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EFFECT OF BALANCED FERTILIZATION ON POTATO GROWTH, YIELD AND QUALITY IN SANDY CALCAREOUS SOIL

A. S. Badawy and M.M.M.Ahmed**

*Hort. Res. Institute. A.R.C. Giza. Egypt.

**Soil, water and Environ. Res. Institute. A.R.C Giza. Egypt.

Abstract: This work was carried out during two successive winter seasons of 2003 and 2004 at Arab El-Awammer Research Station., Agric Res. Center (A.R.C)., Assiut Governorate to study the effect of different rates of Nitrogen, Phosphorus and Potassium fertilizer on growth, yield, quality and chemical composition of potato leaves in sandy calcareous soils under drip irrigation systems.

Applying N at a rate of 120 kg/fed, P at a rate of 60 kg P_2O_5/fed and K at a rate of 60 kg K_2O/fed. significantly affected growth parameters of potato plants including plant height, weight of vines/plant and number of sponts/plant, Applying N at a rate of 120 kg/fed, P at a rate of 30 kg P_2O_5/fed and K at a rate of 60 kg K_2O/fed. gave the highest weight of marketable tubers/fed and gave the highest percentages of tuber dry matter in both seasons.

Nitrogen, P and K concentration in potato plant leaves was significantly affected with increasing N, P and K rates. Maximum values of N, P and K contents in potato plant leaves was obtained from 180 N/fed., 90 kg P_2O_5/fed and 60 kg K_2O/fed

Key words: fertilization, potato, sandy calcareous.

Introduction

There is growing need for site specific fertilizer recommendations according to the crop type, yield level and soil conditions. Balanced fertilization provides the basis for sustainable crop production and soil fertility. Apart from lower yield; unbalanced fertilization impairs the quality of the crop. This refers in the same way to nutritional, hygienic, and functional properties as well as to the environmental compatibility in production. Krauss and Jiyun (2000) reported that numerous field trials conducted by International Potash Institute (IPI) in India, Egypt, Hungary or China showed that balanced fertilization reaps higher yields of better quality resulting in lower production costs and higher profits, lowers import requirement and increases export opportunities. increase purchasing power in the rural area, attracting other business. In this way, balanced fertilization contributes to social security in the rural area. improves the efficiency of land, water and energy, improved fertilizer use efficiency and protects the groundwater and reduces losses of N by volatilization. It is important that we evolve an efficient, economic and integrated nutrient management system to sustain the productivity of different crops and cropping systems.

Extension of potatoes production are sometimes done on sandy coarse-textured soils low in organic matter, low in native fertility, and might be alkaline. Because potatoes has a relatively high requirement for nutrients especially in these soils where're lake to supply nutrients for crop growth; fertilizer use for potato production is usually high. Fattahalla (1998) revealed that application of N at a rate of 80 kg/fed. had the favorable effect in Nicola Potatoes grown in sandy loam soil. Baradisi (2000) evaluate the effect of seven rates of phosphorous application under sandy soil. He found that p application at a rate of 70 kg P_2O_5/fed. was the best in increasing growth and yield of potato. El-Shobaky et al. (2002) indicate that soil application of 120 kg K_2O/fed. and two or three time foliar spray of liquid K (38%) was the most significant treatment on growth and yield of potato under the conditions of sandy soils. continuous fertilizer use has built up the soil levels of certain nutrients. This is why a sensible fertilizer program for potatoes should be based on soil test recommendations, tissue tests, yield goal projections, and yield of the previous crop.

Native fertility of soil cannot support the necessary yield increase. Nutrient inputs through depositions, sedimentation and biological nitrogen fixation are far from sufficient to satisfy the nutrient demand of high yielding varieties. Mineral fertilizer is the primary source of nutrients and usually contributes 35 to 50% to yield increases. Numerous field trials conducted by Krauss (2000) and the private sector have shown that one kg of mineral fertilizer can achieve under farmer's conditions about 10 kg additional yield.

Numerous long-term field trials proved that the initial level of soil fertility and thus crop yield can be maintained provided the nutrient balance is in equilibrium. As indicated earlier, the introduction of high yielding varieties affects the nutrient balance by removing more nutrients with higher biomass. Of course, there are genotypic differences in nutrient use efficiency. At the same level of soil fertility, yield of modern wheat varieties is 50% higher than the old varieties (Karpenstein *et al.*, 1986). Better spatial exploitation of the root system, release of acidifying and/or chelating substances can explain genotypic differences in uptake efficiency.

Imbalance in crop nutrition leads to soil nutrient mining and consequently to soil nutrient depletion The value of lost yield opportunity due to unbalanced fertilization can be considerable. For instance, Bulgaria lost around 135'000 t wheat, 28'000 t maize and 53'000 t sunflower or the equivalent of almost $30 million due to unbalanced fertilization (Nikolova & Samalieva, 1998).

