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THE PRODUCTIVITY OF POTATO YIELD AND ITS QUALITY AS INFLUENCED BY THE APPLICATION OF DIFFERENT NITROGEN FERTILIZER SOURCES

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ABSTRACT

Two field experiments were carried out during the two successive seasons of 2001 and 2002 to study the effect of some different nitrogen sources of fertilizers (cattle manure, town refuse compost and chemical fertilizer) on growth, yield and its components as well as some chemical composition of potato tubers. The obtained data reveals that.

Application of chemical fertilizer (NPK) resulted the best growth characters, the heaviest yield weight (11.73 and 12.35 ton/fed. for the first and second seasons, respectively), number, size of tuber and the highest values of the major elements (N, P and K) in the tissues of the potato tubers. But the highest values of Fe, Mn, Zn, Cu, Pb and Ni resulted from the application of town refuse compost.

INTRODUCTION

Potato (*Solanum tuberosum*, L.) is one of the most important vegetable crops in Egypt. It gained a considerable importance as an export crop to European Markets and one of the national income resources.

Nitrogen is an indispensable elementary constituent of numerous organic compounds of general importance (amino acids, protein, nucleic acids) and it is formation of protoplasm and new cells, as well as, its encouragement for elongation.

The conventional nitrogen fertilizer (chemical) is rapidly lost by either evaporation or by leaching in the drainage water (Daif, 1973). The problem does not only stop at losing big amounts of nitrogen, but it extends to other dangerous environmental pollution.

The need for supplying vegetable crops with organic and inorganic fertilizers was proved to be very essential for the production of higher yield and for improving its quality (Mangle and Kirkby, 1978, Edmoned, *et al.*, 1981 and Borin *et al.* 1987).

Organic manures contain higher levels of relatively available nutrients elements, which are essentially required for plant growth. Moreover, it plays an important role for improving soil physical properties (Bhandari, *et al.*, 1989; Rizk, 2001; Awad, 2002 ; Fatma, 2002 and Fatma, *et al.*, 2002). The organic manure addition could be reputed to increase the rate of organic in soil, resulting more release of plant available nutrients.

Slow release forms of nitrogen include natural organic materials such as compost and animal products (chicken and cow manures, as well as town refuse) these materials release nitrogen over a period time. Natural organic

materials are broken down slowly by soil microorganisms (Hegasy, *et al.*, 1994 and Abady and Barakat, 1997; Rizk, 2001; Shafeek, *et al.* 2001 and Fatma *et al.*, 2002).

The application of municipal solid water (MSW) on squash plant resulted in the highest concentration of Cd, Cu, Pb, Ni and Zn (Dixon, *et al.* 1995 and Ozores, *et al.* 1997).

The aim of this work was to study the effect of some different organic manure (cattle and town refuse) with or without chemical fertilizer (NPK) on growth, yield and yield quality of potato plants.

MATERIALS AND METHODS

Two field experiments were carried out at Experimental Station of the Agricultural Extension at Minia Governorate during the two successive seasons of 2001 and 2002 to study the effect of different sources of organic manure (cattle and town refuse compost) and chemical fertilizers (NPK) which applied as individual and/or as companied on the growth and yield of potato plants. Table (1) presented the physical and chemical properties of the experimental soil, while chemical analysis of the organic manures are given in Table (2).

Tubers of potato cv. New Nicola were sown on 1st October and 25th September in the two growing seasons respectively at 20 cm apart within the rows. Each plot consisted of three rows, each of six meters in length and 80 cm. wide. The plot area 14.4 m^2.

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

Character	Value	Character	Value
pH	7.97	Mn ppm	4.0
E.C. (m mhos)	0.48	Cu ppm	4.1
N ppm	1218	Zn ppm	1.1
P ppm	104	Pb ppm	2.1
K ppm	486	Ni ppm	1.7
Fe ppm	16.8		

Table (2) : The chemical analysis of the used cattle manure and town refuse compost.

