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Effect of Compost, Biofertilizer and Chicken Manure on Nutrient Content and Tuber Quality of Potato Crops

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THIS STUDY was carried out in newly reclaimed land at Sadat city,Taba farm.El Menoufia governorate during 1998/1999 and 1999/2000. Potatoes var.Nicola was cultivated to study the effect of compost, *i.e.* chicken manure (dry manure or extract from chicken after 48h.) and compost (40 m^3 and 60m^3 /fed.) with two kinds of biofertilizer added to the soil (suspension from yeast , pesedoumonas and Bacteria dissolving phosphate) or inoculated with tuber as commercial product called Microbin on nutrient content and yield of potato tuber. The results from this study indicated that applying compost with chicken manure (as dry manure or extract from chicken after 48h.) and biofertilizer that were added to the soil or inoculated with tuber, increased the percentage of nutrients in potato leaves ,dry matter content, total carbohydrates and total yield per plant. The results indicated that using chicken manure as dry manure gave better results than using extract manure after 48 h., but there were no significant differences between these two treatments in most characters recorded. On the other hand, using chicken manure as dry manure with bio fertilizer increased nitrate content in potato tubers than using extract of chicken manure with bio fertilizer, such values were still in the acceptable ranges for human health.

Potato (*Solanum tuberosum* L) is one of the most important vegetable crops grown in Egypt. Using organic fertilizer in potato production is growing in Egypt now to take place in the European market and to have the consumer who is willing to pay high price for a healthy safe product. Alexander (1977) declared that nitrate ion is a well known as on environmental pollutant because of its potential role in infant methemoglobinemia associated with the consumption of nitrate rich water and vegetable. Malysher (1979) reported that application of high rats of P and K increased the available P_2O_5 and K_2O contents and dry matter, starch, vitamin C in potato tubers. Striban *et al.* (1984) suggested that tuber carbohydrates content increased with fertilizer application. The application of 40-320 Kg N/ha reduced the specific gravity of the tubers. (Laurence *et al.*, 1985).

Sharma & Arora (1987) found that increasing N rates significantly caused a decrease in P and K concentrations in the haulm and tubers.Hamouz (1991) on potatoes cvs. Resy and Klara, given 40 ton/ha FYM and 0-240 Kg N/ha, found that nitrate accumulation of cv Klara was 62% higher than Resy,while 300 mg nitrate-N/Kg was acceptable limit for nitrate in potato tuber.Nazarov (1992) suggested that using compost and NPK fertilizers correlated the nitrite content in the soil and potatoes tuber. Abdel-Ati- (1998) mentioned that high rates of chicken manure (15 m^3) increased contents of N, P and K percentage in the leaves. Mondals *et al.* (1985) reported that using organic manure with mineral fertilizer on sandy loam soil with cv Kufri Chandramukhi increased tuber yield.

Giardinia *et al.* (1992)found that recycling of poultry waste as a fertilizer gave high yield of potato crop. Quastel (1965) reported that soil microorganisms known as phosphate solubilizing bacteria (PSB) play a fundamental role in converting P fixed form to be soluble and available for plant nutrition .As well as the microbial breakdown of soil organic matter is associated with an increased CO_2 production which possibly increases the solubility of soil phosphate.Gomaa (1989) mentioned that some effects of phosphate solubilizing bacteria inoculation have been observed in terms of increasing the amount available P. El-Gamal (1996) demonstrated that increasing N fertilizer level or inoculation with HALEX2 increased leaf N content and dry matter content of potato tuber. Ash *et al.* (1996) and Ahmed *et al.* (1997) noticed that nutrient uptake by groundnut plants was significantly increased when organic was applied alone or in combination with either biofertilizer or chemical fertilizers.

Zayed (1998) proved that the phosphorus dissolving bacteria is known by its ability to dissolve the precipitated form phosphors: $Ca_3\ (PO_4)_2$ depending on its ability to produce inorganic, organic acids and /or CO_2 .Rabinovich *et al.* (1999) mentioned that increased doses of bio-fertilizers for potato raised high concentration of denitrificating microorganisms.

El-Dsouky & Attia (1999) concluded that the highest values of N, P and K contents in peanuts shoot were achieved for inoculated plants with phosphate solubilizing bacteria grown in soil fertilized with super phosphate at the rates of 50 or 100 kg/fed.

Material and Methods

Two field experiments were conducted in sandy soil at Sadat city, Taba farm, El -Menoufia Governorate (70 km north Cairo from the Desert Road), during two successive seasons, *i.e.,* 1998/1999 and 1999/2000.

