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EFFECT OF THE COMBINATION BETWEEN ORGANIC AND MINERAL NITROGEN ALONG WITH OR WITHOUT BIOFERTILIZERS AND YEAST EXTRACT ON POTATO GROWTH AND PRODUCTIVITY

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ABSTRACT: *This field experiment was carried out on potato, Solanum tuberosum L., cv. Sponta, at the Experimental Farm of the Environmental Studies & Research Institute in El-Sadat city, Minufiya University, Egypt, during the summer seasons of 2009 and 2010 in sandy loam soil. The study aimed to investigate the effect of organic/mineral nitrogen combination with or without biofertilizer inoculation and with or without foliar application by yeast extract on growth, yield and tuber quality of potato. The treatments used were 150 kg mineral-N /feddan as ammonium nitrate, 100 kg mineral-N + 50 kg organic-N as chicken manure, 75 kg mineral-N + 75 kg organic-N, 50 kg mineral-N + 100 kg organic-N and 150 kg/feddan organic-N with or without biofertilizer "N-free living bacteria (Azotobacter and Azospirillium) and a phosphate dissolving bacteria (Bacillus megatherium)" and with or without foliar application by yeast extract (50 ml/l).*

Results showed that using 75 kg mineral-N + 75 kg organic-N, enhanced plant growth, increased yield and improved tuber quality than other organic-mineral N combination. Also, inoculating tubers with biofertilizer gave good results than no biofertilizer added. Also, sprayed potato plants with yeast extract gave good results (in most cases) in terms of vigor growth, higher yield and tuber quality as compared with those untreated. Therefore, using 75 Kg mineral-N + 75 Kg organic-N /feddan combined with biofertilizer and spray with yeast extract treatment gave the highest values of growth parameters and increased total yield with the best tuber quality as compared with all other used treatments. This increase in yield as a result of using this particular treatment reached 26.66 and 30.15 % as an average in both seasons for yield per plant and per feddan, respectively, as compared with plants supplied with 150 kg mineral-N without biofertilizer or spraying with yeast extract (control).

Key words: *Organic/mineral N combination, chicken manure, yeast extract, biofertilizer, potato tuber*

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important solanaceous vegetable crops grown in Egypt. Its tubers are rich in carbohydrates and contain considerable amounts of proteins, vitamins and minerals (Singh and Kaur, 2009). According to the recorded data obtained from the department of Agricultural Economics and Statistics, Ministry of Agriculture and land Reclamation, the cultivated area of potato in 2009 reached about 329.721 feddans, which yielded 3.659.284 tons of tubers with an average of about 11.098 tons per feddan.

The production of high and safe for human nutrition crop yield require that the soil must have favorable physical, chemical nutritional and biological conditions. Beside its benefit in reducing the hazard effect of mineral fertilization on human health, it was mentioned that organic nitrogen treatment as well as biofertilizer inoculation led to improve root and plant growth parameters. In addition, organic nitrogen and biofertilizer have beneficial effect of increasing population of soil microorganisms especially in the surface layer at root rhizosphere, that produce substances, which stimulate plant growth (Awad, *et al*., 1993). Many workers emphasized the beneficial role of organic manures incorporated with biofertilizer to stimulate plant growth, yield of vegetables

among them Abou-Hussein, *et al*. (2002) on potatoes; El-Araby (2004), El-Gamal and Hammed (2005); Hamed (2008) on Jerusalem artichoke and Agbede (2010) on sweet potato.

Yeast extract is a natural bio-substance suggested to have stimulating, nutritional and protective functions when used on vegetables. Foliar application of yeast was found to increase growth, yield and quality of many vegetable crops (Abou El-Nasr *et al.*, 2001*;* Kabeel *et al.*, 2005*;* Fawzy, 2007 and Ahmed *et al.* 2011). In this connection, yeasts have been reported to be enriched source of phytohormones (especially cytokinins), vitamins, enzymes, amino acids and minerals (Barnett *et al.*, 1990*;* Fathy and Farid, 1996; Khedr and Farid, 2002). It was also reported about its stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Kraig and Haber, 1980*;* and Castelfranco and Beale, 1983).

The objective of this experiment is to study the effect of replacing mineral fertilization which is common in the Egyptian agriculture, by organic source and biofertilizers on potato plants. Such replacing, even in part, may reduce mineral accumulation, particularly nitrate, in the tuber and reduce pollution of the environment.

MATERIALS AND METHODS

Field experiment was carried out at the Experimental Farm of the Environmental Studies & Research Institute, El-Sadat City University, Egypt, during the two successive seasons of 2009 and 2010. This study was carried out to investigate the effect of different N-fertilizer systems i.e., the combination between mineral-N (as ammonium nitrate) and organic-N (as chicken manure) in different ratios, the effect of biofertiliztion (a mixture of N-free fixing bacteria, P-dissolving bacteria) and yeast extract on growth and productivity of potatos (*Solanum tuberosum* L cv. Sponta) grown under sandy loam soil and drip irrigation system.

