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Enhancing Potato Tuber Yield and Quality through Integrated Fertilization

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ABSTRACT

Developing healthy plants is necessary for maximum growth and this requires all essential nutrients to be supplied at optimal rates. So, two field experiments were conducted in a calcareous soil at Nubaria Agricultural Research Station, El-behera governorate, Egypt (Latitude 30° 54' 48.220" N, Longitude 29° 51' 50.634" E), during 2014/015 and 2015/016 winter seasons to assess the effect of potassium (K_2SO_4) and magnesium ($MgSO_4$ $7H_2O$) fertilizers applied separately or in combination on yield and some qualitative parameters of potato (*cv. Alpha*) tubers. The two experiments were laid out in a randomized complete block design with three replicates including fifteen treatments as follows: 0, 24 and 48 kg K_2O fed^{-1} and 0, 5, 10 & 15 kg Mg fed^{-1}. The last three treatments contained 2.5, 5 & 7.5 kg Mg fed^{-1} combined with 24 kg K_2O fed^{-1} plus foliar application of 1% K_2O + 0.63 % Mg. The obtained results show that the combination of both nutrients (K and Mg) as 24 kg K_2O fed^{-1} plus 15 kg Mg fed^{-1} significantly increased number of tubers plant^{-1}, tuber yield plant^{-1}, medium sized tuber yield (35-55mm) and total tuber yield as well as tuber quality *i.e.* total carbohydrate % & starch %, tuber dry weight and N, P, K & Mg uptake in tubers over the control (zero K and Mg fertilizers). On the other hand, the highest large sized tuber yield (>55mm) was obtained under the treatment received 48 kg K_2O fed^{-1} combined with 5 kg Mg fed^{-1} which did not differ significantly from treatment received 24 kg K_2O fed^{-1} plus 7.5 kg Mg fed^{-1} accompanied by foliar spray of 1% K_2O + 0.63 % Mg, whereas soil application of (24 kg K_2O fed^{-1} plus 5 kg Mg fed^{-1}) or (24 kg K_2O fed^{-1} plus 7.5 kg Mg fed^{-1}) accompanied by foliar spray of 1% K_2O + 0.63% Mg recorded higher significant increases in leaf N content and dry matter % of tubers relative to control treatment with no significant difference between the two treatments. The highest values of P and K content in leaves were obtained when plants were treated with 48 kg K_2O fed^{-1} solely, while applying 15 kg Mg fed^{-1} alone gave the highest significant value of Mg content in potato leaves.

Keywords: calcareous soils, magnesium and potassium fertilizers, nutrients content, potato, yield, quality.

INTRODUCTION

Potato is a high yielding and exhaustive crop, thus is requiring a variety of balanced plant nutrients for growth and development. The optimum growth and production of potato depend on management of many factors; one of them is the application of a balanced fertilization program that having all essential nutrients according to soil analyses. Potato requires that all the essential nutrients be supplied at the suitable rate, the right time and the right place for achieving full yield potential (Agu, 2004 and Shaaban & Kisetu, 2014). Deficient or excessive plant nutrients can reduce tuber yield and quality and delay tuber maturity of potato (Zvomuya *et al.,* 2003).

Potato is regarded as an indicator crop for soil K availability due to its high K demand (Roberts and Mc Dole, 1985).Potassium is an essential nutrient for all plants and has a major effect on growth and yield as well as the general health and vigor of the crop (Abd El-latif *et al.,* 2011). It is absorbed by plants in a larger quantity than any other nutrient after nitrogen (Havlin *et al.,* 2005). Its role is well documented in photosynthesis, augmenting enzyme activity, improving synthesis of protein, carbohydrates, fats and translocation of photosynthate resulting higher productivity. Furthermore, it is particularly important in helping plants adapt to environmental stress as drought, winter hardiness, diseases, pests and frost (Brady and Weil, 2002). It is also involved in activation of enzymes that important to energy utilization, N metabolism, starch synthesis and respiration (Havlin *et al.,* 2005). Although the need of potassium could be high, the elevated input of this nutrient can cause some problems, as undesirable nutrients interactions. Excess potassium fertilization often applied affects plant composition and interferes with the uptake (nutrient antagonism) and physiological availability of Ca^{2+} and Mg^{2+}. In addition, interactions between the mineral nutrients are important when the levels of both are near the deficiency range, because augmenting; the supply of one nutrient only stimulates growth, which in turn can induce a deficiency of the other by the dilution effect (Marschner, 1995). Mg deficiencies in soil and crops beings have been a widespread problem affecting crop productivity and quality (Aitken *et al.,* 1999 and Gerendas and Fuhrs, 2013) as well as the dietary Mg intake and hence the human health (White and Broadley, 2009).