Plant materials

Certified seed potato tuber of cultivar Nicola (locally produced and cold stored), obtained from the General Authority for Producers and Exporters of Horticulture Crops, Cairo, Egypt, was used in the experiments. Nicola cultivar is medium early to medium late .The whole seed tubers were planted, on 15^{th} of November in the two seasons, for the two experiments.

Soil properties

The physical and chemical properties of the experimental soil are presented in Table 1. The analysis of compost,chicken and cattle manures used in this experiments are shown in Table 2.

Treatments

This experiment included different levels of compost, chicken manure and bio-fertilizers, as follows.

1-The recommended dose of fertilizer as a check, *i.e.,* 40 m^3 cattle manure, 300 kg rock phoshate before planting, and 150 kg N and 175 kg K_2O/fed after planting at three times (35, 55 and 80 days from planting).

2-Compost at a rate of 40 m^3/fed.

3-Compost at a rate of 60m^3 /fed.

4-Chicken manures at a rate of 30 m^3/fed plus suspensions of bio fertilizers added to the soil, *i.e.,*soil yeast (*Candida tropicals*), Pseudomonas aeruginosa phosphate solubilizing bacteria (*Bacillus megatherium var. phosphaticum*).

5-Chicken manures at a rate of 30 m^3/fed plus bio fertilizer (Microbin) mixed with the seed potato tuber.

6-Compost at a rate of 40m^3/fed + Chicken manure at a rate of 30m^3/fed plus bio-fertilizer (Microbin) mixed with the seed potato tuber .

7-Compost at a rate of 40m^3/fed + Chicken manure at a rate of 30m^3/fed plus suspensions of bio fertilizers added to the soil , *i.e.,* soil yeast (*Candida tropicals*) , *Pseudomonas aeruginosa* and phosphate solubilizing bacteria *(Bacillus megatherium var. phosphaticum).*

8-Compost at rate of 40m^3/fed, extract of chicken manure and bio-fertilizer (Microbin) mixed with the seed potato tuber .

9-Compost at rate of 40m^3/fed, extract of chicken manure and suspensions of bio-fertilizers add to soil, *i.e.,* soil yeast (*Candida tropicals*) , Pseudomonas aeruginosa and phosphate solubilizing bacteria (*Bacillus megatherium var. phosphaticum*).

10- Chicken manure only at a rate of 30 m^3/fed.

TABLE 1. Chemical and physical properties of Taba farm soil (Sadat city).

Mechanical Analysis				pH	Ec	$CaCO_3$	Cations					Anions			
Sand %	Silt %	Clay	Texture		DS/m	%	N %	P %	K %	Ca meq/L	Mg meq/L	Co_3 meq/L	Hco_3	cl	So_4
90	5	5	Sandy soil	8.20	1.50	5.50	Traces	0.44	0.57	2.65	2.40	Zero	3.85	53	55.65

TABLE 2. Analysis of compost,Chicken and cattle manure used in Taba farm.

Organic fertilizer	C %	O.M %	C/N ratio	Macro Elements (%)					Micro Elements	
				N %	P %	K %	Ca %	Mg %	Fe %	Mn ppm
Compost	10.00	20.00	6.09	1.64	0.6813	1.5165	0.1626	0.9070	0.1793	407.60
Chicken manure	18.48	36.96	4.48	4.12	0.1825	2.2500	1.1909	0.5183	0.0642	203.800
Cattle manure	18.71	37.42	11.62	1.61	0.7325	1.2706	0.1607	0.6965	0.6499	190.217

Two kinds of boifertilizers were used in these experiments. The first was Microbin which was thoroughly mixed with tuber seed directly before planting (one sac/fed). It is a commercial product purchased by the General Authority of Agriculture Funds and Equalization. The second was suspension added to the soil directly before planting . It is consisted of yeast, Pseudomonas and bio fertilizer phosphate dissolving bacteria.Each experimental plot contained ten rows 6 m length and 11 m width (area of 66 m^2). Each plot received equivalent amount of 200 Kg sulfur added to the soil before planting.The potassium phosphate contained (52% K_2O) Hortozol imported from Russia. The rock phosphate, sulfur, compost, chicken manure and cattle manure were applied 20 days before planting. Compost, chicken manure and cattle manure were added in the middle of the row at 40 cm depth then the soil was irrigated.Compost in these experiment was made from Water hyacinth (*Eichhornia crassipes*) which was taken from River Nile in front of El Kanater El Khiria barrage. Extract of chicken manure was prepared by using water at a rate of 100 liter of water for each 20 kg of chicken manure and stored for 48hr then the extract was taken and mixed with water at a rate of one litter of extract with one Liter of water then added beside plants three times per week.