The treatments contained three factors: (1) N fertilizer systems contained five combinations between two N sources i.e., as mineral fertilizer and organic manure as follows: 150 kg/feddan mineral-N as ammonium nitrate (33.5 % N), 100 kg mineral-N + 50 Kg organic-N, 75 kg mineral-N + 75 kg organic-N, 50 kg mineral-N + 100 kg organic-N and 150 kg/feddan organic-N as chicken manure. (2) Biofertilization in two treatments : without biofertilizer addition or with biofertilizer. Biofertilizer solution was containing 500 ml of N_2- fixing free living bacterial cultures (*Azotobacter chroococcum* and *Azospirillium lipoferum*) and 500 ml of phosphate dissolving bacterial culture (*Bacillus megaterium*) and (3) Foliar application with yeast extract; contained two treatments: without foliar application or with foliar application. Inoculants of the biofertilizer and yeast extract were prepared in the Botany Department (Microbiology Branch), Faculty of Agriculture, Benha University, Egypt. Yeast extract sprayed at rates of 50 ml/l and it was applied six times at 7 days intervals starting from 6 weeks after planting. Analysis of prepared yeast stock solution was: total protein (5.3%), total carbohydrates (4.7%), N (1.2%), P (0.13%), K (0.3%), Mg (0.013%), Ca (0.02%), Na (0.01%); micro-elements (ppm), Fe (0.13), Mn (0.07), Zn (0.04), Cu (.04), B (0.016), Mo (0.0003), IAA (0.5 mg/ml) and GA (0.3 mg/ml) according to Fathy *et al.* (2000). Plot size was 10.5 m^2 (5x2.1 m) with 25 cm between plants and included 3-ridges each of 70 cm wide and 5.0 m long, each plot contained 60 plants.

The experimental design was a split-split plot design with 3 replicates. The combinations between N sources, biofertilizers and yeast extract applications were assigned at main plots, sub plots and sub-sub plots, respectively.

Certified potato tubers of cv. Sponta were obtained from the General Authority for Producers and Exporters of Horticulture Crops, Cairo, Egypt.

Chicken manure which was obtained from a chicken farm in Moshtohor village, Qalubia, Egypt, containing 2.95 %N, 0.94 % P_2O_5, 0.95 % K_2O and 38.15 % organic matter (O.M.) as an average in both seasons. Tubers were planted in the field on

28 of January in each season. Tuber, inoculation with biofertilizers was done by dipping them for 10 minutes in a suspension of the biofertilizers before planting. Ammonium nitrate (33.5 % N) was applied six times according to the recommendation of Ministry of Agriculture. The super phosphate fertilizer (16% P_2O_5) was added as one dose at soil preparation at a rate of 75 kg P_2O_5 / fed. before planting. Potassium sulphate (48 % K_2O) was added 3 times at 40, 50 and 60 days after planting at a total rate of 150 kg K_2O/fed. All the experimental plots received the same amount of water, using drip irrigation system; the used lines of irrigation were of model GR 16 mm and the flow rate of drippers was 2l / hour. Water pressure 1.5 bar when all lines were opened.

The plants were sprayed 3 times with Fe, Zn, and Mn EDTA at 55, 65 and 75 days after planting in the two seasons. Physical and chemical properties of the soil are presented in Table 1.

Four plants from each plot were randomly taken to measure vegetative growth parameters "plant height, number of stems/plant and fresh and dry weight" of entire plant at 90 days after planting, plant samples were oven-dried at 70°C then ground and kept for analysis. Leaf area was recorded as cm^2 per plant using a digital leaf area meter (L1-300 portable area meter produced by L1-COR, Lincoln, Nebraska, USA). Plants were harvested at 110 days after planting and tuber yield was recorded per plant and per feddan. Specific gravity, it was estimated by Haase (2003), tuber dry matter content was determined by oven dried sample at 70°C for 72 hours using the standard methods as illustrated by A.O.A.C. (1990). Tuber size were measured by calibrating the water volume displaced by immersing the tuber in graduated jar. Starch, reducing, non-reducing and total sugars contents were determined in tubers according to the method in A.O.A.C. (1990). Nitrate content was determined according to the method described by Cataldo et al. (1975). All obtained data from the first and the second seasons were recorded on plot basis and statistically analyzed according to a split-split plot design. Duncan's Multiple Range Test at 5% level was used to compare between treatment means. All the obtained data were subjected to statistical analysis of variance according to the procedure outlined by Gomez and Gomez (1984). MSTAT-C program (1988) was used for statistical computations.

