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The Effect of Foliar Application of Ga_3 and Soil Dressing of Npk at Different Levels on the Plant Productivity of Potatoes (*Solanum tuberosum* L.)

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Abstract: The present work was carried out at the Horticulture Experimental Station (Ministry of Agricultural) at Barmoon experimental farm, Dakhalia Governorate, Egypt., during 2005/2006 and 2006/2007, potato (Solanum tuberosum L.) cv. Spunta was cultivated to study the effect of foliar application of GA_3 and soil dressing of NPK at different levels on the growth, yield of tubers and its nutritional values. The important obtained data reveals that: Application of GA_3 enhanced vegetative growth i.e. the length of plant, average number of shoots, leaves number as well as the fresh and dry weight and gave more yield as ton/fed., gram/plant as well as the average number and size of tubers and caused an enhancement in the elemental nutritional values. The addition of NPK at rates of 120 – 90 – 90 units/fed., resulted in the best values of plant growth, average number of shoots, leaves number as well as fresh and dry weight and gave heaviest tuber yield as well as number and size of tuber per plant and raised, the concentration of the nutrient elemental in tubers yield tissues.

Key words:

INTRODUCTION

The total area cultivated with potatoes amounted by 300662 fed. Produced an average of 3167430 tuber tons (2004/2005). In Egypt, the cultivated area is still small and it's difficult to disturb or to change the crop relation in the cultivated land. So, it must pay attention to increase the productivity of the unit area of land. The production of the best fields requires that the soil must have favorable physical, chemical nutritional and biological conditions. Now more than ever the importance of an adequate supply of plant nutrients to ensure efficient crop production is being recognized. Growers are continually seeking to over come nutrient deficiencies as well as use improved management practices in order that yields may more nearly approach the genetic limit of crop plants.

However, from the horticultural point of view, the yield of any plant is the most important target from any plantation. The role of the various NPK levels has been associated with so many significant increasing in the plant growth and total yield of onion[1] and/or Garlic[2,3]; and potatoes [4,5,6,7].

Gibberellins (GA_3) stimulated cell division and elongation. So the exogenous gibberellic acid (GA_3) application increased shoot growth, photo synthetics, and dry matter accumulation. Many investigators studies the role of GA_3 in some vegetable plants and coming to the opinion that, it's caused an enhancement in plant productivity[8] on onion and as well as[9] on cucumber;[10,11,12] on potatoes.

The aim of this study is to investigate the response of potato plant to the application of NPK and GA_3 at different rates.

MATERIALS AND METHODS

Two field experiments were carried out at the horticulture experimental station (Ministry of Agricultural) at Baramoon experimental farm, Dakhalia Governorate, Egypt., during the two successive seasons of 2005/2006 and 2006/2007 to study the effect of foliar application of GA_3 and soil dressing NPK at different levels on the growth, yield and its nutritional values of potato tubers.

Tubers of potato c.v. Sponta were sown on 1st October and 29th October in the two growing seasons respectively at 20 cm apart in the rows. Each plot consisted of 3 rows, each of five meters in length and 70 cm wide. The plot area was 10.5 m. Each experiment included 6 treatments of NPK (ammonium sulphate 20.5% N, calcium super phosphate 15.5% P_2O_5 and potassium sulphate 48% K_2O), i.e. 120 : 90 : 90 ; 90 : 90 : 90; 120 ; 90 : 60; 120 : 60 : 60; 90 : 90 : 60; 90 : 60 : 60 with and/or without GA_3 application. The NPK fertilizers were added at two times i.e. the first half before tuber plantation and the second on 45 days late. However, GA_3 at rate of 50 ppm was sprayed at 60 days old, twice with 15 days interval. It means that the experiment design was split plot in three replicates. A rate NPK treatment was arranged in the sub main plot and GA_3 was arranged

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in the main plots). Plant growth expressed as plant length (cm), number of shoots and leaves per plant as well as fresh and dry weight of shoots and leaves and whole plant (g) were determined in the samples (3 plants) which were taken at random from every experimental plot at 90 days after planting in both two seasons.