Characters	Cattle manure	Town refuse
pH	7.5	7.8
E.C. (m mhos)	14.1	5.0
Organic carbon %	7.9	18.5
Organic matter %	6.5	38.5
Total nitrogen %	0.42	1.3
C/N ratio	1:19	10:1
Total phosphorus %	0.41	0.5
Total potassium %	0.85	0.5
Fe mg/kg	650	6.5
Manganese mg/kg	135	0.3
Copper mg/kg	11	0.4
Zinc mg/kg	105	1.25

Each experiment included 7 treatments resulting from using the three nitrogen sources, i.e. cattle manure, town refuse compost and NPK and the different simple interaction between them. Whereas, the organic fertilizers (cattle and town refuse) were added during preparing the soil for sowing, but the chemical fertilizer (NPK) added at two times, i.e. the first half before tuber plantation and the second one 45 days late.

A complete randomize plot design with 3 replicates was used. The normal cultural practices used for the potato production, i.e. irrigation and pest control were followed according to the traditional cultivation in the experimental location.

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 representative samples (4 plants), which were taken at random from every experimental plot at 75 days after planting in both investigated seasons.

At harvesting time, fresh tuber yield and its quality were calculated in terms of 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 (1945), Troug and Mayer (1939) and Brown and Lilleland (1946) respectively. As well as Fe, Mn, Zn, Cu, Pb and Ni concentration were determined using flame ionization atomic absorption, spectrometer model 1100 B of Perkin Elemer according to the method of Chapman and Pratt (1978).

The obtained data subjected to the analysis variance procedure and treatment means were compared to the L.S.D. test according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A. Plant growth:

The obtained data of Table (3) show clearly that, the potato plants which received the chemical fertilizer as NPK resulted the vigor plant growth character, i.e. the tallest plant, that carried the highest number and heaviest leaves and stems weights. Moreover, when mixed NPK as chemical fertilizer with town refuse as organic fertilizer at rate of 1:1 gave also a vigor in plant growth but less than using NPK alone. In the same time it could be concluded that mixing town refuse with NPK gave a result better than using town refuse alone. On the contrary, the poorest plant growth characters particularly the fresh and dry weight of whole potato plant and its different leaves and stems were recorded with that plants fertilizers with cattle only manure. Their findings were true in both seasons of 2001 and 2002. With a general view, it could be abstracted from the obtained date that, with the three individual fertilizer sources, the application of NPK as a chemical source gained a superior in plant growth than applying town refuse and cattle manure. Moreover, it is clearly that using town refuse was better than cattle manure. These trends were similar in the two experimental seasons.

Table (3): Effect of some different nitrogen sources as individual or compained on growth characters of potato plant during two seasons of 2001 and 2002 .

Treatments	Length/ Cm/plant	No/plant		Fresh weight (g) /plant			Dry weight (g) /plant		
		leaves	stems	leaves	Stems	total	leaves	stems	total
First season									
Town refuse (TR)	49	47	3.8	270	45	364	35.8	10.0	45.8
Cattle (CTL)	52	40	3.7	253	39	292	29	6.4	35.4
NPK	59	55	5.6	347	113	460	59.1	17.5	76.6
TF+CTL	51	48	4.0	281	51	332	34.1	19.5	53.6
TR+NPK	56	46	4.4	294	57	351	43.1	13.5	56.6
CTL+NPK	58	46	4.7	255	87	342	31.5	14.5	46
TR+CTL+NPK	53	47	4.1	281	57	338	36.2	16.5	52.7
L.S.D.at 5% level	3.6	6.1	1.2	11.8	8.5	20.5	3.7	2.51	7.4
Second seasons									
Town refuse (TR)	51	51	4.4	283	64	347	44.5	19.1	63.5
Cattle (CTL)	55	46	4.5	278	61	339	38.7	16.8	55.5
NPK	61	61	6.6	391	116	507	68.7	23.7	72.4
TF+CTL	52	54	4.6	308	67	375	41.5	21.5	63.0
TR+NPK	58	48	5.5	333	76	409	51.5	16.1	67.6
CTL+NPK	63	53	4.9	296	75	371	48.1	17.4	65.5
TR+CTL+NPK	52	53	4.9	296	75	371	48.1	17.4	65.5
L.S.D.at 5% level	2.91	6.4	1.76	11.7	8.5	29.1	4.5	3.7	4.5

The previous obtained data, could be attributed to the applying the organic fertilizer source which contains the minerals in the organic form, firstly it must be transferred into the mineral form through the mineralization processes, then the plant could be absorbed it. This chemical changes needs time, consequently this will refluxed on the growth of plants. So the superiority in plant growth resulted from that plants, which supplied with NPK only and/or with mixing it with the organic fertilizer may be attributed to he solubility and availability of minerals in this formula. Moreover, the promotion of plant growth with town refuse manure compared to the addition of cattle more might be due to the more elemental contains of the first one than the second. Many investigators studied the response of plant growth to the sources of fertilization and obtained data supported the obtained of our study (Abdel-Mouty, *et al.*, 2000; Abdel-Mouty, *et al.*, 2001;Rizk, 2001; Fatma, 2002; Fatma, *et al.*, 2002).