RESULTS AND DISCUSSION

Vegetative growth

Data presented in Tables 2 & 3 show that, the plants which were fertilized with 75 kg mineral-N + 75 kg organic-N gave in general the highest values of plant height, leaf area, fresh and dry weights as compared with those produced by other treatments in both seasons. However, number of stems was not significantly affected by N fertilization regime only in 2009 season. This result is in harmony with Kate *et al.* (2005) on potato who found that mineral + organic fertilizer together gave the best vegetative growth over than when each N form (mineral or organic) applied alone.

Also, in spite of biofertilizers which did not gave a distinct effect on vegetative growth of potato plants, yeast extract, on the other hand had a favourable effect in most cases on such growth parameters (Tables, 2 & 3).

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

Mechanical analysis			Texture	pH	EC. dS/m	CaCO3	O.M.%
Sand%	Silt%	Clay%					
70.0	26.0	4.0	Sandy loam	7.26	6.00		0.80

Chemical analysis									
Cations (meq/L)						Anions (meq/L)			
N^+	P^+	Ca^{++}	Mg^{++}	Na^+	K^+	CO_3^-	HCO^-3	CL^-	SO_4^{--}
Traces	0.40	53.75	23.75	17.1	2.16	Zero	8.0	68.0	20.76

Table (2): Vegetative growth of potato plants (at 90 days after planting) as affected by the interaction among organic-mineral N combinations, biofertilizer and yeast foliar application treatments during the summer season of 2009.

		Characters Treatments	Plant height cm	Number of stems/plant	Leaf/area cm^2/plant	Fresh weight g/plant	Dry weight g/plant
150 kg mineral-N	Without biofertilizer	Without yeast extract	51.43 F	2.233 A	1470.0 CDEFGH	221.2 EFG	24.23 EF
		With yeast extract	59.40 AB	2.567 A	1592.0 CDEFG	280.9 B	30.47 ABC
	With biofertilizer	Without yeast extract	51.47 F	2.233 A	1540.0 CDEFGH	235.7 CDEF	24.17 EF
		With yeast extract	54.37 DE	2.367 A	1661.0 BCDEFG	245.8 BCDE	26.30 DE
100 kg mineral-N + 50 kg organic-N	Without biofertilizer	Without yeast extract	53.77 E	2.233 A	1251.0 DEFGH	221.8 EFG	23.37 F
		With yeast extract	54.43 DE	2.500 A	1781.0 BCDEF	264.1 BCD	28.30 CD
	With biofertilizer	Without yeast extract	51.43 F	2.267 A	1426.0 CDEFGH	233.2 DEF	24.27 EF
		With yeast extract	56.47 CD	2.333 A	2561.0 A	271.5 BC	28.27 CD
75 kg mineral-N + 75 kg organic-N	Without biofertilizer	Without yeast extract	57.20 BC	2.500 A	1892.0 BCDE	277.6 B	29.37 BC
		With yeast extract	58.20 ABC	2.500 A	1970.0 BCD	274.2 B	29.30 BC
	With biofertilizer	Without yeast extract	59.20 AB	2.567 A	2056.0 BC	321.3 A	31.33 AB
		With yeast extract	60.43 A	2.667 A	2342.0 AB	324.2 A	32.40 A
50 kg mineral-N + 100 kg organic-N	Without biofertilizer	Without yeast extract	40.40 GH	2.233 A	1036.0 FGH	203.3 FG	18.20 HI
		With yeast extract	42.37 G	2.267 A	1061.0 FGH	209.4 EFG	22.27 FG
	With biofertilizer	Without yeast extract	42.43 G	2.333 A	1122.0 FGH	213.0 EFG	22.30 FG
		With yeast extract	42.33 G	2.267 A	1180.0 EFGH	188.0 GH	20.17 GH
150 kg mineral-N	Without biofertilizer	Without yeast extract	37.27 IJ	2.233 A	1006.0 GH	162.2 H	15.33 J
		With yeast extract	39.37 HI	2.233 A	1016.0 GH	166.2 H	17.30 IJ
	With biofertilizer	Without yeast extract	35.37 J	2.167 A	696.6 GH	162.6 H	15.23 IJ
		With yeast extract	36.40 J	2.167 A	985.9 GH	163.7 H	16.30 IJ

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (3): Vegetative growth of potato plants (at 90 days after planting) as affected by the interaction among organic-mineral N combinations, biofertilizer and yeast foliar application treatments during the summer season of 2010.