At harvesting, fresh tuber yield and its quality were recorded in terms of tuber size (cm^3), number and weight of tubers per plant as well as total yield as ton/fed.

The chemical constituents of potato yield were determined as total nitrogen, phosphorus and potassium according to the methods of Pregl[13] Troug and Mayer[14] and Brown and Lilleland[15] respectively. As well as Fe, Mn, Zn, Pb and Ni concentration were determined using flame ionization atomic absorption, spectrometer model 1100 B of Perk in Elmer according to the method of Champman and Pratt[16]. The obtained data were subjected to the analysis variance procedure and treatment means were compared to the L.S.D. test according to Gomez and Gomez[17].

RESULTS AND DISCUSSION

Vegetative Plant Growth Characters: The results presented in Table (2) shows clearly that, potato plants which received GA_3 as foliar application resulted the vigor plant growth if compared with that no GA_3 treatment. These findings are in good accordance in both experiments for all growth features. However, GA_3 substances enhanced the length of plant, average shoots and leaves number per plant, as well as the fresh and dry weight of whole plant and its their different organs. The statistical analysis of the obtained data reveals that, the differences within the application and no application of GA_3 treatments were enough to reach the 5 % level of significant. These were true for all plant growth characters in both experiments, with some exception that of height of plant, number of branches, fresh weight of shoots and dry weight of whole potato plant and its leaves in 1st experiment. Also, the dry weight of leaves in 2nd experiment followed the same pattern which above mentioned. Generally, in spite of the no significant response of some plant growth features to GA_3 application, but, it could be summarized that, the vigor plant growth was detected with that received GA_3. This vigoristy could be amounted by 54; 29.3 % in fresh weight of whole plant and by 33.9; 31.3 % for dry weight of whole plant respectively in 1st and 2nd season.

It is known that in potatoes, Gibberellins are involved in many important processes such as seed germination, flowering, maturation, tuber dormancy and tuber ization. Gibberellins are a group of naturally occurring plant hormones that affect cell enlargement and division which leads to internodes elongation in stems, consequently increased the fresh and dry weight of various plant organs. The obtained results are in good accordance with that which obtained by Abou El-Magd *et al*.,[8]; Fatma *et al*.,[10]; Mikitizel,[12]; Khan *et al*.,[18]; Awad *et al*.,[19].

Regarding the response of potato plants to the NPK fertilization, the obtained results which shown in Table (2) clearly indicate that, the vigor plant growth was associated with the higher rates of NPK addition, i.e. 120 – 90 – 90. whereas, that tallest plants which carried the highest shoots and leaves number as well as their heaviest fresh and dry weights, were recorded with that plants which received the highest rate of NPK application. Moreover, the statistical analysis of the collected data reveals that the variation within different NPK rates were great to record the significant level at 5 %. These findings were completely similar in the two experimental seasons. Generally, it could be concluded that, the addition of NPK at rates of 120 – 90 – 90 resulted in the best values of plant growth, followed in descending order by that plants which supplied 120 – 90 – 60, NPK, then that plants received NPK at rates of 120 – 60 – 90. These findings indicate that, the balance within NPK rates is more important than the role of individual elements on growth of plant. Also, its could concluded that, the role of potassium in plant growth of potato plant is more important than phosphorus. It is known that potato plant requirements of potassium are quite high and when this element is presented is short supply, characteristics deficiency symptoms appear in the plant. Also, there is no doubt that K as an important nutritional element plants its part in regulating many physiological criteria in the plant which in turn affect the vigor of plant, i.e. fresh and dry weight of whole plant and its different organs. However, the review of literature of current knowledge about K may reflect the interest of many workers in studying its mode of action and its role in the plant production. However, one fact must be put in mind is that the provided 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. From other, side, it is known that increasing the levels of NPK in rooting zone raised the availability of these elements in the soil solution which favored the NPK absorption and hence increased plant growth. Whereas, nitrogen fertilization increase plant growth could be attributed to nitrogen role in enhancing plant capacity in protein synthesis leading to an increase in building up carbohydrates, and then in turn resulted in increases in plant growth characters. But, the effect of p-application on plant growth could be explain through the role of phosphorus which extremely important as structural part of many components, notable nucleic

Table 1: Some physical and chemical properties of the experimental soil (Averages of the two seasons).