All experimental plots received the same amount of water from planting till harvest,using drip irrigation system, the flow rate of drippers was 4L/hr and the distance between the lateral irrigation line was one m with distances of 50 cm between the drippers.

The experimental design

The treatments was arranged in a randomized complete block design with three replicates.

Data recorded

A random sample of three plants were taken 50 and 80 days after planting from every treatment for the determination of growth and chemical characters of the plant.

Chemical measurements

A random sample of fifteen tubers was selected from every treatment after harvesting for the determination of total carbohydrates, ,nitrate content. Sample of the fourth top leaves was taken at 50 and 80 days from planting to determine N, P, K, Ca and Mg.

Determination of total carbohydrates

Total carbohydrates was determined according to the method described by Shaffer & Hartmann (1921).

Determination of nitrate

Nitrate content in tuber was determined according to method described by Holty & Petwerowski (1972) .

Determination of N, P, K, Ca and Mg

For mineral analysis, dried leaves were digested in H_2SO_4 and the minerals contents were estimated as follows:-

Total nitrogen, Potassium, calcium and magnesium

Total nitrogen content was determined according to the procedure described by FAO Soils Bulletin (1980) .

Phosphorus

Phosphors content was determined using the method described by Chapman & Pratt (1961).

Yield

Each experimental plot was harvested individually after 120 days from planting and yield data were recorded:

5-Total yield per (plant and feddan.)

Statisticall analysis

The statistical analysis was done according to Steel and Torric (1960) .

Results

Nutrients content of potato leaf

Nitrogen

The percentage of nitrogen, phosphorus, potassium, magnesium and calcium was affected with applied organic and biofertilizers (Table 3). Applying compost, chicken manure and biofertilizer either added to the soil or inoculated with tuber, in general, increased the percentage of N in leaf of potato plants at both samples in the first season. In the second season, applying compost, chicken manure with bio fertilizer added to the soil recorded the highest value at first sample. Whereas, the highest value was obtained by using chicken manure with bio fertilizer inculcated with tuber at the second sampling date.

Phosphorus

Results illustrated in Table 3 indicated that applying compost and chicken manure with biofertilizer inoculated with tuber was the most favorable treatments for increasing P in potato leaves. Chicken manure and bio fertilizer inoculated with tuber was sometimes effective.

Potassium

In the first season, as shown in Table 3, obtained results indicated that after 50 days from planting the applying compost, chicken manure with biofertilizers added to the soil was the best treatment for increasing the percentage of K in potato leaves. On the other hand, the highest value recorded at the second sampling date was with applying compost, extract of chicken manure and biofertilizer inoculated with tuber.

In the second season, applying chicken manure with bio fertilizer added to the soil was the most favorable treatment at first sample. While, the highest value was observed with applying compost, chicken manure with biofertilizers added to the soil at the second sampling date.

Calcium

Results in Table 3 show the effect of compost, chicken manure and biofertilizers on percentage of Ca in potato leaves .In the first season, the highest value was recorded with applying compost at a rate of 40 m^3 /fed whereas, the lowest value was recoded with applying compost, chicken manure with biofertilizer inoculated with tuber at the first sampling date. At the second sampling, the check treatment that received the recommended dose of mineral fertilizers for potato crops gave the highest recorded Ca % in potato leaves. While, the compost, chicken manure and biofertilizer added to the soil had less effect on Ca percentage. In the second season, applying chicken manure alone recorded the highest value at first sample. On the other hand, using compost, chicken manure with bio fertilizer added to the soil was the most effective treatment at the second sampling date.

TABLE 3. Effect of compost, chicken manure and bio fertilizers on nutrient content of potato leaves in 1998/1999 and 1999/2000 seasons.