Treatments		Characters	Plant height cm	Number of stems/plant	Leaf area cm^2/plant	Fresh weight g/plant	Dry weight g/plant
150 Kg mineral-N	Without biofertilizer	Without yeast extract	52.23 H	2.200 E	1492.0 CDEFGH	221.5 J	23.83 DE
		With yeast extract	60.07 B	2.300 CDE	1622.0 CDEFG	282.0 B	29.90 B
	With biofertilizer	Without yeast extract	52.27 H	2.667 ABCD	1562.0 CDEFGH	238.0 G	24.83 D
		With yeast extract	55.13 G	2.267 DE	1672.0 BCDEFG	248.4 F	27.00 C
100 Kg mineral-N + 50 Kg organic-N	Without biofertilizer	Without yeast extract	51.11 I	2.167 E	1272.0 DEFGH	225.8 I	24.00 DE
		With yeast extract	55.30 F	2.833 A	1811.0 BCDEF	263.9 E	27.73 C
	With biofertilizer	Without yeast extract	52.12 H	2.667 ABCD	1435.0 CDEFGH	233.3 H	25.00 D
		With yeast extract	57.27 E	2.233 DE	2582.0 A	275.2 D	27.77 C
75 Kg mineral-N + 75 Kg organic-N	Without biofertilizer	Without yeast extract	57.94 D	2.367 BCDE	1912.0 BCDE	279.2 C	29.97 B
		With yeast extract	58.87 C	2.333 BCDE	1982.0 BCD	276.7 CD	30.00 B
	With biofertilizer	Without yeast extract	59.98 B	2.767 AB	2089.0 BC	355.6 A	30.83 AB
		With yeast extract	61.14 A	2.433 ABCDE	2372.0 AB	358.0 A	31.80 A
50 Kg mineral-N + 100 Kg organic-N	Without biofertilizer	Without yeast extract	41.23 K	2.667 ABCD	1060.0 FGH	172.5 N	19.00 G
		With yeast extract	43.21 J	2.167 E	1096.0 FGH	210.1 L	22.93 E
	With biofertilizer	Without yeast extract	43.34 J	2.733 ABC	1152.0 FGH	215.2 K	21.73 F
		With yeast extract	43.29 J	2.200 E	1192.0 EFGH	188.2 M	20.93 F
150 Kg organic-N	Without biofertilizer	Without yeast extract	38.11 M	2.167 E	1026.0 GH	165.3 O	16.00 I
		With yeast extract	40.16 L	2.200 E	1048.0 GH	166.0 O	17.90 H
	With biofertilizer	Without yeast extract	36.25 O	2.133 E	819.6 H	165.6 O	14.83 J
		With yeast extract	37.30 N	2.100 E	1005. GH	167.0 O	15.77 IJ

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

However, the highest values of plant height, leaf area and fresh and dry weight of potato plants (at 90 days after planting) in both seasons, were obtained when plants received 75 kg N organic + 75 kg N mineral, biofertilized and sprayed with yeast extract. It seems from such results that the condition in which N in mineral form was equal to that in organic gave the optimal growth and regeneration of microorganisms in the soil. Since the free living nitrogen fixing bacteria have the ability not only to fix nitrogen but also to release certain phytohormons of nature GA3 and IAA which could stimulate plant growth, absorption of nutrients and photosynthesis process (Abd El-Latif *et al.*, 2001).

In general, increasing organic-N ratio in the fertilizer combinations than 50% (75 kg N) in the expense of mineral-N, tended to decrease significantly growth parameters. However, increasing mineral-N ratio over 50% (75 kg N) in such combination show only slight decrease (significant in few cases) in plant growth, this may suggests that organic-N might not exceed 50% of N in the organic- mineral N combination (Tables 2 and 3).

However, using yeast extracts as foliar application gave in most cases higher values of plant growth parameters than those un-sprayed. The beneficial effect of yeast extract on the growth parameter of potato plants may be due to that yeast as a natural source for cytocinins had stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophylls formation (Spencer *et al.*, 1983). Also, yeast was found to contain carbohydrate, amino acids and lipids as well as several vitamins and some nutritional element i.e., Na, Ca, Fe, Mg, K, P, S, Zn and Si (Shady, 1978 and Nagodawithana, 1991).

Total yield and its components

It seems from Table 4 that treatment which received 75 kg N/fed. in mineral form with 75 kg N/fed. in organic form, particularly treated with biofertilizer gave the heaviest tuber weight and hiefgest total yield per plant and per fed.

It is also observed that the effect of biofertilizers in enhancing yield of all treatments, unlike its effect on plant growth, was more pronounced. This observation may suggests that the favourable effect of biofertilizers may appear late in the growing season. Also, plants that sprayed with yeast extract gave higher tuber weight and tuber yield than those did not spray with yeast regardless N fertilization treatments (Table, 4).

Also, data presented in Table 4 indicate that increasing the ratio of either organic or mineral N in the fertilizer combination over 50% of both resulted in decreasing average tuber weight and yield/plant and per feddan, but the reduction in yield was more pronounced when the ratio of organic N increased.

Thus the significant lowest values of average tuber weight and total yield were observed when all N dose was added in organic form (Table 4).

The presence of mineral nitrogen with organic one in 50/50 % ratio achieve the most efficient decomposition of organic matter which maintain slow but constant release of mineral nutrition in root zone (Tisdale and Nelson, 1975). Such conditions may provide good media for the optimum activity of biofertilizer and thus increases soil fertility (Marschner, 1997 and Havlin *et al.* 1999). Accordingly, the highest tuber weight and yield of potato was recorded to the treatment received 75 kg N in mineral form with 75 kg/fed. N in organic form and treated by both biofertilizers and yeast extract.