Sand %	Silt %	Clay %	Texture	O.M.	pH	Available (ppm)		
						N	P	K
27.0	23.5	48.4	Clay	1.1	8.0	31.8	14.6	115

Table 2a: Effect of NPK fer v v vvvilizers of different levels with and / or without GA_3 application on plant growth characters of potato tuber during the season of 2006.

Treatments		Plant length (cm)	No. plants		Fresh weight (g)/ plant			Dry weight (g)/ plant		
GA_3	N – P - K		Leaves	Shoots	Leaves	Shoots	Total	Leaves	Shoots	Total
Without GA_3	120-90-90	61.09	4.57	47.93	69.38	158.21	227.59	9.39	13.61	23.00
	120-90-60	56.11	4.27	43.63	64.37	138.03	202.40	8.63	11.28	19.91
	120-60-60	62.46	2.97	38.57	52.86	130.90	183.76	6.20	10.36	16.56
	90 -90 -90	55.80	3.80	39.73	57.04	132.17	189.22	7.68	11.74	19.42
	90 -90 -60	42.06	3.50	36.70	44.94	123.93	168.87	7.08	11.14	18.22
	90 -60 -60	41.41	2.73	42.90	41.34	119.39	160.74	5.66	10.06	15.72
Mean		53.15	3.64	41.58	54.99	133.77	188.76	7.44	11.37	18.80
With GA_3	120-90-90	73.97	5.63	72.33	86.19	227.57	313.76	18.95	11.81	30.76
	120-90-60	68.93	5.10	64.10	77.35	198.50	275.85	16.19	10.45	26.64
	120-60-60	57.77	4.83	50.87	71.85	155.70	227.55	13.10	9.90	23.00
	90 -90 -90	66.80	4.80	61.70	72.68	191.13	263.81	15.94	10.15	26.09
	90 -90 -60	48.63	4.77	49.67	69.54	155.65	225.19	12.96	9.73	22.69
	90 -60 -60	45.93	4.50	35.67	68.86	109.90	178.76	9.49	9.49	18.98
Mean		60.34	4.94	55.72	74.41	173.07	247.49	14.44	10.25	24.69
Average	120-90-90	67.53	5.10	60.13	77.78	192.89	270.67	14.17	12.71	26.88
	120-90-60	62.52	4.68	53.87	70.86	168.27	239.13	12.41	10.87	23.28
	120-60-60	60.11	3.90	44.72	62.36	143.30	205.66	9.65	10.13	19.78
	90 -90 -90	61.30	4.30	50.72	64.86	161.65	226.51	11.81	10.95	22.76
	90 -90 -60	45.35	4.13	43.18	57.24	139.79	197.03	10.02	10.43	20.45
	90 -60 -60	43.67	3.62	39.28	55.10	114.65	169.75	7.58	9.77	17.35
L.S.D. at 5%	GA_3	1.38	0.52	4.36	7.73	16.04	22.85	1.76	N.S.	2.80
	N P K	3.78	0.36	4.67	5.69	9.60	11.17	0.88	0.75	1.21
	Interactions	5.35	0.50	6.61	N.S.	13.58	15.80	1.25	N.S.	1.71

acid and phosphorus on indispensable role in energy metabolism the high energy of hydrolysis of phosphate and various organic phosphate bonds being used to induce chemical reaction.

Generally, many investigators studied the role of NPK in enhancement the plant growth of potato plant such as Vos,[20]; Errebhi *et al*.,[21]; Belonger *et al*.,[22] and[23]; Shafeek *et al*.,[4]; Mikitizel,[12]; Aisha *et al*.,[6]; Awad *et al*.[19] and Shaheen *et al*.,[7].

In spite of the no significant response of some plant growth criteria's, but the presented results in Table (2) show clearly that, the interaction treatment of using GA_3 as foliar application with the fertilization by the highest rate 6of NPK (120 – 90 – 90) resulted the vigor potato plants. These findings are in good accordance in both seasons.