Detailed information is available on the impact of soil K mining on soil fertility. As readily available K is depleted, K supply to the soil solution depends more on K release from the non-exchangeable or slowly available fraction, the K reserve. As shown by Cheng *et al*. (1999) on soils in North China, the rate of release of K from the exchangeable fraction is much higher (5-9 mg K/kg/min) than that from the non-exchangeable fraction (0.1-0.5 mg K/kg/min). Consequently, with depletion of soil K and thus with increase of the contribution from non-exchangeable K, the yield declines because the release intensity cannot cope with the demand of high yielding crops. Therefore, This research work was carried out to study the effect of different rates of Nitrogen, Phosphorus and Potassium fertilizer on growth, yield, quality and chemical composition of potato leaves in sandy calcareous soils under drip irrigation systems.

Materials and Methods

This work was carried out during two successive winter seasons of 2003 and 2004 at Arab El-Awammer Research Station; Agric Res. Center (A.R.C); Assiut Governorate. to study the effect of different levels of Nitrogen, Phosphorus and Potassium fertilizer on growth, yield, quality and chemical composition of potato leaves in sandy calcareous soil under drip irrigation systems. The main soil characteristics are shown in Table 1.

The experiment included 18 treatments which were the combina-ion between 3 levels of nitrogen, 3 levels of phosphorus and 2 levels of potassium fertilizers. A split spilt plot design with 4 replications was used to test the effect of treatments, in which nitrogen application was conducted on the main plots, phosphorus on sub plots whereas potassium was in the sub sub plots.

Table(1): Some physical and chemical properties of a representative soil sample used in the experimental site

Season	PH 1:1 suspenti on	EC (1:1 extract) dsm $^{-1}$	$CaCO_3$%	Soluble cations meq/100 g soil				Soluble anions meq/100g soil	
				Ca^{+2}	Mg^{+2}	Na^{+1}	K^{+1}	CO_3+ HCO_3	Cl
2003	8.21	0.59	27.33	0.30	0.24	0.11	0.01	0.32	0.28
2004	8.43	0.77	32.15	0.33	0.28	0.15	0.03	0.38	0.22

Season	available nutrients			Mechanical analysis %			Soil texture
	N %	P ppm	K meq /100g soil	Sand	Silt	Clay	
2003	0.06	5.14	0.14	85.4	8.7	5.9	Sandy
2004	0.04	4.88	0.12	87.2	7.2	5.6	

All plots received equal amounts of compost at a rate of 2 ton/fed. at soil preparation. All other cultural practices for potato production were followed in this work.

Nitrogen, phosphorus and potassium fertilizers were added in the form of ammonium nitrate (33.5%N) at the rates of 60, 120 and 180 Kg N/fed., phosphoric acid (H_3PO_4) at the rates of 30, 60 and 90 Kg P_2O_5/fed. and potassium sulphate (48% K_2O) at the rates of 30 and 60 Kg K_2O /fed., respectively. The three mineral fertilizers were splitted into 30 equal doses and scheduled to be added at 2-days intervals, started 3 weeks after planting and continued up to one week before harvesting. Fertilizers were dissolved in water and injected directly into the irrigation water through fertigation under drip irrigation system in both growing seasons.

Certified potato seed tubers cv. diamont (Locally produced and cold stored) were sown on September, 18 in both seasons at 30 cm apart. A random sample of five plants from each plot (1/400 fed.) was taken before harvesting for measuring the vegetative growth parameters; i.e., plant height (cm), weight of vines/plant (g) and number of sprouts/plant. To measure yield and its components; i.e., tubers from each plot, number of tubers/plant, weight of tubers/plant, as well as weight of tubers/fed were calculated. Random tuber sample from each plot were taken which 100 grams of fresh tubers were dried at 65 C for 72 hr using standard methods as illustrated by AOAC (1990) and dry matter % (DM %) was calculated as a parameter of tuber quality.

Recently mature leaf samples were taken after 80 days from planting. Dried leaves were digested in H_2SO_4. Total nitrogen was determined using the micro-Kjeldahl method due to Bremner and Mulvaney (1982). Phosphorus was estimated according to Olsen and Sommers (1982) and potassium was determined according to the method described by Jackson (1970).

The collected data were statistically analyzed using MSTAT computer program as described by Freed et al. (1987).

Results and Discusion

Growth attributes:

Data presented in Table 2 clearly showed significant effect on growth of potato plants expressed as plant height, weight of sprouts/plant and number of sprouts/plant in both seasons.

Plant height was significantly increased with increasing the rate of both nitrogen and phosphorous. Increasing the rate of applied N from 60 to 120 kg/fed. gave highly significant effect on plant height and number of sprouts/plant. The highest values for weight of vines/plant were obtained from applying 180 kg

N/fed. Increasing the rate of P application from 30 to 60 kg P_2O_5/fed., significantly increased plant height in the 2 nd seasons and weight of vines/plant in both growing seasons. Increasing the rate to 90 kg P_2O_5/fed., did not exert any significant effect on both growth parameters. The increase in growth of potato plants may be due to the simulative effect of P on plant growth through its content in nucleic acids DNA and RNA (Mengel and Kirkby, 1987) and through its role in photosynthesis and respiration (Ashour, 1998). Also, data in this table show that K rates had no effect on plant height and number of sprouts /plant as reported by El-Shobaky et al. (2002). Weight of vines/plant was significantly increased with increasing potassium rate to 60 kg K_2O /fed.