Tuber physical characteristics

It is clear from data presented in Table 5 that treatment received 50% of total nitrogen in organic and other 50% in mineral forms gave, the highest values of tuber, size and dry matter content particularly when combined with biofertilizer treatment, regardless the effect of yeast extract application. However, there was a tendency that such N fertilization treatment (50 % N organic /50% N mineral) increased specific gravity, but the recent treatments, in general, failed to show a clear trend regarding this character (Table 5).

Table (4): Tuber yield and its components of potato plants (at 110 days after planting) as affected by the interaction among organic-mineral N combinations, biofertilizer and yeast foliar application treatments during the summer seasons of 2009 & 2010.

Treatments / Characters			First Season (2009)			Second Season (2010)		
			Average weight of tuber (g)	Total yield g/plant	Total yield ton/fed	Average weight of tuber (g)	Total yield g/plant	Total yield ton/fed
150 Kg mineral-N	Without biofertilizer	Without yeast extract	110.2 FG	551.0 BC	11.220 GH	112.3 ABC	581.9 DEF	11.48 GH
		With yeast extract	116.2 D	581.2 BC	11.950 CD	115.8 ABC	611.9 C	11.95 DE
	With biofertilizer	Without yeast extract	113.0 EF	565.0 BC	11.560 EF	114.7 ABC	591.3 CDEF	11.670 EFG
		With yeast extract	117.7 CD	588.3 B	12.120 C	119.3 ABC	596.5 CDE	12.470 C
100 Kg mineral-N + 50 Kg organic-N	Without biofertilizer	Without yeast extract	108.7 G	543.3 C	11.040 H	109.8 ABC	579.7 EF	11.120 I
		With yeast extract	111.6 FG	558.0 BC	11.390 FG	114.3 ABC	570.8 F	11.360 HI
	With biofertilizer	Without yeast extract	111.7 FG	558.3 BC	11.400 FG	113.1 ABC	590.3 CDEF	11.490 FGH
		With yeast extract	115.3 DE	576.7 BC	11.840 CDE	117.3 ABC	602.3 CD	12.010 D
75 Kg mineral-N + 75 Kg organic-N	Without biofertilizer	Without yeast extract	114.7 DE	573.3 BC	11.760 DE	115.1 ABC	593.0 CDE	11.780 DEF
		With yeast extract	120.3 C	585.0 B	12.840 B	123.2 ABC	636.3 B	13.010 B
	With biofertilizer	Without yeast extract	152.0 B	700.0 A	14.800 A	149.5 AB	733.3 A	14.630 A
		With yeast extract	158.7 A	703.5 A	14.880 A	157.9 A	731.4 A	14.640 A
50 Kg mineral-N + 100 Kg organic-N	Without biofertilizer	Without yeast extract	75.3 I	301.3 DEF	7.233 J	78.6 BC	329.5 HI	7.320 K
		With yeast extract	80.3 H	321.3 D	7.713 I	81.1 BC	354.1 G	8.000 J
	With biofertilizer	Without yeast extract	79.7 H	318.7 DE	7.647 I	80.8 BC	347.9 GH	7.840 J
		With yeast extract	80.8 H	323.3 D	7.760 I	81.6 BC	355.0 G	7.787 J
150 Kg organic-N	Without biofertilizer	Without yeast extract	62.7 K	250.7 GH	6.017 L	64.5 C	283.7 K	6.253 M
		With yeast extract	71.0 J	284.0 EFG	6.820 K	70.1 C	315.4 IJ	6.880 L
	With biofertilizer	Without yeast extract	61.0 K	244.0 H	5.860 L	61.7 C	275.4 K	5.927 N
		With yeast extract	69.0 J	276.0 FGH	6.623 K	70.1 C	306.5 J	6.740 L

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (5): Size, dry matter content and specific gravity of potato tubers (at 110 days after planting) as affected by the interaction among organic-mineral N combinations, biofertilizer and yeast foliar application treatments during the summer season of 2009 & 2010.