Total Tubers Yield: Total tubers yield of potatoes as affected by the NPK fertilization and applied with or without GA_3 in both experiments of 2005 and 2006 are presented in Table (3). Whereas, that potato plants which sprayed by GA_3 substances gave more yield as

Table 2b: Effect of NPK fertilizers of different levels with and / or without GA_3 application on plant growth characters of potato tuber during the season of 2005.

Treatments			No. plants		Fresh weight (g)/ plant			Dry weight (g)/ plant		
GA_3	N – P - K	Plant length (cm)	Leaves	Shoots	Leaves	Shoots	Total	Leaves	Shoots	Total
Without GA_3	120-90-90	64.80	4.78	52.43	60.40	177.40	237.80	7.97	17.55	25.51
	120-90-60	62.47	4.10	46.57	55.97	170.15	226.12	7.19	15.53	22.72
	120-60-60	52.03	3.41	41.87	49.43	152.90	202.33	6.54	14.11	20.65
	90 -90 -90	59.50	3.93	44.23	53.63	165.13	218.77	7.05	15.34	22.39
	90 -90 -60	47.23	2.89	40.13	42.53	138.73	181.27	6.13	13.48	19.62
	90 -60 -60	45.90	2.60	35.57	11.60	133.33	144.94	5.57	11.67	17.24
Mean		55.32	3.62	43.47	45.60	156.28	201.87	6.74	14.61	21.35
With GA_3	120-90-90	80.07	6.47	55.57	64.76	193.10	257.86	8.23	19.67	27.90
	120-90-60	65.78	5.27	47.77	56.77	175.53	232.30	7.28	15.30	22.58
	120-60-60	63.17	4.05	48.03	47.33	159.90	207.23	6.96	13.93	20.90
	90 -90 -90	69.43	5.18	49.90	61.93	175.43	237.37	8.26	18.05	26.31
	90 -90 -60	61.97	4.53	49.03	56.20	161.50	217.70	6.63	14.53	21.16
	90 -60 -60	48.84	3.80	41.87	45.87	143.07	188.93	6.20	13.47	19.67
Mean		64.88	4.88	48.69	55.48	168.09	223.57	7.26	15.82	23.09
Average	120-90-90	72.43	5.62	54.00	62.58	185.25	247.83	8.10	18.61	26.71
	120-90-60	64.12	4.68	47.17	56.37	172.84	229.21	7.24	15.41	22.65
	120-60-60	57.60	3.73	44.95	48.38	156.40	204.78	6.75	14.02	20.77
	90 -90 -90	64.47	4.56	47.07	57.78	170.28	228.07	7.66	16.69	24.35
	90 -90 -60	54.60	3.71	44.58	49.37	150.12	199.48	6.38	14.01	20.39
	90 -60 -60	47.37	3.20	38.72	28.74	138.20	166.94	5.88	12.57	18.45
L.S.D. at 5%	GA_3	N.S.	N.S.	3.71	N.S.	3.53	17.73	0.45	N.S.	N.S.
	N P K	8.86	0.74	1.82	7.15	9.35	11.86	0.44	2.48	2.66
	Interactions	N.S.	N.S.	2.58	10.11	N.S.	16.78	N.S.	N.S.	N.S.

Generally, the obtained data concerning the response of tuber potato yield to the GA_3 treatments are in good accordance with that which recorded by Mikhtizal,[12] and Khan *et al*.,[18].

The addition more NPK, the increases in total tubers yield as tons/fed., or/as gram/plant as well as tuber number/plant and size. The relationship within the higher NPK rates and tubers yield expressed as tons/fed., was significantly only in 2nd experiments, but were significantly in both seasons for other criteria's. Generally, it could be summarized that, the addition of 120 – 90 – 90 units/fed. respectively of N, P and K resulted the heaviest tuber yield, i.e. 10.24 and 10.40 tons/fed. In 1st and 2nd season respectively, followed in decreasing order by that plants received 120 – 90 - 60, 120 – 60 – 60, 90 – 90 – 90; 90 – 90 – 60 and lastly 90 – 60 – 60. These finding held good in both experiments.