Table(2): Effect of fertilization levels of N, P and K fertilization on vegetative growth of potato plants grown on sandy calcareous soil during 2003 and 2004 seasons.

Nutrient levels	Plant height (cm)		Weight of Vines/plant (gm)		No. of sprouts /plant	
	2003	2004	2003	2004	2003	2004
Nitrogen levels.						
60 kg N/fed	35.9	36.3	1005.4	1004.3	3.4	3.2
120 kg N/fed	52.8	55.1	1349.5	1351.4	5.4	6.0
180 kg N/fed	55.0	55.0	1362.9	1365.7	5.9	5.9
F. Value.	**	**	**	**	**	**
L.S.D 0.05	3.4	3.9	5.5	4.9	0.6	0.5
Phosphorus levels.						
30 kg P/fed	45.6	47.3	1229..8	1231.5	4.8	4.6
60 kg P/fed	48.6	49.5	1243.9	1244.8	4.8	5.2
90 kg P/fed.	49.6	49.6	1244.1	1245.0	5.1	5.2
F. Value.	*	*	**	**	NS	NS
L.S.D 0.05	3.1	1.6	4.4	4.1	-	-
Potassium levels.						
30 kg K/fed	46.8	48.6	1236.4	1237.4	4.8	4.9
60 kg K/fed	49.0	49.0	1242.1	1243.4	4.9	5.1
F. Value.	NS	NS	*	*	NS	NS
L.S.D 0.05	-	-	2.5	2.1	-	-

The obtained data in Table 3 revealed that the studied growth parameters of potato plants were significantly affected with the interaction between N and P. Application of 120 kg N combined with 90 kg P_2O_5/fed resulted in the highest values of plant height in the 1 st and 2 nd seasons and No. of sprouts /plant in the 2 nd season with values of 57.1 and 56.9 cm and 6.9, respectively. While, applying 180 kg N with 30 kg P_2O_5/fed raised insignificantly the weight of vines/plant from 1360.6 to 1367.0 gm in the 2 nd season. Values of weight of vines/plant resulted insignificant differences either with 180 or 120 kg N/fed. So, application of 120 kg N combined with 60 kg P_2O_5/fed could be consider the best rates in the economic point of view. Moreover, the interaction between N and K (Table, 4) showed clearly that application of 120 kg N and 60 kg K_2O significant affected the studied growth parameters of potato plants. The highest values of plant height were obtained due to the application of 120 kg N and 60 kg K_2O, While, weight of vines/plant and No. of sprouts /plant were obtained due to the application of 180 kg N and 60 kg K_2O. The increase in both parameters due to the high rate of N and K fertilizers compared to application of 120 kg N and 60 kg K_2O are not significant as mentioned before. Weight of vines/plant (Table, 5) was significantly affected with the interaction between P and K at a rate of 60 kg P and 30 kg K_2O /fed. Plant height and No. of sprouts/plant were not significantly affected with this interaction.

Table(3): Effect of the N X P interaction on vegetative growth of potato plants grown on sandy calcareous soil during 2003 and 2004 seasons.

Nutrient levels	Plant height (cm)		Weight of Vines/plant (gm)		No. of sprouts /plant	
	2003	2004	2003	2003	2004	2003
60 kg N X 30 kg P_2O_5	36.6	35.8	1001.2	998.3	3.5	2.8
X 60 kg P_2O_5	35.6	36.6	1005.1	1003.8	3.3	3.8
X 90 kg P_2O_5	35.6	36.0	1010.0	1010.9	3.5	3.0
120 kg NX 30 kg P_2O_5	45.1	51.8	1326.9	1329.4	5.0	5.1
X 60 kg P_2O_5	56.2	56.7	1361.9	1364.3	5.8	6.1
X 90 kg P_2O_5	57.1	56.9	1359.7	1360.6	5.4	6.9
180 kg NX 30 kg P_2O_5	55.0	54.4	1361.4	1367.0	5.8	6.1
X 60 kg P_2O_5	54.1	55.2	1364.9	1366.5	5.4	5.8
X 90 kg P_2O_5	56.0	55.4	1362.5	1363.6	6.4	5.7
F. Value.	*	*	**	**	*	*
L.S.D 0.05	5.3	4.0	7.6	7.1	0.6	1.1

Table(4): Effect of the N X K interaction on vegetative growth of potato plants grown on sandy calcareous soil in 2003 and 2004 seasons.