B. Total yield and its some physical properties:

Table (4) clearly reveals that, total tuber potato yield as tons/fed. and/or as grams/plants significantly influenced by the addition of two sources of organic manure and chemical fertilizer (NPK) as individual or as mixed. Whereas, addition of chemical fertilizer (NPK) for potato plant resulted the heaviest total tuber yield as tons/fed. in both seasons. But with regarding to the heaviest plant yield as g/plant it was fluctuated within the two seasons, where in 1st one the highest value was recorded with addition of NPK, but in 2nd one it was recorded with mixing NPK with cattle (1:1) but the variation between then failed to be significant.

The highest tuber size in both experiments, as well as the highest number of tubers/plant, all of then were resulted from that potato plants received NPK as chemical fertilizers. From other side mixing NPK with cattle manure gained the highest values of total tuber yield and its some physical properties, but these values were less than that which resulted when NPK were used. On the contrary, the lowest tuber yield and its properties in the two experiments of 2001 and 2002 were registries when cattle manure alone were used for potatoes fertilization.

It could be concluded that, the addition of chemical fertilizer (NPK) was better than using cattle and/or town refuse as organic manure, since the heaviest yield weight, number and tuber size were gained. The obtained results are in good accordance with that obtained previously by Fatma, 2002 and Fatma, *et al.*, 2002),all of them reported that, the heaviest yield was corrected with the addition of chemical fertilizer.

C. Nutritional elements:

The major elements (N ,P and K) of potato tuber tissues recorded its significant highest values with that plants received chemical fertilizer as individual application if compared with the other treatments (Table 5). On the contrary, the lowest N ,P and K contents were determined in tuber tissues of that plants fertilized with cattle manure as individual addition.

Table (4) : Effect of some different nitrogen sources as individual or compained on total tubers yield of potatoes and its some physical properties during two seasons of 2001 and 2002 .

Treatments	Fist season				Second season			
	Total yield		Average tubers No/plant	Av. Tuber size / cm3	Total yield		Average tubers No/plant	Av. Tuber size / cm3
	Ton fed.	g. /plant			Ton / fed.	g. / plant		
Town refuse (TR)	6.13	476	5.7	71	7.36	511	5.5	74
Cattle (CTL)	5.47	451	5.1	65	6.71	505	5.2	71
NPK	11.73	755	8.7	115	12.35	695	7.1	108
TF+CTL	5.77	455	6.1	66	8.75	467	6.2	74
TR+NPK	8.92	658	7.3	81.8	7.37	671	6.8	82
CTL+NPK	6.51	735	7.7	95	9.37	749	6.7	89
TR+CTL+NPK	8.75	641	7.35	88	0.66	655	7.17	97
L.S.D.at 5% level	1.55	55.1	1.37	6.3	0.66	31.5	1.61	6.7

Moreover, mixing chemical fertilizer with cattle (1:1) for fertilizing potato plant gained a mild values of N ,P and K. It means that its contains were more than which obtained by addition of cattle, but less than that of chemical application. The above findings were true in both experimental seasons.

Regarding to, the tuber contents of minor elements, i.e. Fe, Mn, Zn, Cu, Pb and Ni, the presented data of Table (5) clearly showed that the addition of town refuse manure as organic fertilizer resulted in the highest values of the previous mentioned elements. Whereas, the statistical analysis of the data reveals that the differences within different fertilizer treatments were significantly at 5 % level. These were true for Fe and Pb (two seasons), Mn and Zn (1st season) and Cu (2nd season).

On the contrary, the potato plants received NPK as chemical fertilizer resulted in the lowest values of Fe (two seasons), Cu (2nd season) and Ni (2nd season). But that plants received cattle manure resulted in the lowest values of Mn (two seasons). However, using town refuse + NPK + cattle (1:1:1) as a mixture for potato fertilization gained the lowest content values of Zn (1st season), Pb (two seasons) and Ni (1st season).