It is known that, nitrogen is a consistent of amino acids, proteins, coenzymes, nucleic acids and chlorophyll. Nitrogen has a great affect on plant productivity. Concerning the phosphorus, it is known that it is a consistent of ATP nucleic acid and phospholipids and certain coenzyme. It is very important in plant energy transfer system. Potassium acts as a coenzyme or activator of many enzyme systems. Potassium levels are required for protein synthesis and fruit production. Generally, the roles of NPK in metabolism synthesis are reflected on the tuber yield of potatoes.

Table 3: Effect of NPK fertilizers of different levels with and / or without GA_3 application on the total tuber yield of potato plant during the seasons of 2005 and 2006.

Treatments		2005				2006			
GA_3	N-P-K	Tuber		Yield		Tuber		Yield	
		No.	Size	plant	ton/fed.	No.	Size	plant	ton/fed.
Without GA_3	120-90-90	7.50	96.00	640.00	9.73	5.94	20.52	511.00	9.63
	120-90-60	7.10	93.00	633.00	9.11	5.73	18.17	464.67	9.10
	120-60-60	6.00	70.00	490.00	8.40	5.78	16.36	470.43	7.57
	90 -90 -90	6.90	90.00	500.00	8.65	5.40	17.63	197.00	7.78
	90 -90 -60	7.00	85.00	500.00	8.81	5.40	13.32	427.00	3.87
	90 -60 -60	5.50	65.00	440.00	7.50	3.63	13.14	175.33	3.73
Mean		6.67	83.17	533.89	8.70	4.32	16.52	374.24	6.95
With GA_3	120-90-90	9.10	97.00	753.33	10.75	7.20	28.00	620.00	11.17
	120-90-60	8.80	93.00	710.00	10.10	6.13	27.03	532.67	10.87
	120-60-60	6.40	74.00	510.00	9.10	7.07	18.67	613.33	9.33
	90 -90 -90	8.40	92.00	610.00	10.00	5.93	19.43	486.00	10.10
	90 -90 -60	7.60	88.00	530.00	9.50	6.13	17.53	506.67	8.03
	90 -60 -60	5.90	71.67	491.67	9.10	5.87	17.37	485.33	7.97
Mean		7.70	85.94	600.83	9.76	6.39	21.34	540.67	9.58
Average	120-90-90	8.30	96.50	696.67	10.24	5.57	24.26	565.50	10.40
	120-90-60	7.95	93.00	671.67	9.61	5.93	22.60	498.67	9.98
	120-60-60	6.20	72.00	500.00	8.75	6.42	17.51	541.88	8.45
	90 -90 -90	7.65	91.00	555.00	9.33	5.67	18.53	341.50	8.94
	90 -90 -60	7.30	86.50	515.00	9.16	5.77	15.43	466.86	5.95
	90 -60 -60	5.70	68.33	465.83	8.30	4.75	15.25	33.33	5.85
L.S.D. at 5%	GA_3	N.S.	N.S.	41.01	N.S.	N.S.	N.S.	19.05	.20
	N P K	1.24	9.52	88.28	N.S.	041	1.65	22.86	.21
	Interactions	N.S.	N.S.	N.S.	N.S.	058	2.34	32.33	.30

The recorded data that which detected in this script are in good agreement with that which previously obtained by other investigators such as Prosba-Bialczyk,[24]; Belonger *et al*.,[22] and[23]; Shafeek *et al*.,[4]; Faten *et al*.,[5]; Love *et al*.,[25]; Awad *et al*.,[19]; Shaheen *et al*.,[7].

The potato plants which fertilized by NPK at the highest rate, i.e. 120 - 90 – 90 and treated by GA_3 substance as foliar application resulted the heaviest tubers yield as well as the highest tubers numbers/plant and size. These results were completely similar in both experiments. On the contrary the lowest values of the above mentioned properties are resulted by that plants which applied the lowest rate of NPK, i.e. 90 – 60 – 60 and no GA_3 treated.