Nutrient levels	Plant height (cm)		Weight of Vines/plant (gm)		No. of sprouts /plant	
	2003	2004	2003	2003	2004	2003
60 kg N X 30 kg K_2O	35.6	36.4	1006.6	1005.2	3.4	3.1
X 60 kg K_2O	36.2	36.2	1004.3	1003.5	3.4	3.3
120 kg NX 30 kg K_2O	50.1	54.5	1340.3	1342.1	5.7	6.1
X 60 kg K_2O	55.5	55.8	1358.8	1363.7	5.1	5.9
180 kg NX 30 kg K_2O	54.7	54.9	1362.6	1365.2	5.4	5.8
X 60 kg K_2O	55.4	55.1	1363.3	1366.3	6.3	6.0
F. Value.	*	*	**	**	*	*
L.S.D 0.05	1.0	0.8	4.8	3.6	0.7	0.6

Table(5): Effect of P X K interaction on vegetative growth of potato plants grown on sandy calcareous soil in 2003 and 2004 seasons.

Nutrient levels	Plant height (cm)		Weight of Vines/plant (gm)		No. of sprouts /plant	
	2003	2004	2003	2003	2004	2003
30 kg P X 30 kg K_2O	42.5	46.8	1220.5	1220.9	4.8	4.7
X 60 kg K_2O	48.6	47.9	1239.1	1242.2	4.8	4.6
60 kg P X 30 kg K_2O	48.5	49.6	1244.5	1246.7	4.6	5.2
X 60 kg K_2O	48.7	49.4	1243.4	1243.0	5.0	5.2
90 kg P X 30 kg K_2O	49.3	49.5	1244.4	1244.9	5.2	5.8
X 60 kg K_2O	49.8	49.8	1243.8	1245.3	5.0	5.3
F. Value.	NS	NS	**	**	NS	NS
L.S.D 0.05	-	-	4.8	3.6	-	-

In spite of the insignificant effect of the other treatment on growth parameters compared to the treatments (120kg N + 60kg P_2O_5/fed) or (120kg N + 60 kg K_2O /fed) or even compared to (60kg P_2O_5 + 60 kg K_2O /fed) it my be stated that the application of N at a rate of 120 kg/fed, P at a rate of 60 kg P_2O_5/fed and K at a rate of 60 kg

K_2O /fed. was more effective than the other balanced fertilizer.

Moreover, Table 6 demonstrated that the increment of plant height was pronounced with balanced fertilizer treatment (120 kg N + 90 kg P_2O_5 + 60 kg K_2O) in comparison to the other treatments. While, weight of vines/plant was affected with this treatment but slightly insignificantly increased by the balanced fertilizer treatment (180 kg N + 30 kg P_2O_5 +30 kg K_2O) as mentioned before. It is obvious also that, the response of growth characters to balanced fertilizer treatment (120 kg N + 60 kg P_2O_5 + 60 kg K_2O) could be the best rates under this conditions.

Table(6): Effect of the N X P X K on vegetative growth of potato plants grown on sandy calcareous soil during 2003 and 2004 seasons.

Nutrient level combinations	Plant height (cm)		Weight of Vines/plant (gm)		No. of sponts/plant	
	2003	2004	2003	2003	2004	2003
60 kg N X 30 kg P_2O_5 X 30 kg K_2O	36.4	36.1	1000.8	993.7	3.5	2.8
60 kg N X 30 kg P_2O_5 X 60 kg K_2O	36.9	35.5	1001.5	1002.8	3.5	2.8
60 kg N X 60 kg P_2O_5 X 30 kg K_2O	35.4	36.3	1007.8	1006.8	3.0	3.8
60 kg N X 60 kg P_2O_5 X 60 kg K_2O	35.8	37.0	1002.5	1001.0	3.5	3.8
60 kg N X 90 kg P_2O_5 X 30 kg K_2O	35.1	37.0	1011.3	1015.0	3.8	2.8
60 kg N X 90 kg P_2O_5 X 60 kg K_2O	36.0	36.0	1008.8	1006.8	3.3	3.3
120 kg N X 30 kg P_2O_5 X 30 kg K_2O	38.0	50.6	1297.5	1301.5	5.5	5.4
120 kg N X 30 kg P_2O_5 X 60 kg K_2O	52.3	53.0	1356.3	1357.3	4.5	4.8
120 kg N X 60 kg P_2O_5 X 30 kg K_2O	55.4	56.5	1363.8	1367.0	5.8	6.0
120 kg N X 60 kg P_2O_5 X 60 kg K_2O	57.0	56.9	1360.0	1361.3	5.8	6.3
120 kg N X 90 kg P_2O_5 X 30 kg K_2O	57.0	56.3	1359.5	1357.8	5.8	7.0
120 kg N X 90 kg P_2O_5 X 60 kg K_2O	57.3	57.6	1360.0	1363.5	5.0	6.8
180 kg N X 30 kg P_2O_5 X 30 kg K_2O	53.3	53.6	1363.3	1367.5	5.3	6.0
180 kg N X 30 kg P_2O_5 X 60 kg K_2O	56.3	55.1	1359.5	1366.5	6.5	6.3
180 kg N X 60 kg P_2O_5 X 30 kg K_2O	54.9	56.0	1362.0	1366.3	5.0	5.8
180 kg N X 60 kg P_2O_5 X 60 kg K_2O	53.4	54.4	1362.8	1366.8	5.8	5.8
180 kg N X 90 kg P_2O_5 X 30 kg K_2O	55.9	55.1	1362.5	1361.8	6.0	5.5
180 kg N X 90 kg P_2O_5 X 60 kg K_2O	56.1	55.8	1362.5	1365.5	6.8	6.0
F. Value.	*	*	*	*	NS	NS
L.S.D 0.05	1.0	1.4	8.0	6.4	-	-

