

## **Effect of Cattle Manure, Bio Fertilizers and Reducing Mineral Fertilizer on Nutrient Content and Yield of Potato Plant**

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**T**HE PRESENT WORK was carried out in newly reclaimed land at Sadat city, Tabá farm, El-Menoufia governorate during 1998/1999 and 1999/2000 Potatoes var. Nicola was cultivated to study Effect of cattle manure, bio fertilizers and reducing mineral fertilizer on nutrient content and yield of potato plant. The results from this study indicated that percentages of N, P, K, Mg and Calcium were increased in potato leaves by reducing the mineral fertilizer of the recommended dose (300 kg rock phosphate and 150 kg N and 175 kg K<sub>2</sub>O) to half or quarter with bio fertilizer. Using biofertilizer with half or quarter of recommended dose of mineral fertilizer caused increasing in specific gravity of potato tuber. Adding biofertilizer alone increased dry matter content in potato tuber. Whereas, this increment was not significant with application of the half or quarter of recommended mineral fertilizer dose and biofertilizer. Increasing in total carbohydrates was found by applying biofertilizer alone in potato tuber. Whereas, this increase was not significant with reducing the mineral fertilizer to half or quarter of recommended dose and biofertilizer. Applying the recommended dose of mineral fertilizer (check) compared with other treatments increased the nitrate content in potato tuber.

Reducing mineral fertilizer to half or quarter of recommended dose with biofertilizer increased total yield per plant and per feddan.

Potato (*Solanum tuberosum* L) is one of the most important vegetable crops grown in Egypt. Bio-fertilization is generally based on altering the rizosphere flora, by seed or soil inoculation with certain organisms, capable of inducing beneficial effects on a compatible host. Bio fertilizers mainly comprise nitrogen fixers, phosphate dissolvers or silicate bacteria, (El-Hadad, 1993). The availability of nutrients to potato plant is determined as much by the rate at which nutrients are cycled within the system as it is by the level of inputs to the system. The organic residues from plants which are broken down by soil microorganisms can be taken up by plants. Kuzmich & Pfrfravo (1985) found that starch content decreased in potato tubers by adding NPK, although, the starch yield increased in the control (unfertilized). Singh and Brar (1985) concluded that applying K and FYM to the soil increased potassium concentration in the leaves at 30, 45 and 60 days after planting. While Mg contents in the leaves were reduced by K application but this effect decreased when FYM was applied. Dry matter of leaves, stems and tubers of potato plant was very high during the early growth stages in the treatments given NPK fertilizer. While these values in the organic treatments became higher in the later stage of the growth (Banerje & Singhamahapatra, 1986). Mica *et al.* (1986) showed that when potatoes were given 35 FYM t/ha and 20 or 160 N/ha the tuber fresh weight and dry matter contents were the greatest at the highest N rate. Also the best dry matter was obtained with 120 kg/ha. Singe (1986) reported that increasing N rates adding to the soil caused linear increasing in nitrate N in the tuber. On the other hand, decreased the dry matter and K contents. Vokal *et al.* (1986) suggested that applying the organic fertilizers including FYM and cattle slurry increased NPK and Mg content in the haulm, particularly in the later half of the growing season. Also, cattle slurry increased K concentration in the haulm. Sharma & Arora (1987) found that increasing N rates significantly caused a decrease in P and K concentrations in the haulm and tubers. Grzeskiewick & Socko (1989) stated that applying cattle slurries had more favorable effects on starch and DM content than mineral fertilizers. 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 300mg nitrate-N/Kg was acceptable limit for nitrate in potato tuber.

Trehan *et al.* (1991) found that applying potash and FYM to the soil increased available soil K, while, applying P, P + K increased available soil K

that increased K uptake. Specific gravity increased with low rate of K fertilizer, but general trend for K application was reducing specific of gravity (Champman *et al.*, 1992). Nazarov (1992) suggested that using compost and NPK fertilizers were correlated to the nitrite content in the soil and potatoes tuber. Shatilov and Sharov (1992) found that starch of potato tuber content decreased with increasing FYM rate to 200 ton/ha. Moreover, nitrate content increased from 64 to 190mg/kg with high FYM rate. Saleh & Abd El Fettah (1997) observed that application of organic manures alone increased dry weight over the control treatment (100% chemical fertilizer). Also, the uptake of N, P and K significantly increased with adding organic manure.