Nutritional Values: Nutritional values expressed as the determination of N, P, K, Fe, Mn, Zn, Pb, Ni and Cu of potato tubers as affected by the application of NPK at different rates and treated the plant foliage by GA_3 in both seasons of 2005 and 2006 are shown in Table (4). It evident that, GA_3 caused an enhancement in the elemental nutritional values if compared with that plants no-GA_3 applied. The statistical analysis of the obtained data reveals that in spite the recorded significant differences in most elemental nutrition, but are not great. Generally, it could be conducted that, GA_3 substance caused an increase in plant growth expressed as height of plant, numbers of shoots and/or leaves as well as fresh and dry weight of different plant organs, consequently increased the efficiency of

Table 4a: Effect of NPK fertilizers of different levels with and / or without GA_3 application on the nutritional values of potato tuber during the season of 2005.

Treatments		%			ppm					
GA_3	N – P - K	N	P	K	Fe	Mn	Zn	Pb	Ni	Cu
Without GA_3	120-90-90	1.95	0.36	2.40	135.67	26.40	28.37	2.72	1.19	9.27
	120-90-60	1.85	0.35	2.24	129.00	25.87	27.23	2.66	1.15	9.00
	120-60-60	1.79	0.34	2.10	124.67	23.73	25.00	2.51	1.10	8.77
	90 -90 -90	1.84	0.34	2.17	127.67	25.30	26.07	2.61	1.10	8.57
	90 -90 -60	1.76	0.33	2.17	126.33	24.47	25.17	2.53	1.09	8.40
	90 -60 -60	1.57	0.30	2.02	121.33	23.00	23.40	2.46	0.98	7.73
Mean		1.79	0.34	2.18	127.44	24.79	25.87	2.58	1.10	8.62
With GA_3	120-90-90	2.35	0.39	2.73	142.33	33.53	30.30	3.74	1.28	10.87
	120-90-60	2.19	0.37	2.64	133.67	31.87	29.37	3.60	1.22	10.07
	120-60-60	1.96	0.36	2.58	131.33	28.77	26.03	3.31	1.16	9.60
	90 -90 -90	2.13	0.35	2.60	136.00	31.23	28.43	3.44	1.17	9.83
	90 -90 -60	7.83	0.35	2.52	132.00	29.07	25.47	3.34	1.16	9.73
	90 -60 -60	1.82	0.34	2.42	130.00	26.97	24.07	2.93	1.07	9.30
Mean		3.04	0.36	2.58	134.22	30.24	27.28	3.39	1.18	9.90
Average	120-90-90	2.15	0.37	2.57	139.00	29.97	29.33	3.23	1.23	10.07
	120-90-60	2.02	0.36	2.44	131.33	28.87	28.30	3.13	1.19	9.53
	120-60-60	1.88	0.35	2.34	128.00	26.25	25.52	2.91	1.13	9.18
	90 -90 -90	1.98	0.34	2.39	131.83	28.27	27.25	3.02	1.14	9.20
	90 -90 -60	4.79	0.34	2.35	129.17	26.77	25.32	2.93	1.12	9.07
	90 -60 -90	1.69	0.32	2.22	125.67	24.98	23.74	2.70	1.02	8.52
L.S.D. at 5%	GA_3	N.S.	0.00	0.12	0.63	0.39	0.16	0.15	0.04	0.19
	N P K	N.S.	0.01	0.07	0.80	0.41	0.27	0.09	0.02	0.19
	Interactions	N.S.	N.S.	N.S.	1.13	0.58	0.38	0.13	N.S.	0.27

plant to absorb more nutrition elements, hence increase their concentration in plant tissues and/or the storage organ in potato. There many investigators investigated the effect of application GA_3 on the behavior of nutritional values of vegetables and gained the same trend of results which written here (Omar *et al*.,[9]; Prosbsa-Bialczyk,[24]; Fatma *et al*.,[10]; Mikitizel,[12]).