Treatments / Characters			First Season (2009)			Second Season (2010)		
			Tuber size cm^3	Dry matter %	Specific gravity g/cm^3	Tuber size cm^3	Dry matter %	Specific gravity g/cm^3
150 Kg mineral-N	Without biofertilizer	Without yeast extract	159.0 GH	16.24 IJ	1.045 EFG	161.8 F	16.23 J	1.061 A
		With yeast extract	186.3 C	18.61 CD	1.048 B	187.7 B	18.41 D	1.058 B
	With biofertilizer	Without yeast extract	162.7 G	16.37 HI	1.04 K	165.3 E	16.24 IJ	1.050 HI
		With yeast extract	181.0 DE	18.43 DE	1.046 CDE	184.5 B	18.32 D	1.056 CD
100 Kg mineral-N + 50 Kg organic-N	Without biofertilizer	Without yeast extract	151.7 I	15.98 KL	1.044 EFGH	154.5 G	15.81 M	1.057 BC
		With yeast extract	179.7 DE	17.00 G	1.047 BC	181.0 C	16.87 G	1.054 DE
	With biofertilizer	Without yeast extract	173.7 F	16.57 H	1.042 IJ	176.5 D	16.34 HI	1.052 FG
		With yeast extract	180.0 DE	17.33 F	1.043 HI	180.8 C	17.02 F	1.053 EF
75 Kg mineral-N + 75 Kg organic-N	Without biofertilizer	Without yeast extract	184.4 CD	18.40 E	1.046 CDE	187.3 B	18.20 E	1.056 CD
		With yeast extract	193.0 B	18.77 C	1.051 A	194.7 A	18.64 C	1.058 B
	With biofertilizer	Without yeast extract	198.3 A	19.58 A	1.045 DEF	198.1 A	19.47 A	1.045 J
		With yeast extract	194.7 AB	19.33 B	1.049 B	197.7 A	19.23 B	1.059 B
50 Kg mineral-N + 100 Kg organic-N	Without biofertilizer	Without yeast extract	151.3 I	15.87 LM	1.044 FGHI	152.2 G	15.86 M	1.050 GHI
		With yeast extract	175.7 EF	16.57 H	1.040 K	180.2 C	16.37 H	1.046 J
	With biofertilizer	Without yeast extract	170.7 F	16.38 HI	1.044 EFGH	173.3 D	16.25 IJ	1.051 GHI
		With yeast extract	180.0 DE	17.13 G	1.045 EFG	180.5 C	17.02 F	1.051 FGH
150 Kg organic-N	Without biofertilizer	Without yeast extract	152.7 I	15.75 M	1.042 HIJ	153.8 G	15.55 N	1.049 I
		With yeast extract	152.7 I	16.23 IJ	1.047 BCD	154.0 G	16.10 K	1.057 BC
	With biofertilizer	Without yeast extract	150.7 I	15.70 M	1.041 JK	153.5 G	15.57 N	1.054 DE
		With yeast extract	155.7 HI	16.11 JK	1.043 GHI	158.7 F	15.97 L	1.050 HI

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Increasing ratio of both mineral-N or organic-N in the fertilizer than 50%, resulted in decreasing tuber physical characteristics particularly with increasing the ratio of organic N in the fertilizer.

It is also obvious (Table 5) that the favourable effect of biofertilizer in increasing tuber size was more pronounced when N at both forms were applied at equal dose (50/50%). However, such effect of biofertilizer diminished as organic N increased than 50% in the fertilizer combination.

In addition, yeast extract treatment enhanced tuber size and dry matter content. The favourable effect of yeast extract application on tuber size was more pronounced as long as mineral N ratio in the fertilizer was equal or highest than organic one (Table 5).

Plants that received all nitrogen dose in organic form (150 kg) either treated with biofertilizer or yeast extract or not gave the least values of tuber physical characters (Table, 5). Obtained results are agreement with those reported by Arisha and Bardisi (1999), Calskan *et al.* (2004) and Bekhit *et al.* (2005) on potato.

Tuber chemical constituents

With few exceptions starch content in potato tuber increased gradually with changing N organic/N mineral ratio toward that treatment received equal dose of both forms. In other words treatment fertilized with 75 kg N organic/75 kg N /fed. as mineral particularly with biofertilizer application gave the highest starch content (Tables 6 & 7). Although, yeast extract treatments enhanced starch content in some cases (particularly when the ratio of mineral N were high) its effects did not take a clear trend in general.

Also, reducing, non-reducing and total sugars gradually increased with reducing N ratio of both forms from 100% (full dose) toward 50% of both forms (Tables 6 & 7). Treatment that received this particular ratio (75 kg N organic + 75 kg N/fed. mineral) particularly with biofertilizer and yeast application gave the highest values of sugars. However, high sugar content in potato tuber is not favourable particularly in French fries processing.

Also data in Tables, 6 and 7 showed that nitrate accumulation in tubers was relatively low in plants received 150 kg organic-N, medium in plants fertilized with 75 kg organic -N+75 kg mineral -N and high in plants supplied with all dose of N as inorganic form i.e 150 kg mineral-N. This may be due to the increase in the rate of nitrogen absorption than the metabolism within the plant (Scott, 2008). On the other hand, the addition of organic-N over 50% significantly decreased nitrate accumulation in potato tubers. Similar result was reported by Youssef (2007) who found that fertilization potato plants with 150 kg mineral-N/fed. increased nitrate content in tubers. Also, these results are in harmony with those of Barmaki *et al.* (2008) who found that nitrate contents in tubers of plants received with organic manure alone or organic manure combined with inorganic N fertilizers were less than tubers of plants received chemical fertilizers only.