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 increase CO<sub>2</sub> 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 of 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 significantly increased when organic was applied alone or in combination with either biofertilizer or chemical fertilizers. Mahendran & Chandramani (1998) found that starch content of tubers and N, P and K available were the highest by applying 100% NPK basically together with Azospirillum and phosphobactriem, while N, P and K uptake were the greatest with 100% NPK applied in 2 equal split doses+bio-fertilizers (Azospirillum and phosphobactriem).

Zayed (1998) proved that the phosphorus dissolving bacteria is known by its ability to dissolve the precipitated form phosphors: Ca<sub>3</sub> (PO<sub>4</sub>)<sub>2</sub> depending on its ability to produce inorganic, organic acids and /or CO<sub>2</sub>. Rabinovich *et al.* (1999) mentioned that increased doses of bio-fertilizers for potato raised high concentration of denitrificating microorganisms.

### 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 tubers of Nicola cultivar (locally produced and cold stored), obtained from the General Authority for Producers and Exporters of Horticulture Crops, Cairo, Egypt, were used in the experiments. Nicola cultivar is medium early to medium late .The whole seed tubers were planted, on 15th 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 cattle manures used in this experiments are shown in Table 2.

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

Mechanical Analysis				pH	Ec	CaCO <sub>3</sub>	Cations					Anions			
Sand %	Silt %	Clay	Texture		DS/m	%	N %	P %	K %	Ca meq/L	Mg meq/L	Co <sub>3</sub>	Hco <sub>3</sub>	cl	So <sub>4</sub>
meq/L															
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 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
Cattle manure	18.71	37.41	11.62	1.61	0.7325	1.2706	0.1607	0.6965	0.6499	190.217

#### Treatments

This experiment included five treatments which were as follows :

- 1- Cattel manure only at a rate of 40 m<sup>3</sup> .
- 2-Suspensions of bio fertilizers only, *i.e.*, soil yeast (*Candida tropicalis*) ,

*Pseudomonas aeruginosa* and phosphate solubilizing bacteria (*Bacillus megatherium* var. *phosphaticum*).

- 3- The recommended dose of fertilizer as a check, i.e., 40 m<sup>3</sup> cattle manure, 300 kg rock phosphate before planting, and 150 kg N and 175 kg K<sub>2</sub>O/fed. after planting at three times (35, 55 and 80 days from planting).
- 4-Half of recommended dose of mineral fertilizer and bio fertilizer suspensions, i.e., soil yeast (*Candida tropicalis*), *Pseudomonas aeruginosa* and phosphate solubilizing bacteria (*Bacillus megatherium* var. *phosphaticum*).
- 5-Quarter of recommended dose of mineral fertilizer plus bio fertilizer suspensions of, i.e., soil yeast (*Candida tropicalis*), *Pseudomonas aeruginosa* and phosphate solubilizing bacteria (*Bacillus megatherium* var. *phosphaticum*).

Boifertilizers used in these experiment were used as suspension added to the soil directly before planting. It is consisted of yeast, *Pseudomonas* and bio fertilizer phosphate dissolving bacteria. Experiment contained five rows each experimental plot was 6 m length and 6 m width, making an area of 36 m<sup>2</sup>. Each plot received equivalent amount of 200 Kg sulfur added to soil before planting. The potassium phosphate contained (52% K<sub>2</sub>O) Hortozol imported from Russia. The rock phosphate, Sulfur and cattle manure were applied 20 days before planting. Cattle manure was added in the middle of the row at 40 cm depth then the soil was irrigated. All the 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 were arranged in a randomized complete block design with three replicates.

#### *Data recorded*

##### *Yield*

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

- 1-Average tuber weight
- 2-Average tuber number per plant
- 3-Specific gravity
- 4-Total yield per (plant and feddan.).

*Determination of specific gravity*

Tuber specific gravity was calculated from samples weights measured in air and water .

*Determination of dry matter content*

Dry matter content was determined at 65°C for 72 hr using the standard methods as illustrated by AOAC (1990) .