Yield and its components:

Date illustrated in Table 7 showed the main effect of N, P and K rates on number marketable tubers/plant, weight of marketable tuber/plant, as well as weight of marketable tuber/fed.

Table(7): Effect of fertilization levels of N, P and K on yield components of potato plants grown on sandy calcareous soil during 2003 and 2004 seasons.

Nutrient levels	No. of marketable tubers/plant		Weight of marketable tubers/plant (gm)		Weight of marketable tubers/fed. (ton)		Dry matter percentage of tubers%	
	2003	2004	2003	2004	2003	2004	2003	2004
Nitrogen levels.								
60 kg N/fed	3.0	3.1	285.4	267.9	2.771	2.570	27.9	28.1
120 kg N/fed	6.7	6.8	686.9	680.0	6.600	6.528	30.1	30.4
180 kg N/fed	6.4	6.6	672.1	673.8	6.469	6.444	28.4	28.6
F. Value.	**	**	**	**	**	**	**	**
L.S.D 0.05	0.5	0.6	11.6	9.6	0.1	0.1	0.3	0.3
Phosphorus levels.								
30 kg P/fed	5.2	5.3	542.5	539.2	5.235	5.176	29.4	29.9
60 kg P/fed	5.7	5.8	548.3	540.8	5.277	5.170	28.7	28.8
90 kg P/fed.	5.2	5.4	553.5	541.7	5.328	5.196	28.2	28.3
F. Value.	*	*	*	*	*	NS	*	*
L.S.D 0.05	0.5	0.4	6.2	5.3	0.06	-	0.4	0.6
Potassium levels.								
30 kg K/fed	5.4	5.6	548.1	538.8	5.270	5.156	28.8	29.1
60 kg K/fed	5.3	5.3	548.2	542.4	5.290	5.205	28.7	28.9
F. Value.	NS	NS	NS	NS	NS	NS	NS	NS
L.S.D 0.05	-	-	-	-	-	-	-	-

Application of 120 kg N/fed showed highly significant effect of N rates on yield and its components compared to the application of 60 kg N/fed. Increasing N rates to 180 kg/fed did not exert any significant effect on all yield and its components as compared with the 120 kg N rate. Increasing the rate of P to 90 kg P_2O_5/fed increased the weight of marketable tubers/plant and weight of marketable tubers/fed.

but this increase was not significant as compared to the 60 kg P_2O_5/fed rate. It is worthy to mention that application of 60 kg P_2O_5/fed was the most favorable P rate for increasing weight of marketable tuber/fed. Also, Bardisi (2000) reported that application of 70 kg P_2O_5 increased tuber yield of potato in sandy soil.

The obtained data in Table 7 showed that increasing potassium levels did not affect the yield and its components. This may be due to the completion with Ca for uptake by plant as reported by Locascio et al (1992) for potato grown in fine sandy soil. Moreover, Rhue et al (1986) reported that with a soil K concentration of 38 to 44 mg/kg^{-1}, a response to the higher K rate was not expected, and an increase in the K rate from 225 to 450 kg. ha^{-1} had no effect on tuber yield.

Table 8 show that the interaction between N and P rates on yield and its components was significant compared to the application of 60 kg N/fed + all rates of P_2O_5 . Application of either 120 kg N or 180 kg N/fed + 60 kg P_2O_5/fed gave the significant values of the studied parameters of yield and its components. The highest values of these parameters were obtained under the application of 120 kg N + all P_2O_5/fed. The differences between these values were insignificantly.

The interaction N x K on yield and its components are shown in Table 9. Weight of marketable tubers/plant and weight of marketable tubers/fed. were significantly affected with the application rates of 120 kg N and 60 kg P_2O_5/fed.

The interaction P x K on yield and its components are shown in Table 10. The highest values of weight of tubers /plant and consequently tubers/fed. were obtained under the application of 90 P_2O_5 + 30 K_2O and 30 P_2O_5 + 60 K_2O respectively.

Interactions effects of N X P X K on yield and its components are shown in Table 11. Appling N at a rate of 120 kg/fed, P at a rate of 90 kg P_2O_5/fed and K at a rate of 30 kg K_2O /fed. gave the highest values of weight of marketable tuber/plant in the 1 st season. While, the highest values of weight of marketable tuber/plant in the 2 nd was obtained due to the treatment (120 N +60 P_2O_5+60 K_2O). However, the highest values of weight of marketable tuber/fed were obtained due to the treatment (120 N +30 P_2O_5+60 K_2O) which in the same time insignificant as compared with the first one. Moreover, No. of marketable tubers/plant show insignificant differences among various forms of applied fertilizers as previously mentioned.