Montagu and Goh (1990) and Faller and Fialho (2009) explained that nutrients from organic fertilizers are released more slowly and steadily to the plant, whereas synthetic chemical fertilizers offer more readily available sources of nitrogen, to accelerate plant growth and accumulate the excess N in the form of nitrate. In addition N in mineral form, particularly when combined with similar amont with organic N form, prove the optimum conditions of nutrients utilization by microorganism in the soil to build up new generation. The high microorganism populations actively degrade the organic mater and release N countinusly but slowly.

The European Commission Scientific Committee on Food (SCF) agreed to retain its earlier Acceptable Daily Intake (ADI) for the nitrate ion of 3.7 mg kg^{-1} body weight (*European Commission, 1997*). Maximum level of nitrates and nitrites permitted in lettuce in Romania is 2 g kg^{-1} DW (Socaciu and Stanila, 2007).

It is worthy to mention that nitrate concentration in potato tubers found in this experiment is still in the safe border for human consumption.

Table (6): Some chemical constituents of potato tubers (at 110 days after planting) as affected by the interaction among organic-mineral N combinations, biofertilizer and yeast foliar application treatments during the summer season of 2009.

Treatments		Characters	Starch%	Sugars %			Nitrate mg/kg^{-1} D.W.
				Reducing	Non-reducing	Total	
150 Kg mineral-N	Without biofertilizer	Without yeast extract	18.32 FGH	0.478 J	1.624 K	2.101 H	306.2 DE
		With yeast extract	26.47 B	0.534 C	1.938 F	2.471 E	305.0 DE
	With biofertilizer	Without yeast extract	23.36 C	0.472 KL	1.558 N	2.029 I	311.3 E
		With yeast extract	22.44 D	0.455 O	2.333 A	2.787 B	302.8 DE
100 Kg mineral-N + 50 Kg organic-N	Without biofertilizer	Without yeast extract	17.67 GH	0.473 K	1.503 P	1.975 J	297.6 CDE
		With yeast extract	27.49 A	0.496 G	1.732 H	2.227 F	291.2 BCDE
	With biofertilizer	Without yeast extract	20.40 E	0.471 LM	1.599 L	2.069 HI	314.0 E
		With yeast extract	23.42 C	0.484 H	1.742 G	2.225 F	297.6 CDE
75 Kg mineral-N + 75 Kg organic-N	Without biofertilizer	Without yeast extract	26.56 B	0.510 E	2.017 E	2.526 D	263.8 ABC
		With yeast extract	23.60 C	0.508 F	2.152 D	2.659 C	271.2 ABCD
	With biofertilizer	Without yeast extract	27.49 A	0.581 B	2.318 B	2.898 A	264.1 ABC
		With yeast extract	27.53 A	0.614 A	2.284 C	2.897 A	271.5 ABCD
50 Kg mineral-N + 100 Kg organic-N	Without biofertilizer	Without yeast extract	18.55 F	0.437 Q	1.484 Q	1.920 K	257.6 AB
		With yeast extract	26.35 B	0.532 D	1.623 K	2.154 G	261.4 BCD
	With biofertilizer	Without yeast extract	26.61 B	0.458 N	1.714 I	2.171 G	256.7 AB
		With yeast extract	23.43 C	0.453 P	1.580 M	2.032 I	257.5 AB
150 Kg organic-N	Without biofertilizer	Without yeast extract	18.43 FG	0.453 P	1.633 J	2.085 HI	254.1 AB
		With yeast extract	17.60 H	0.470 M	1.452 R	1.921 K	239.8 A
	With biofertilizer	Without yeast extract	17.62 H	0.454 OP	1.383 S	1.836 L	252.6 A
		With yeast extract	18.42 FG	0.481 I	1.553 O	2.033 I	253.4 AB

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

Table (7): Some chemical constituents of potato tubers (at 110 days after planting) as affected by the interaction among organic-mineral N combinations, biofertilizer and yeast foliar application treatments during the summer season of 2010.