*Chemical measurements*

A random sample of fifteen tubers was selected from every treatment after harvesting for determination of total carbohydrates, dry matter, 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 were determined according to the method described by Shaffer & Hartman (1921).

*Determination of nitrate*

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

*Determination of N, P, K, Ca and Mg*

For mineral analysis, dried leaves were digested in H<sub>2</sub>SO<sub>4</sub> and the minerals content 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*

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

*Statistical analysis*

The statistical analysis was done according to Steel & Torrie (1960) .

**Results***Nutrient content of potato leaf**Nitrogen*

The percentages of nitrogen, phosphorus, potassium, calcium and magnesium

were affected with the applied fertilizer (Table 3) . The obtained results indicated that applying half recommended dose of mineral fertilizers with biofertilizer or using check (recommended dose) increased N % in potato leaves at both samples, in the first season. In the second season,applying check (recommended dose) gave the highest value at first sample.Whereas, using bio fertilizer alone increased N percentage in potato leaves at the second sampling date.

#### *Phosphorus*

Data presented in Table 3 showed the effect of cattle manure, biofertilizer or biofertilizer with reducing mineral fertilizer on phosphorus content in potato leaves. The reduced mineral fertilizer and added biofertilizer increased uptake of phosphorus in potato leaves at the first sample and quarter recommended mineral fertilizer at the second sample,in first season. In the second season, the highest value was found with applying cattle manure at first sample,and biofertilizer and to rate quarter of recommended mineral fertilizer dose at the second sample.

#### *Potassium*

Response of the potassium content in potato leaves to cattle manure, biofertilizer and reducing mineral fertilizer with biofertilizer is illustrated in Table 3 . Applying check treatment recorded the highest potassium content in potato leaves at first sample . Whereas, Applying half recommended dose with biofertilizer increased the percentage of potassium in potato leaves at the second sample, in the first season.While, in the second season using cattle manure alone recorded the highest potassium content in potato leaves at first sampling date and check (recommended dose) at the second sample.

#### *Calcium*

Data presented in Table 3 showed the effect of cattle manure, biofertilizer and reducing mineral fertilizer with biofertilizer on the percentage of calcium content in potato leaves. In first season, the half of recommended dose of mineral fertilizer with biofertilizer increased calcium content in potato leaves at the first sample .On the other hand, using cattle manure alone gave the highest value at the second sampling date.Whereas,using mineral fertilizer with biofertilizer at the first sample and biofertilizers alone at the second sample were the most favourable treatments in second season.

**TABLE 3. Effect of cattle manure, bio fertilizers and reducing mineral fertilizer with bio fertilizer on nutrient content of potato leaves in 1998/1999 and 1999/2000 seasons.**

Treatments	N %	P %	K %	Ca %	Mg %	N %	P %	K %	Ca %	Mg %
<b>1998/1999</b>										
	<b>50 days from planting</b>					<b>80 days from planting</b>				
Cattle manure	3.68	0.84	7.71	1.17	0.64	3.51	0.85	5.52	2.85	0.54
Bio fertilizer	4.40	0.94	6.51	0.95	0.52	3.50	0.64	7.53	1.33	0.54
Check	3.46	0.86	8.60	1.39	0.62	4.42	0.86	6.55	1.56	0.53
Half recommended dose+Bio fertilizers.	4.44	1.32	7.52	1.41	0.70	4.30	0.76	8.51	2.40	0.55
Quarter recommended dose +Bio fertilizers.	4.28	0.93	7.70	1.34	0.57	3.86	1.01	7.50	2.14	0.55
<b>1999/2000</b>										
Cattle manure	4.28	0.92	8.48	0.70	0.65	3.48	0.60	6.46	1.75	0.79
Bio fertilizer	4.62	0.71	8.45	1.12	0.63	4.74	0.65	7.91	1.96	0.73
Check	4.79	0.86	7.31	1.12	0.65	3.33	0.51	8.45	1.86	0.64
Half recommended dose+Bio fertilizers.	4.51	0.69	7.74	1.27	0.63	3.35	0.54	7.06	1.84	0.80
Quarter recommended dose +Bio fertilizers.	4.22	0.74	7.26	1.29	0.68	3.37	0.63	7.70	1.74	0.75

Recommended dose: (300 kg rock phosphate and 150 kg N and 175 kg K<sub>2</sub>O).