In summery, it be stated that marketable tuber/fed was differentially affected by variation in fertilizer rates. The influence of one variable depended on the other.

Based on the previously discussed results, it seems that the best balanced fertilizer for potato plants is 120 N +60 P_2O_5+60 K_2O.

Table(8): Effect of the N X P interaction on yield component of potato plants grown on sandy calcareous soil during 2003 and 2004 seasons.

Nutrient levels	No. of marketable tubers/plant		Weight of marketable tubers/plant (gm)		Weight of marketable tubers/fed. (ton)		Dry matter percentage of tubers %	
	2003	2004	2003	2004	2003	2004	2003	2004
60 kg N X 30 kg P_2O_5	2.6	2.8	271.3	259.4	2.626	2.490	30.1	30.8
X 60 kg P_2O_5	3.4	3.4	286.3	265.6	2.791	2.544	26.9	26.9
X 90 kg P_2O_5	3.1	3.3	298.8	278.8	2.895	2.676	26.5	26.6
120 kg NX 30 kg P_2O_5	6.9	6.9	686.3	680.6	6.589	6.534	28.2	29.1
X 60 kg P_2O_5	7.1	7.3	684.4	680.6	6.575	6.534	31.3	31.4
X 90 kg P_2O_5	6.0	6.1	690.0	678.8	6.636	6.516	30.7	30.8
180 kg NX 30 kg P_2O_5	6.1	6.4	670.0	677.5	6.491	6.504	30.0	29.9
X 60 kg P_2O_5	6.5	6.6	674.4	676.3	6.465	6.432	27.7	28.2
X 90 kg P_2O_5	6.5	6.9	671.9	667.5	6.453	6.396	27.3	27.5
F. Value.	*	*	*	*	*	*	*	*
L.S.D 0.05	0.7	0.6	10.1	11.5	0.11	0.11	0.6	0.7

Table(9): Effect of the N X K interaction on yield component of potato plants grown on sandy calcareous soil during 2003 and 2004 seasons.

Nutrient levels	No. of marketable tubers/plant		Weight of marketable tubers/plant (gm)		Weight of marketable tubers/fed. (ton)		Dry matter percentage of tubers %	
	2003	2004	2003	2004	2003	2004	2003	2004
60 kg N X 30 kg K_2O	3.0	3.1	282.5	261.7	2.740	2.512	28.5	28.3
X 60 kg K_2O	3.1	3.2	288.3	274.2	2.801	2.628	27.3	27.9
120 kg NX 30 kg K_2O	6.6	7.0	683.3	675.4	6.565	6.484	29.8	30.4
X 60 kg K_2O	6.8	6.5	690.4	684.5	6.635	6.572	30.3	30.5
180 kg NX 30 kg K_2O	6.7	6.8	678.3	679.2	6.505	6.472	28.1	28.5
X 60 kg K_2O	6.1	6.4	665.8	668.3	6.434	6.416	28.6	28.6
F. Value.	NS	NS	*	*	*	*	*	*
L.S.D 0.05	-	-	8.7	8.9	0.08	0.08	0.4	0.4

Table(10): Effect of the P X K interaction on yield component of potato plants grown on sandy calcareous soil in 2003 and 2004 seasons.

Nutrient levels	No. of marketable tubers/plant		Weight of marketable tubers/plant (gm)		Weight of marketable tubers/fed. (ton)		Dry matter percentage of tubers %	
	2003	2004	2003	2004	2003	2004	2003	2004
30 kg PX 30 kg K_2O	5.2	5.4	535.8	534.2	5.142	5.128	29.8	30.3
X 60 kg K_2O	5.3	5.3	549.2	544.2	5.329	5.224	29.1	29.6
60 kg P X 30 kg K_2O	5.8	5.8	552.9	542.1	5.330	5.162	28.6	28.7
X 60 kg K_2O	5.6	5.7	543.8	539.5	5.224	5.176	28.7	28.9
90 kg P X 30 kg K_2O	5.3	5.7	555.4	540.0	5.338	5.176	28.0	28.2
X 60 kg K_2O	5.1	5.2	551.7	543.3	5.318	5.216	28.4	28.4
F. Value.	NS	NS	*	*	*	*	*	*
L.S.D 0.05	-	-	8.7	7.5	0.08	0.08	0.4	0.3

Table(11): Effect of the N X P X K interaction on yield component of potato plants grown on sandy calcareous soil during 2003 and 2004 seasons.