The effect of NPK fertilization at rates of 120 – 90 – 90, 120 – 90 – 60; 120 – 60 – 90; 90 – 90 – 90; 90 – 90 – 60 and 90 – 60 – 60 on the tuber constituents of N, P, K, Fe, Mn, Zn, Pb, Ni and Cu during the two experiments of 2005 and 2006 are shown in Table (4). There were statistical significant responses recorded upon to the effect of NPK treatments on the elemental values in both seasons except the content of N in 1st season as well as P and Ni in 2nd season. Generally, in spite of the no significant trend, but it could be say that, with increasing the rate of NPK, the constituents of mineral in tubers tissue recorded an increase. It means that, the lowest mineral content recorded with that plants received the lowest NPK rate, i.e. 90 – 60 – 60 with little exception. It is known that, increasing the quantity of NPK in rooting media, caused an increase in the absorption, consequently raised the concentrations of the nutrient elimination in plant tissues. The obtained data are in good accordance with that which previously recorded with Shaheen *et al*.,[1]; Shafeek, *et al*.[4]; Aisha *et al*.,[6].

Table 4b: Effect of NPK fertilizers of different levels with and / or without GA_3 application on the nutritional values of potato tuber during the season of 2006.

Treatments		%				ppm				
GA_3	N – P - K	N	P	K	Fe	Mn	Zn	Cu	Pb	Ni
Without GA_3	120-90-90	1.78	0.34	2.35	130.33	23.23	24.00	2.54	0.94	8.60
	120-90-60	1.76	0.23	2.22	127.67	22.83	22.73	2.48	0.92	8.35
	120-60-60	1.72	0.32	2.19	125.33	22.33	21.77	2.42	0.88	8.23
	90 -90 -90	1.72	0.32	2.17	126.00	22.67	22.67	2.45	0.91	8.27
	90 -90 -60	1.71	0.30	2.15	124.00	22.10	21.40	2.39	0.86	8.10
	90 -60 -60	1.54	0.30	1.97	118.67	21.13	21.30	2.33	0.84	8.03
Mean	1.70	0.30	2.17	125.33	22.38	22.31	2.44	0.89	8.26	
With GA_3	120-90-90	2.32	0.37	2.60	132.67	24.47	26.33	2.77	1.08	9.73
	120-90-60	2.13	0.36	2.58	131.33	23.90	25.13	2.70	1.07	8.87
	120-60-60	1.91	0.33	2.47	130.67	23.00	24.00	2.62	1.06	8.50
	90 -90 -90	2.01	0.34	2.48	130.67	23.77	24.07	2.61	1.07	8.47
	90 -90 -60	2.20	0.34	2.42	130.33	21.00	23.03	2.50	1.32	8.30
	90 -60 -60	1.72	0.32	2.36	127.33	20.00	22.47	2.71	1.02	8.03
Mean	2.05	0.34	2.49	130.50	22.69	24.17	2.65	1.10	8.65	
Average	120-90-90	1.95	0.29	2.47	131.50	23.85	25.17	2.66	1.01	9.17
	120-90-60	1.95	0.29	2.40	129.50	23.37	23.93	2.59	1.00	8.61
	120-60-60	1.82	0.32	2.33	128.00	22.67	22.88	2.52	0.97	8.37
	90 -90 -90	1.87	0.33	2.33	128.33	23.22	23.37	2.53	0.99	8.37
	90 -90 -60	1.96	0.32	2.29	127.17	21.55	22.22	2.45	1.09	8.20
	90 -60 -60	1.63	0.31	2.17	123.00	20.57	21.88	2.52	0.93	8.03
L.S.D. at 5%	GA_3	0.28	N.S.	0.02	1.10	0.21	0.02	0.12	N.S.	0.04
	N P K	0.21	N.S.	0.03	0.86	0.18	0.25	0.07	N.S.	0.09
	Interactions	N.S.	N.S.	0.05	1.21	0.26	0.35	0.10	N.S.	0.13

In both two experimental seasons, that potato plants which received the NPK at the highest rates, i.e. 120 – 90 – 90 and sprayed by GA_3 substances gave the best elemental values in both two season. These data are in good accordance for all determined elements with except of N and P content in tuber tissues. However, the statistical analysis of the resulted data showed that, the N, P, K and Ni in 1st experiment, and N, P and Ni in 2nd experiment no significant response with the interaction treatments.

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