### *Magnesium*

As shown in Table 3, the effect of cattle manure, biofertilizer and reducing mineral fertilizer with biofertilizer on the percentage of magnesium in potato leaves. The half of recommended dose of mineral fertilizer increased magnesium content in potato leaves at both samples in the first season. In the second season, reducing mineral fertilizer to rate of quarter recommended dose with biofertilizer recorded the highest value at first sample. Whereas, the half recommended dose with biofertilizer was the most effective treatment at the second sample.

### *Yield characters*

#### *Average tuber weight*

Data illustrated in Table 4 represent the effect of cattle manure, biofertilizer and reducing mineral fertilizer on average tuber weight of potato plant. Check treatment produced at the highest average tuber weight compared with other treatments both samples in both seasons, with the exception of, the biofertilizer which was the best in the first season only.

**TABLE 4.** Effect of cattle manure, biofertilizers and reducing mineral fertilizer with bio fertilizer on yield characters of potato plant in 1998/1999 and 1999/2000 seasons.

Treatments	Average Tuber Weight (g)	Specific Gravity (g/cm <sup>3</sup> )	Dry Matter (%)	Total Carbohydrates (%)	Nitrate ppm	Total Yield Per plant (g)
<b>1998/1999</b>						
Cattle manure	72.43	1.02	21.61	42.74	400.92	720.00
Bio fertilizer	130.52	1.01	27.66	47.37	429.37	1227.66
Check	111.91	1.01	23.73	47.86	510.94	1259.66
Half recommended dose+ Bio fertilizer.	93.74	1.06	24.40	45.17	419.97	1816.66
Quarter recommended dose + Bio fertilizer.	106.35	1.05	25.53	41.56	334.22	1314.00
L.S.D at 5%	23.51	0.04	4.15	3.98	109.67	893.65
<b>1999/2000</b>						
Cattle manure	100.83	1.01	23.58	42.07	350.50	606.33
Bio fertilizer	93.84	1.01	23.95	47.33	400.37	706.66
Check	111.75	1.01	22.48	47.83	510.65	920.66
Half recommended dose+ Bio fertilizer.	104.64	1.05	18.26	45.53	419.26	1297.66
Quarter recommended dose + Bio fertilizer.	109.37	1.04	22.12	41.24	333.86	1128.66
L.S.D at 5%	12.93	0.03	2.86	4.00	107.06	143.14

Recommended dose: (300 kg rock phosphate and 150 kg N and 175 kg K<sub>2</sub>O).

#### *Specific gravity*

Data in Table 4 represent the effect of cattle manure, biofertilizer and reducing mineral fertilizer with biofertilizer on specific gravity of potato tuber. Reducing mineral fertilizers to half or quarter of the recommended dose plus biofertilizer increased specific gravity compared with other treatments in both seasons.

#### *Dry matter*

Data presented in Table 4 show the effect of cattle manure, biofertilizer and reducing mineral fertilizer on the percentage of dry matter content of potato tuber. Applying biofertilizer alone increased dry matter content compared with other treatments in both seasons.

#### *Total carbohydrates*

Results in Tables 4 indicated that application of biofertilizer alone or check treatment increased total carbohydrates of potato tuber compared with other treatments in both seasons.

#### *Nitrates content*

Effect of cattle manure, biofertilizer and reducing mineral fertilizer with biofertilizer on nitrate content of potato tuber is shown in Table 4. Applying check treatment gave the highest value of nitrate content of potato tuber compared with other treatments in both seasons. While, the lowest values of nitrate content were detected in tubers produced from plants received the quarter recommended mineral fertilizer.