Treatments	N %	P %	K %	Ca %	Mg %	N %	P %	K %	Ca %	Mg %
	1998/1999									
	50 days from planting					**80 days from planting**				
Check	3.17	0.25	7.51	1.40	0.54	3.38	0.20	5.88	2.47	0.55
Compost 40 m3	3.30	0.19	6.33	1.61	0.63	3.08	0.10	5.53	2.03	0.72
Compost 60m3.	3.16	0.22	6.93	1.56	0.64	3.43	0.14	6.08	2.21	0.58
Chicken +Biofertilizer(tuber)	3.68	0.34	7.30	1.29	0.53	3.26	0.29	5.41	2.28	0.86
Chicken +Biofertilizer (soil)	3.55	0.43	6.64	1.40	0.66	2.99	0.14	5.45	2.45	0.83
Compost +chicken manure +Biofertilizer (tuber)	3.77	0.42	7.50	1.21	0.67	3.40	0.22	6.32	1.98	0.62
Compost +chicken manure +Biofertilizer (soil)	3.95	0.36	7.63	1.25	0.59	3.91	0.38	6.39	1.69	0.58
Compost +Extract chicken.+Biofertilizer (tuber)	3.63	0.16	6.39	1.24	0.63	3.49	0.24	6.67	2.05	0.54
Compost+ Extract chicken + Biofertilizer (soil)	3.59	0.23	6.80	1.44	0.65	3.63	0.24	6.00	2.37	0.53
Chicken only	2.90	0.35	5.67	1.42	0.45	3.27	0.73	5.02	2.09	0.64
	1999/2000									
Check	4.47	1.12	7.76	0.76	0.61	3.38	0.53	8.91	1.12	0.82
Compost 40 m3	3.56	0.74	8.96	0.66	0.58	3.25	0.36	7.46	1.82	0.79
Compost 60m3.	3.84	1.13	8.16	0.71	0.59	3.29	0.48	7.61	1.55	0.71
Chicken manure +Biofertilizer (tuber)	4.55	1.48	7.43	0.95	0.57	3.84	0.61	8.21	1.77	0.75
Chicken manure +Biofertilizer (soil)	4.32	1.20	8.96	0.91	0.68	3.56	0.52	8.61	1.57	0.69
Compost +chicken manure +Biofertilizer (tuber)	4.53	1.13	7.11	1.08	0.62	3.66	0.55	8.41	2.16	0.71
Compost +chicken manure +Biofertilizer (soil)	5.23	1.34	7.31	0.97	0.55	3.67	0.72	11.49	1.70	0.65
Compost +Extract chicken.+Biofertilizer (tuber)	3.98	1.07	6.72	0.50	0.58	3.38	0.42	7.91	1.78	0.75
Compost+ Extract chicken + Biofertilizer (soil)	4.09	0.58	8.66	0.85	0.71	3.56	0.31	7.46	1.25	0.71
Chicken only	4.71	0.61	6.58	1.35	0.72	3.58	0.58	6.67	1.65	0.77

Magnesium

Data presented in Table 3 show the effect of compost, chicken manure and biofertilizers on percentage of magnesium in potato leaves. Results indicated that applying compost, chicken manure and biofertilizer inoculated with tuber increased the percentage of magnesium in potato leaves at the first sampling date. But after 80 days from planting, the highest value was observed with applying chicken manure plus boifertilizer inoculated with tuber .In the second season, using chicken manure alone recorded the highest value at first sample. Whereas, adding check (recommended dose) was the most favorable treatment at the second sapling date.

Tuber quality

Total carbohydrates

Response of total carbohydrates to compost, chicken manure and biofertilizers is shown in Table 4. It is clear that all studied treatments decreased total carbohydrates compared with the check treatment in both seasons. The most effective treatment in reducing total carbohydrates in both seasons was chicken manure only or combined with compost and bio fertilizer inoculated with tuber at both seasons.

Nitrates

Table 4 presents the effect of compost, chicken manure and biofertilzer on nitrates content in potato tuber .It could be concluded that applying dry chicken manure combined with biofertilizers inoculated with tuber or added to the soil increased nitrate content in tuber in both seasons in comparison with check treatment. On the other hand, using compost, extract of chicken manure and bio fertilizers added to soil or inoculated with tuber or dry chicken manure were the most effective treatments in reducing nitrate content in potato tuber in both seasons.

TABLE 4. Effect of compost, chicken manure and bio fertilizer on yield characters of potato crop in 1998/1999 and 1999/2000 seasons.

