08	93.60	11.30	8.87	10.97
	12	85.87	11.03	9.11	10.91	79.00	9.50	8.16	9.63
Mean		**89.57**	**11.10**	**9.81**	**11.73**	**81.07**	**9.05**	**8.03**	**9.70**
300	0	69.71	7.00	7.67	9.23	60.43	5.33	5.80	6.78
	3	83.37	10.13	8.47	10.21	72.73	8.37	8.86	9.41
	6	94.43	12.20	9.67	11.62	80.16	10.46	9.26	10.26
	12	81.10	9.87	8.20	9.83	69.96	7.40	7.50	8.50
Mean		**82.15**	**9.80**	**8.50**	**10.22**	**70.82**	**7.89**	**7.86**	**8.74**
Average K-Humate	0	72.89	7.35	7.83	9.10	63.61	5.45	6.16	7.88
	3	84.78	11.09	9.23	11.07	74.88	8.84	8.33	9.13
	6	94.31	13.01	9.92	12.01	83.71	10.91	8.62	10.11
	12	83.08	10.54	8.58	10.38	73.38	8.65	7.93	8.56
LSD at 5% level	K-sulphate	**1.56**	**0.51**	**0.05**	**0.17**	**1.18**	**0.24**	**0.20**	**0.07**
	K-Humate	**1.44**	**0.85**	**0.03**	**0.08**	**0.96**	**0.16**	**0.13**	**0.20**
	Interaction	**2.50**	**NS**	**0.06**	**0.14**	**1.67**	**0.27**	**0.23**	**0.35**

Table (6): Effect of potassium sulphate and potassiom humate on chemical content of onion bulb during 2001/2002 and 2002/2003 seasons.

Treatments		2001/2002								2002/2003							
K-sulphate (kg/fed)	K-Humate (L/fed)	TSS	%			Ppm				TSS	%			ppm			
			N	P	K	Fe	Mn	Zn	Cu		N	P	K	Fe	Mn	Zn	Cu
0	0	10.50	1.68	0.34	1.69	133.43	33.13	24.60	16.47	10.68	1.67	0.33	1.94	133.43	32.40	26.43	16.46
	3	11.41	1.98	0.39	1.74	135.13	34.13	26.20	16.80	11.49	1.97	0.34	1.97	135.13	35.60	27.33	16.80
	6	11.87	1.99	0.38	1.78	140.07	36.30	27.80	17.20	11.82	1.99	0.35	1.99	141.80	36.40	29.11	17.20
	12	11.27	1.79	0.38	1.72	142.17	38.03	26.77	17.63	10.96	1.77	0.37	1.87	142.27	37.90	29.80	17.61
Mean		**11.26**	**1.86**	**0.37**	**1.73**	**137.70**	**35.40**	**26.34**	**17.03**	**11.24**	**1.85**	**0.34**	**1.94**	**138.16**	**35.57**	**28.17**	**17.02**
150	0	11.72	1.74	0.35	1.78	124.13	35.10	27.80	18.43	10.89	1.73	0.36	1.96	124.13	34.60	28.41	18.43
	3	12.10	2.12	0.38	1.81	127.70	36.13	28.87	18.87	12.56	2.14	0.37	1.98	127.70	37.59	29.43	18.86
	6	12.67	2.21	0.38	1.83	178.00	37.37	29.40	19.27	11.92	2.25	0.37	1.99	178.00	38.57	29.83	19.26
	12	11.53	2.03	0.38	1.84	179.00	40.33	29.80	19.70	11.03	2.09	0.37	2.00	179.00	39.16	30.11	19.53
Mean		**12.01**	**2.03**	**0.37**	**1.81**	**152.00**	**37.23**	**28.97**	**19.07**	**11.60**	**2.05**	**0.36**	**1.98**	**152.21**	**39.40**	**29.44**	**19.02**
300	0	11.20	1.71	0.35	1.91	135.10	37.43	28.13	20.13	11.98	1.72	0.36	1.98	135.10	36.81	29.70	20.13
	3	11.77	2.07	0.38	1.92	137.03	38.13	29.17	20.60	12.98	2.00	0.36	1.96	137.03	38.73	30.80	20.50
	6	12.17	2.00	0.38	1.94	141.13	38.37	30.30	21.43	12.93	2.07	0.36	2.01	141.13	39.41	31.10	21.53
	12	11.43	1.91	0.32	1.89	144.20	40.33	30.57	22.13	7.00	1.90	0.37	2.01	145.07	40.12	31.26	22.13
Mean		**11.64**	**1.92**	**0.36**	**1.91**	**139.00**	**38.57**	**29.54**	**21.08**	**11.19**	**1.92**	**0.36**	**1.99**	**139.58**	**38.76**	**30.73**	**21.07**
Average K-Humate	0	11.14	1.71	0.35	1.79	130.89	35.22	26.84	18.34	11.19	1.70	0.35	1.96	139.29	34.60	28.18	18.34
	3	11.76	2.06	0.38	1.82	133.29	36.13	28.08	18.76	12.30	2.03	0.35	1.97	133.29	37.31	29.21	18.72
	6	12.23	2.07	0.38	1.85	153.07	37.34	29.17	19.30	12.22	2.10	0.36	1.99	153.64	38.02	30.01	19.33
	12	11.41	1.91	0.36	1.81	155.12	39.57	29.04	19.82	9.66	1.92	0.37	1.96	155.44	38.06	30.39	19.76
LSD at 5% level	K-sulphate	**0.12**	**0.03**	**NS**	**0.00**	**0.59**	**0.08**	**0.98**	**0.06**	**NS**	**0.03**	**NS**	**0.01**	**0.74**	**NS**	**0.10**	**0.05**
	K-Humate	**0.06**	**0.02**	**NS**	**0.00**	**0.49**	**0.05**	**0.84**	**0.07**	**1.73**	**0.02**	**NS**	**0.01**	**0.85**	**0.10**	**0.05**	**0.12**
	Interaction	**0.10**	**0.04**	**NS**	**0.01**	**0.86**	**0.08**	**NS**	**0.12**	**NS**	**0.03**	**NS**	**0.02**	**1.48**	**0.17**	**0.09**	**0.22**