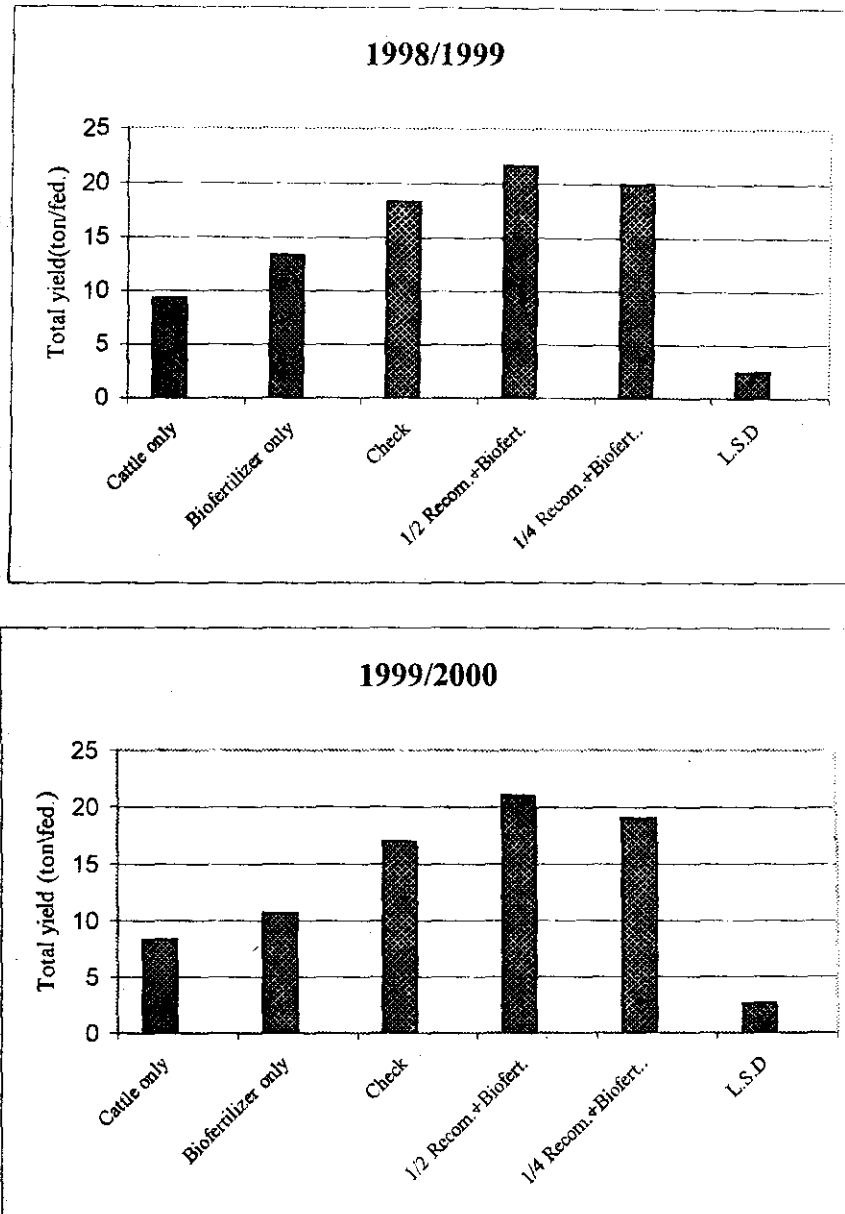
#### *Total yield*

Data illustrated in Table 4 and Fig.1 show the effect of cattle manure, biofertilizer and reducing mineral fertilizer with biofertilizer on total yield per plant and per feddan. Reducing mineral fertilizer to half recommended dose with biofertilizer added to the soil produced the highest total yield per plant and per feddan followed, in descending order, by quarter recommended dose with biofertilizer. This was true in both seasons.

### **Discussion**

Applying biofertilizer to potato crop with reducing mineral fertilizers increased the percentage of N, P, K, Mg and Ca in potato leaves. On the other hand, adding biofertilizer increased dry matter, specific gravity and total carbohydrates. This effect could be due to that biofertilizers play a fundamental role in converting P or K fixed form to be soluble ready for plant nutrition making the uptake of nutrients by plants more easy. Similar results were found by Quastel (1965) and Zayed (1998) who found that soil microorganisms known as phosphate solubilizing bacteria (PSB) play a fundamental role in converting P fixed form to be available. Increasing N fertilizer level or inoculation with HALEX2 increased leaf N content and dry matter content of potato tuber (El Gamal, 1996).