Nutrient levels	No. of marketable tubers/plant		Weight of marketable tubers/plant (gm)		Weight of marketable tubers/fed. (ton)		Dry matter percentage of tubers %	
	2003	2004	2003	2004	2003	2004	2003	2004
60 kg N X 30 kg P_2O_5 X 30 kg K_2O	2.5	2.8	253.8	251.3	2.436	2.412	31.5	31.5
60 kg N X 30 kg P_2O_5 X 60 kg K_2O	2.8	2.8	288.8	267.5	2.816	2.568	28.8	30.0
60 kg N X 60 kg P_2O_5 X 30 kg K_2O	3.5	3.3	300.0	268.8	2.946	2.580	27.3	26.9
60 kg N X 60 kg P_2O_5 X 60 kg K_2O	3.3	3.5	272.5	262.5	2.636	2.509	26.7	26.9
60 kg N X 90 kg P_2O_5 X 30 kg K_2O	3.0	3.3	293.8	265.0	2.838	2.544	26.6	26.6
60 kg N X 90 kg P_2O_5 X 60 kg K_2O	3.3	3.3	303.8	292.5	2.952	2.808	26.4	26.7
120 kg N X 30 kg P_2O_5 X 30 kg K_2O	7.0	7.3	671.3	666.3	6.497	6.396	27.8	29.4
120 kg N X 30 kg P_2O_5 X 60 kg K_2O	6.8	6.5	701.3	695.0	6.732	6.671	28.5	28.9
120 kg N X 60 kg P_2O_5 X 30 kg K_2O	7.0	7.5	678.8	675.0	6.522	6.480	31.2	31.1
120 kg N X 60 kg P_2O_5 X 60 kg K_2O	7.3	7.0	690.0	686.3	6.627	6.588	31.4	31.7
120 kg N X 90 kg P_2O_5 X 30 kg K_2O	5.8	6.3	700.0	685.0	6.726	6.576	30.4	30.7
120 kg N X 90 kg P_2O_5 X 60 kg K_2O	6.3	6.0	680.0	672.5	6.546	6.456	31.0	30.8
180 kg N X 30 kg P_2O_5 X 30 kg K_2O	6.0	6.3	682.5	685.0	6.543	6.576	29.9	30.0
180 kg N X 30 kg P_2O_5 X 60 kg K_2O	6.3	6.5	657.5	670.0	6.438	6.432	30.1	29.9
180 kg N X 60 kg P_2O_5 X 30 kg K_2O	6.8	6.8	680.0	682.5	6.522	6.432	27.4	28.1
180 kg N X 60 kg P_2O_5 X 60 kg K_2O	6.3	6.5	668.8	670.0	6.408	6.431	28.0	28.2
180 kg N X 90 kg P_2O_5 X 30 kg K_2O	7.3	7.5	672.5	670.0	6.450	6.408	27.0	27.3
180 kg N X 90 kg P_2O_5 X 60 kg K_2O	5.8	6.3	671.3	665.0	6.456	6.384	27.6	27.7
F. Value.	NS	NS	*	*	*	*	*	*
L.S.D 0.05	-	-	15.1	15.4	0.15	0.13	0.6	0.4

Tuber quality:

Nitrogen application rates exerted a significant effect on the percentages of dry matter as one of the important tuber quality (Table, 7). The highest values of dry matter percentage in both seasons were obtained at a rate of 120 kg N/fed., further increase of N up to 120 kg N/fed., decreased tuber dry matter at harvest. These results can be explained as found by Van der Zaag (1992) who indicated that mineral uptake influenced the dry matter and starch contents. These results are in agreement with those obtained by Sharma and Arora (1988).

Dry matter percentage decreased with increasing P rates as reported by Bardisi (2000) who reveal that the application of 30 kg P_2O_5 /fed. Reflected significant favorable effect on DM percentage of potato tuber. Similar conclusion was reported by Rohricht (1992).

Significant differences in the percentage of dry matter were found with the interaction between N and P (Table, 8). The highest values of dry matter percentage in both seasons were obtained at a rate of 120 kg N/fed., in the presence P at a rate of 60 kg P_2O_5 /fed. Also, the interaction between N and K, (Table, 9) it exerted significant variation in tuber contents of dry matter. The highest percentages of dry matter in both seasons were obtained at a rate of 120 kg N/fed., and 60 kg K_2O /fed. Moreover, the interaction between P and K (Table, 10) showed that the highest percentages of dry matter in both seasons were obtained at a rate of 30 kg P_2O_5/fed., and 30 kg K_2O /fed.

Concerning the interaction between N, P and K, data in Table 11 revealed that the balanced fertilizer treatment of 120 kg N/fed., 60 kg P_2O_5/fed. and 60 kg K_2O /fed. gave the highest percentages of dry matter in the second season (2004).

Nutrient content of potato leaves:

Data presented in Table 12 indicated that increasing N rates exerted significant increase in N% in potato leaves in both seasons. Maximum values of N, P and K contents in potato leaves were obtained from the application of 180 N/fed. but these values were not significant when compared with 120 N/fed. in the first season. Also, N, P and K concentration in potato leaves was significantly affected with increasing P and K rates.