It can concluded that, the superiority in N,P and K content in potato tissues by which resulted addition of chemical fertilizer are attributed to higher content of these 3 elements in fertilizer source which refluxed on the higher absorption of these elements, consequently increasing their contents in tubers tissues.

The higher values of minor elements that resulted when using town refuse manure over than the other fertilizer treatments may be attributed to its higher content in the town refuse manure (Table 2). Whereas, increasing these elements in rooting zone encouraged the plant to absorb; more of them, consequently increasing its levels in plant tissues.

The obtained results are supported by that which recorded by other investigators such as Abdel-Mouty et al., 2001; Rizk,2001; Awad,2002; Fatma, 2002 and Fatma *et al.*, 2002.

Table (5) :Effect of some different nitrogen sources as idividual or compained on the elemental nutrition of tubers yield of potatoes during two seasons of 2001 and 2002 .

Treatments	%				ppm				
	N	P	K	Fe	Mn	Zn	Cu	Pb	Ni
First season									
Town refuse (TR)	1.56	0.33	1.85	251	25.7	33.9	11.31	4.51	1.19
Cattle (CTL)	1.33	0.23	1.78	215	11.6	25.1	8.31	3.66	1.05
NPK	2.13	0.39	2.50	135	24.3	26.4	9.4	2.75	1.01
TF+CTL	1.41	0.25	1.91	178	14.7	26.5	9.4	3.81	1.11
TR+NPK	1.53	0.35	1.98	187	25.4	27.4	9.6	4.71	1.07
CTL+NPK	1.73	0.29	2.11	191	15.3	27.0	7.5	2.31	1.11
TR+CTL+NPK	1.43	0.35	2.31	149	14.6	21.8	9.5	2.17	1.01
L.S.D.at 5% level	0.21	0.046	0.39	21.5	3.71	4.13	NS	0.13	NS
Second season									
Town refuse (TR)	1.85	0.29	1.65	249	36.1	38.1	15.8	3.77	0.94
Cattle (CTL)	1.09	0.21	1.45	211	24.0	30.1	10.55	2.81	0.78
NPK	2.25	0.37	2.61	145	35.4	31.5	7.21	2.25	0.61
TF+CTL	1.68	0.27	1.77	169	28.7	33.0	11.3	2.66	0.77
TR+NPK	1.71	0.31	2.11	177	33.5	35.6	10.5	3.71	0.74
CTL+NPK	1.68	0.28	2.15	186	27.1	34.2	8.71	2.56	0.64
TR+CTL+NPK	1.79	0.33	2.33	151	27.8	31.5	11.6	2.08	0.67
L.S.D.at 5% level	0.31	0.071	0.225	7.50	NS	NS	0.46	0.36	NS

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استجابة محصول البطاطس لمصادر مختلفة للتسميد الازوتى

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اجريت تجربتان حقليتان بمزرعة ادارة الارشاد الزراعى بمحافظة المنيا فى عام ٢٠٠١ ــ ٢٠٠٢ لدراسة تأثير مصادر مختلفة من الاسمدة العضوية والاسمدة الكيماوية (NPK) ومخلوط منهما بنسبة ١:١ على صفات النمو والمحصول والجودة وكذلك محتوى الدرنات من النـــتروجين والفوسفور والبوتاسيوم والحديد والزنك والمنجنيز والنحاس والرصاص والنيكل . وتضمنت اهـــم نتائج الدراسة مايلى :

اضافة السمادالكيماوى (NPK) ادى الى الحصول على افضل صفات للنمو الخضـــرى واعلى كمية محصول (١١,٧٣ – ١٢,٣٥ طن/ف للموسم الاول والثانى على التوالـــى) وكذلـــك افضل صفات طبيعية للدرنات واعلى محتوى كيماوى للدرنات مـــن النـــتروجين – الفوســـفور – البوتاسيوم بالمقارنة باضافة سماد القمامة او السماد البلدى – بينما كان اعلـــى محتـــوى كيمـــاوى للدرنات من عناصر الحديد – الزنك – المنجنيز – النحاس – الرصاص – النيكل) عند اســـتخدام سماد القمامة .