Average tuber weight was increased by applying biofertilizers with reducing mineral fertilizers which lead to increase total yield. This effect might be due to



**Fig.1. Effect of organic manure, bio-fertilizers and reducing mineral fertilizer with bio fertilizer on total yield/plant of potato plant in 1998/1999 and 1999/2000 seasons.**

that applying biofertilizer increased microorganisms in the soil, which convert 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 and tuber size increased, which consequently increased the total yield. Similar results were found by Kundu & Gaur (1980), who reported that potato inoculated with culture suspension of *Bacillus polymyxa* and *Pseudomonas straita* gave the higher yield. Hauka *et al.* (1990) reported that inoculation of PSB increased yield of tomato. Large and medium sized tubers and total potato tuber yield were the greatest from combination of both biofertilizer and growth regulator (Ghosh & Das , 1998).

The obtained results showed also that applying the half recommended dose of mineral fertilizers along with biofertilizers resulted in higher potato yield than check treatment. This may be attributed to enhancing plant growth parameters, *i.e.* plant height, leaf number, fresh and dry weight, N, P and K content in potato leaves compared to check treatment. In other words, using biofertilizers had beneficial influence in reducing the amount of mineral fertilizers added for potato production

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## تأثير السماد العضوى وخفض الأسمدة المعدنية مع السماد الحيوى على محتوى العناصر والمحصول لنباتات البطاطس

شعبان نسوتى أبو حسين ، ابراهيم العكش \* طه الشوربجى و  
أبو بكر محمود جمعه\*\*

قسم بحوث الخضرا - المركز القومى للبحوث ، \* قسم البساتين -  
كلية الزراعة - جامعة مين شمس و \*\* قسم الميكروبيولوجيا  
الزراعية - المركز القومى للبحوث - القاهرة - مصر .

أجريت هذه الدراسة فى عامى ١٩٩٨/١٩٩٩ و ١٩٩٩ / ٢٠٠٠ فى  
مزرعة طابا - بمدينة السادات - محافظة المنوفية لدراسة تأثير  
خفض الأسمدة المعدنية واطافة الأسمدة الحيوية ( اضافة مباشرة  
للتربة) ومقارنتها باستخدام الأسمدة العضوية فقط أو الجرعة  
الموصى بها وكان الصنف المستخدم فى هذه الدراسة هو نيكولا .  
تقليل كمية السماد المعدنى ( الجرعة الموصى بها ) الى النصف مع  
اطافة الأسمدة الحيوية ( اضافة مباشرة للتربة ) أدى الى زيادة  
النسبة المثوية لسكل من النتروجين والفوسفور والبيوتاسيوم  
فى أوراق نباتات البطاطس . كما أدى استخدام السماد الحيوى  
( اضافة مباشرة للتربة ) مع خفض كمية السماد المعدنى ( الجرعة  
الموصى بها ) الى النصف أدى الى زيادة الكثافة النوعية للدرنات .

أدى استخدام السماد الحيوى ( اضافة مباشرة للتربة ) فقط الى  
زيادة المادة الجافة فى الدرناات كما أدى استخدام السماد الحيوى  
( اضافة مباشرة للتربة ) فقط الى زيادة الكربوهيدرات الكلية فى  
الدرنات ولكن هذه الزيادة لم تكن معنوية مع معاملة المقارنة  
والتي استخدم فيها الجرعة الموصى بها من السماد المعدنى أو مع  
خفض السماد المعدنى ( الجرعة الموصى بها ) الى الربع أو الى  
النصف مع السماد الحيوى . أظهرت النتائج فى هذه التجربة أن  
أعلى معدل للدرنات فى الدرناات كان عند اضافة الجرعة الموصى  
بها من السماد بالمقارنة باستخدام السماد العضوى أو الحيوى

(اضافة مباشرة للتربة ) فقط وكذلك مع خفض السماد المعدنى الى الربع أو الى النصف مع اضافة السماد الحيوى (اضافة مباشرة للتربة ).

أدى استخدام السماد الحيوى ( اضافة مباشرة للتربة ) مع نصف المعدل من السماد المعدنى الى زيادة متوسط وزن الدرنة عن اضافة ربع السماد . كما أوضحت النتائج أن خفض معدل السماد المعدنى الى النصف مع اضافة السماد الحيوى ( اضافة مباشرة للتربة ) أدى الى زيادة فى محصول الدرناات للنبات والمحصول الكلى للفدان .