With regard to N, P and K interactions, the results in Table 13 show that all of these interaction were insignificant regarding N, P and K in potato plant leaves. Several concepts have been advanced to explain the nature of the effect of N compounds on P uptake by plants. Cole et al (1963) studied the effect of nitrogen on phosphorus absorption and translocation by corn plants. They found that the presence of nitrate or ammonium ions in the nutrient solution during the uptake period had negligible effects on P uptake rates, while P uptake were highly correlated with total N level in the roots. The stimulation of P uptake with high plant N level suggests a connection between N metabolism and P uptake processes. This result is in agreement with what have been reported by Thien and Mclee (1970) who found that the absorption and translocation of phosphorus in corn plants significantly increased by nitrogen. Also, Hegab (1988) indicated that the highest values of P uptake were obtained in the presence of mineral N fertilizers through application of Urea and ammonium sulphate at 45 and 90kg N/fed. respectively. He added that phosphorus fertilization increased the efficiency of various forms of nitrogen in increasing N uptake by maize plant except urea which was more effective N source on increasing N uptake without P application.

Results of the present work reveal that N, P and K concentration in plant leaves were significantly affected with increasing K rates except N content in the 1 st season. Potassium concentration of leaf tissues increased significantly with an increase in K rate from 30 to 60 kg/fed. This results were in harmony with what have found by Rhue et al. (1986).

It can be concluded that the application of N at a rate of 120 kg/fed, P at a rate of 60 kg P_2O_5/fed and K at a rate of 60 kg K_2O /fed. was superior with respect to both tuber quality and nutrients contents in potato leaves.

Table(12): Effect of fertilization levels of N, P and K on nutrient contents of potato plants grown on sandy calcareous soil during 2003 and 2004 seasons.

Nutrient levels	N%		P%		K%	
	2003	2004	2003	2004	2003	2004
Nitrogen levels.						
60 kg N/fed	3.01	3.27	0.23	0.25	5.17	5.38
120 kg N/fed	3.65	3.65	0.25	0.28	5.40	5.56
180 kg N/fed	3.72	3.81	0.29	0.34	5.62	5.68
F. Value.	**	**	**	**	**	**
L.S.D 0.05	0.13	0.14	0.02	0.01	0.08	0.09
Phosphorus levels.						
30 kg P/fed	3.34	3.43	0.21	0.24	5.31	5.48
60 kg P/fed	3.45	3.59	0.25	0.30	5.39	5.55
90 kg P/fed.	3.66	3.71	0.31	0.34	5.49	5.59
F. Value.	**	**	**	**	**	*
L.S.D 0.05	0.14	0.08	0.03	0.02	0.05	0.07
Potassium levels.						
30 kg K/fed	3.46	3.53	0.24	0.28	5.31	5.40
60 kg K/fed	3.51	3.63	0.27	0.31	5.48	5.68
F. Value.	NS	**	*	**	**	**
L.S.D 0.05	-	0.06	0.02	0.02	0.04	0.06

Table(13): Significance of different NPK fertilizer interactions on potato plant leaves grown on sandy calcareous soil during 2003 and 2004 seasons.

Nutrient Interactions	N%		P%		K%	
	2003	2004	2003	2004	2003	2004
N X P	NS	NS	NS	NS	NS	NS
N X K	NS	NS	NS	NS	NS	NS
P X K	NS	NS	NS	NS	NS	NS
N X P X K	NS	NS	NS	NS	NS	NS

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تأثير التسميد المتوازن على نمو و محصول البطاطس وجودته في الأراضي الرملية الجيرية

عبد الحكيم شوقي بدوى* و محمد محمود محمد أحمد**

* معهد بحوث البساتين-مركز البحوث الزراعية –جيزة-مصر

** معهد بحوث الأراضي والمياه والبيئة-مركز البحوث الزراعية-جيزة-مصر

أجريت هذه الدراسة في عامي 2003-2004 بمحطة البحوث الزراعية بعرب العوامر- مركز البحوث الزراعية - محافظه أسيوط لدراسة تأثير معدلات مختلفة من ألا سمده الازوتيه-الفسفورية والبوتاسية على النمو والمحصول والجودة لمحصول البطاطس ومحتوى الأوراق من العناصر في ارض رمليه جيرية تحت نظام الري بالتنقيط .

- إضافة النيتروجين بمعدل 120كجم N / للفدان والفسفور بمعدل 60كجم P_2O_5 / للفدان والبوتاسيوم بمعدل 60كجم K_2O / للفدان أدى الى زيادة معنوية لكل عوامل النمو شاملة ارتفاع النباتات ووزن العرش للنبات وعدد السيقان للنبات .

- أعطت هذه المعاملة أعلى القيم لوزن درنات البطاطس للنبات وبالتالي وزن محصول البطاطس للفدان .

- أعطت هذه المعاملة أعلى نسبة مئوية للمادة الجافة .

- تأثير محتوى أوراق البطاطس معنويا بكل من النيترجين والفسفور والبوتاسيوم بمعدلات التسميد المختلفة وكانت أعلا القيم راجعة للتسميد ب 120 كجم نيترجين 90 كجم فسفور و 60 كجم بوتاسيوم .