Treatments	1998/1999			1999/2000		
	Total Carbohydrates (%)	Nitrates ppm	Total Yield Per plant (g)	Total Carbohydrates (%)	Nitrates ppm	Total Yield Per plant (g)
Check	49.30	281.11	1250.00	50.60	275.70	1032.67
Compost 40 m3	45.62	248.35	727.00	45.83	245.20	815.67
Compost 60m3.	47.79	234.67	885.33	47.80	230.67	950.67
Chicken manure +Biofertilizer (tuber)	47.05	332.18	1159.00	47.22	330.51	1117.67
Chicken manure +Biofertilizer (soil)	48.28	380.85	1236.00	47.32	360.50	1005.00
Compost +chicken manure +Biofertilizer (tuber)	41.20	293.52	1606.00	45.50	290.80	1127.33
Compost +chicken manure +Biofertilizer (soil)	46.22	229.93	1416.00	46.25	225.50	1536.00
Compost +Extract chicken.+Biofertilizer (tuber)	47.28	168.73	926.33	47.44	180.73	893.33
Compost+ Extract chicken + Biofertilizer (soil)	45.72	120.78	972.67	45.71	170.50	1162.67
Chicken only	40.27	131.49	943.67	40.27	150.00	792.67
L.S.D at 5%	2.96	16.88	348.37	2.12	16.99	204.67

Total yield

It could be concluded from the data presented in Table 4 and Fig.1 that the total tuber yield per plant and per feddan increased by applying compost, dry

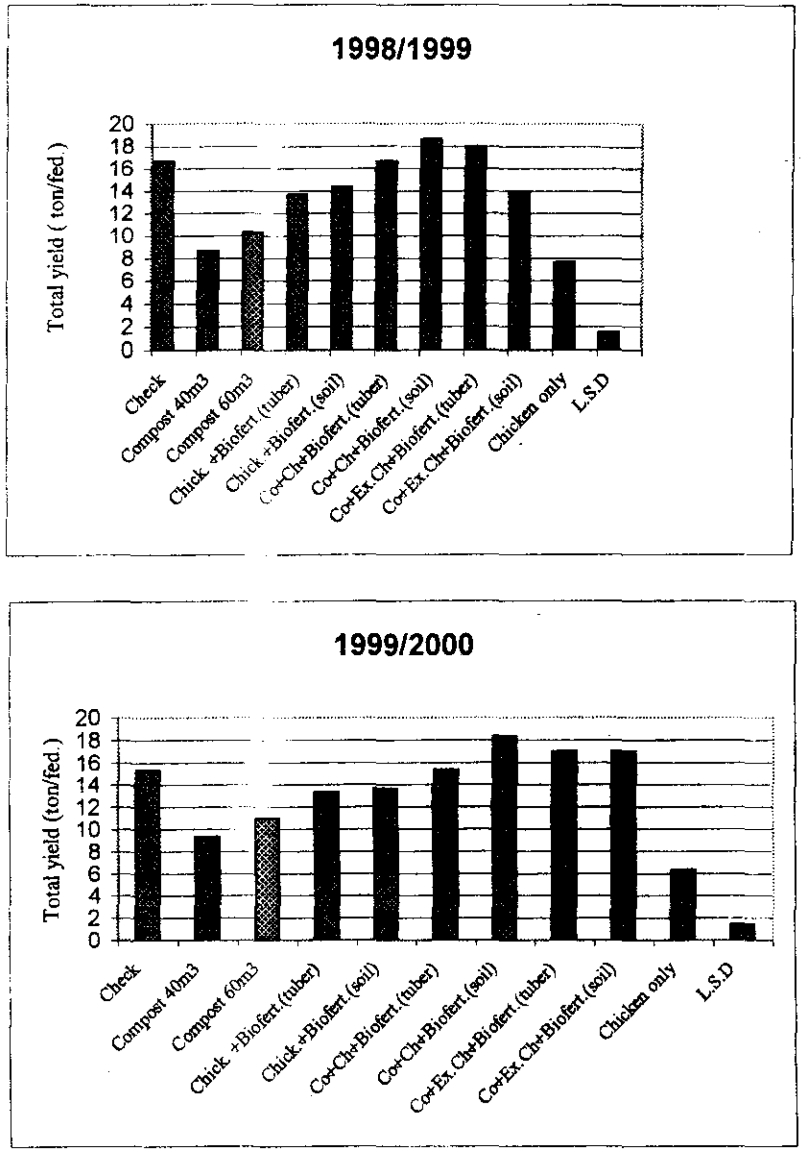

Fig.1. Effect of compost, chicken manure and bio-fertilizer on total yield of potato plant in 1998 / 1999 and 1999 /2000 seasons.

chicken manure along with biofertilizers added to the soil or inoculated with tuber in both seasons.