Treatments \ Characters			Starch%	Sugars %			Nitrate mg/kg^{-1} D.W.
				Reducing	Non-reducing	Total	
150 Kg mineral-N	Without biofertilizer	Without yeast extract	19.11 L	0.494 J	1.699 G	2.192 HI	306.7 G
		With yeast extract	27.39 D	0.542 C	1.963 E	2.505 E	303.8 G
	With biofertilizer	Without yeast extract	23.84 H	0.484 K	1.600 H	2.083 K	302.2 G
		With yeast extract	22.91 I	0.471 N	2.408 A	2.878 B	316.8 H
100 Kg mineral-N + 50 Kg organic-N	Without biofertilizer	Without yeast extract	18.23 N	0.481 L	1.544 HIJ	2.026 L	301.1 FG
		With yeast extract	28.28 B	0.522 G	1.774 F	2.295 F	304.0 G
	With biofertilizer	Without yeast extract	20.98 J	0.473 M	1.674 G	2.146 IJ	296.7 F
		With yeast extract	23.99 G	0.506 H	1.767 F	2.273 FG	289.7 E
75 Kg mineral-N + 75 Kg organic-N	Without biofertilizer	Without yeast extract	27.06 E	0.536 E	2.075 D	2.611 D	258.1 BC
		With yeast extract	24.35 F	0.524 F	2.227 C	2.751 C	259.4 C
	With biofertilizer	Without yeast extract	28.45 A	0.589 B	2.343 B	2.932 A	273.7 D
		With yeast extract	28.14 C	0.626 A	2.326 B	2.952 A	276.8 D
50 Kg mineral-N + 100 Kg organic-N	Without biofertilizer	Without yeast extract	18.86 M	0.453 Q	1.542 IJ	1.995 L	257.6 BC
		With yeast extract	27.00 E	0.540 D	1.664 G	2.205 H	257.3 BC
	With biofertilizer	Without yeast extract	27.35 D	0.484 K	1.756 F	2.239 GH	257.8 BC
		With yeast extract	24.27 F	0.455 P	1.655 G	2.109 JK	254 BC
150 Kg organic-N	Without biofertilizer	Without yeast extract	19.37 K	0.462 O	1.674 G	2.136 JK	233.5 A
		With yeast extract	18.02 O	0.482 L	1.510 J	1.992 L	252.3 B
	With biofertilizer	Without yeast extract	18.29 N	0.470 N	1.441 K	1.911 M	252.6 B
		With yeast extract	19.10 L	0.503 I	1.578 HI	2.081 K	252.6 B

Means of the same column followed by the same letter were not significantly differed due to Duncan MRT at 5%.

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تأثير التداخل بين التسميد النيتروجينى العضوى والمعدنى مع أو بدون التسميد الحيوى أو مستخلص الخميرة على النمو وإنتاجية البطاطس

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الملخص العربى

أجريت تجربة حقلية على نبات البطاطس صنف سبونتا بمزرعة معهد الدراسات والبحوث البيئية بمدينة السادات – جامعة المنوفية وذلك أثناء الموسم الصيفى لعامى 2009 ، 2010 فى أرض رملية صفراء. وكان تصميم المعاملات فى التجربة هو القطع المنشقة مرتين فى ثلاث مكررات. وتهدف هذه التجربة إلى دراسة تأثير خمس معاملات من التداخل بين التسميد النيتروجينى العضوى والمعدنى ومعاملتين تسميد حيوى ومعاملتين رش ورقى بمستخلص الخميرة على نمو ومحصول وجودة درنات البطاطس. وهذه المعاملات هى إما استخدام سماد نترات الأمونيوم بمعدل 150 كجم ن/فدان أو إستخدام نترات أمونيوم بمعدل 100 كجم ن + سماد الدواجن بمعدل 50 كجم ن للفدان أو استخدام نترات أمونيوم بمعدل 75 كجم ن + سماد الدواجن بمعدل 75 كجم ن للفدان أو استخدام نترات أمونيوم بمعدل 50 كجم ن + سماد الدواجن بمعدل 100 كجم ن للفدان أو استخدام سماد الدواجن بمعدل 150 كجم ن/فدان، وذلك مع أو بدون التلقيح بخليط من التسميد الحيوى "بكتيريا تثبيت آزوت الهواء الجوى وبكتيريا إذابة الفوسفور"، وأيضا مع أو بدون الرش الورقى بمستخلص الخميرة (50 مل/لتر).

وقد وجد من النتائج أن استخدام خليط من التسميد النيتروجينى مناصفة بين التسميد العضوى على صورة سماد الدواجن بمعدل 75 كجم نيتروجين للفدان والتسميد المعدنى على صورة نترات أمونيوم بمعدل 75 كجم نيتروجين للفدان قد أدى إلى تحسن النمو والمحصول والجودة لدرنات نباتات البطاطس، كما وأن تلقيح الدرنات ببكتيريا التسميد الحيوى والرش الورقى بمستخلص الخميرة (50 مل مستخلص خميرة لكل لتر ماء رش) مع الخليط السابق من النيتروجين العضوى والمعدنى قد أعطى أعلى القيم لصفات النمو الخضرى وأعلى محصول للنبات والفدان، وأدى إلى تحسين الصفات الطبيعية والكيميائية للدرنات وذلك مقارنة بباقى معاملات التجربة، وكانت الزيادة فى محصول النبات والفدان قدرها 26.66 ٪ و 30.15 ٪ كمتوسط عام وعلى الترتيب فى موسمى الزراعة وذلك مقارنة بالمعاملة التى سمدت نباتاتها بمعدل نيتروجين معدنى (150 كجم للفدان) وبدون تسميد حيوى أو الرش الورقى بمستخلص الخميرة (معاملة المقارنة).