Discussion

Percentage of N, P and K were increased in the leaves due to application of chicken manure, compost and biofertilizer. Also the specific gravity, total carbohydrates and yield were increased by adding chicken manure (dry or extract) and compost plus bio fertilizers. This effect could be resulted from the increase of these elements in the soil. Similar results were found by Abou Hussein (1995), Albregets & Howard (1981), Singh & Brar (1985), Vokal *et al.* (1983), Sharma & Arora (1987), Paula *et al.* (1989) and Saleh & Abd El Fattah (1997).

Applying chicken manure and compost plus biofertilizers increased nitrate content in tuber but the value is still within the acceptable range for human health. This effect may be due to that adding chicken manure and compost plus biofertilizer increased N nutrient in the soil and the uptake was then increased by plants. The nitrate concentrating in potato was recorded in the range between 75 and 1000 mg /kg of tuber fresh weight. (US National Academy of Sciences, 1981).

On the other hand, increasing rate of compost from $40m^3$ to $60\ m^3$ increased the percentage of N,P and K in potato leaves , total carbohydrates and nitrate in potato tuber but the differences in most cases were not significant. This effect might be due to that applying compost can increase the cation exchange capacity of soils, thus increased availability of certain nutrients such as Ca, Mg and K. Compost also help neutralize and buffer soil pH (A grower's Guide, 1999). Applying biofertilizers together with compost and chicken manure which leading to increase average tuber weight increased, total yield. This effect might be due to that applying biofertilizer increased microorganisms in the soil, which converting the ability of mobilizing the unavailable forms of nutrients elements to available forms (Ishac, 1989). On the other hand, the microorganisms produce growth-promoting substances, which increase the plant growth. This increase in plant growth may increase the photosynthetic rates leading to an increase of the assimilation rates. So that the tuber weight increased, which consequently increased the total yield. Similar results were found by Kundu and Gaur (1980), who reported that potato inoculated with culture suspension of *Bacillus polymyxa* and *Pesudomonas straita* gave the higher yield. tubers and total tuber yield were the greatest from combination of both biofertilizer and growth regulator.(Ghosh & Das , 1998)

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تـأثير الكمبوست ، سـماد الكتكوت والسماد الحيـوى على محتوى العناصـر و المحصول لنباتات البطاطس

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قسم بحوث الخضر - المركز القومي للبحوث ، * قسم البساتين - كلية الزراعة - جامعة عين شمس و ** قسم الميكروبيولوجيا الزراعية - المركز القومي للبحوث - القاهرة - مصر .

أجريت هذه الدراسة فى عامى ١٩٩٨ / ١٩٩٩ و ١٩٩٩ / ٢٠٠٠ فى مزرعة طابا- بمدينة السادات - محافظة المنوفية وذلك لمعرفة أنسب المعدلات السمادية من مكمورة ورد النيل (الكمبوست) وسماد الكتكوت على صورتين (الصورة الجافة والمنقوع) وكذلك الأسمدة الحيوية (خلط مع الدرنات أو اضافة مباشرة للتربة) أظهرت النتائج أن أضافة الأسمدة الحيوية (خلط مع الدرنات أو أضافة مباشرة للتربة) مع سماد الكتكوت (جاف أم منقوع) ومكمورة ورد النيل (كمبوست) أدى الى زيادة العناصر المعدنية فى التربة وجعلها ميسرة لامتصاص النبات وكان ذلك واضحا عند تحليل العناصر المعدنية التالية فى الأوراق (النتروجين -الفوسفور- البوتاسيوم) . أظهرت النتائج أن أضافة الأسمدة الحيوية (خلط مع الدرنات أو أضافة مباشرة للتربة) مع سماد الكتكوت (جاف أو منقوع) ومكمورة ورد النيل (كمبوست) الى زيـادة الكربوهيدرات الكلية فى الدرنات كما أدى سماد الكتكوت (الجاف) مع الأسمدة الحيوية (خلط مع الدرنات أو أضافة مباشرة للتربة) الى زيادة النترات فى الدرنات ولكنها كانت فى المدى المسموح به .

وقد لوحظ تحت ظروف هذه الدراسة أن استخدام منقوع سماد الكتكوت مع الأسمدة الحيوية (خلط مع الدرنات أو أضافة مباشرة

للتربة) والسماد العضوى الصناعى أدى الى خفض نسبة النترات
فى الدرنات . كما أدى استخدام سماد الكتكوت (جاف أو منقوع)
مع الأسمدة الحيوية (خلط مع الدرنات أو أضافة مباشرة للتربة)
بالاضافة الى السماد العضوى الصناعى الى زيادة المحصول الكلى
للنبات وكذلك المحصول الكلى للفدان .