Magnesium has a high hydrated radius and is less strongly adsorbed to soil colloids than other cations. Thus, Mg is highly prone to leaching, which is considered as the most important factor in reducing Mg availability for roots (Hermans *et al*., 2004). In addition, the rate of Mg uptake could be strongly depressed by other cations, such as K^+, Ca^{2+}, NH_4^+, Mn^{2+}, Al^{3+} and H^+ leading frequently to plant Mg deficiency (Marschner, 1995 & Rengel and Robinson, 1990). Mg deficiency decreases the content of chlorophyll in the leaves and changes the chlorophyll a:b ratio in favor of chlorophyll b visually it is seen as chlorosis of older leaves and causes premature abscission. Chlorosis is occurred either by Mg deficiency, high content of soil Ca in calcareous soils or a combination of these factors (Marschner, 2002; Ksouri *et al*., 2005 and Gluhic *et al*., 2009).

Magnesium is an essential secondary element required for the normal growth and development of higher plants and plays a key role in plant defence mechanisms in a biotic stress situations (Cakmak and Yazici 2010; Gransee and Fuhrs 2013 & Cakmak, 2013). It is involved in many physiological and biochemical processes such as being a component of the chlorophyll molecule in the light-absorbing complex of chloroplasts and its contribution to photosynthetic fixation of CO_2 (Cakmak and Yazici, 2010 & Gerendas and Fuhrs, 2013). Magnesium is present in more mobile forms in plants (Marschner, 2012). Because of its high phloem mobility, Magnesium can easily be translocated to active growing parts of the plant since it is needed for chlorophyll formation, enzyme activation and phloem export of photosynthates to improve vegetative and generative growth. So, the first visual deficiency symptoms occur at older leaves (Cakmak and Kirkby, 2008; White and Broadley, 2009 & Gransee and Fuhrs, 2013).

So, the present investigation was undertaken to find out the optimum rates of potassium and magnesium to improve yield, some qualitative parameters and minerals content of potato plants grown on calcareous soil.

MATERIALS AND METHODS

Experimental site:

Two field experiments were carried out at Nubaria Agricultural Research Station, El-behera governorate, Egypt (Latitude 30° 54' 48.220" N, Longitude 29° 51' 50.634" E) in two consecutive winter seasons of 2014/015 and 2015/016 where the soil is calcareous (27.50 % $CaCO_3$) having clay loam texture as shown in Table (1) according to the analytical methods described by Black (1965).

Studied crop: Seed potato tubers (*Solanum tuberosum L. cv. Alpha*) were sown in autumn in 2014 and 2015 seasons.

Table 1. Some physical and chemical properties of the experimental soil before sowing (average of two seasons).

Properties	Value	Properties	Value
Particle size distribution (%)		**Soluble ions (*soil paste mmole$_c$L^{-1}*):**	
Sand	28.75	Ca^{++}	12.50
Silt	40.75	Mg^{++}	4.85
Clay	30.50	Na^{+}	20.44
Texture class	Clay loam	K^{+}	1.21
$CaCO_3$ (%)	27.50	$CO_3^{=}$	0.0
Organic matter (%)	0.57	HCO_3^{-}	4.72
pH (1:2.5 soil:water susp.)	8.22	Cl^{-}	18.33
EC (dSm^{-1}, soil paste ext.)	3.90	$SO_4^{=}$	15.95
Available macronutrients (*mg kg^{-1}*):			
N	P	K	Mg
40	7.70	343	84

Experimental design and treatments:

The experimental design was a randomized complete blocks with three replications having a plot area of 17.15 m^2 which contained seven ridges each of 3.5 m in length and 4.9 m apart. The experiment included fifteen treatments as follows:

T_1- zero ((control) without K or Mg addition)
T_2- zero K_2O + 5 kg Mg fed^{-1}
T_3- zero K_2O + 10 kg Mg fed^{-1}
T_4- zero K_2O +15 kg Mg fed^{-1}
T_5- 24 kg K_2O fed^{-1} + zero Mg
T_6- 24 kg K_2O fed^{-1} + 5 kg Mg fed^{-1}
T_7- 24 kg K_2O fed^{-1} + 10 kg Mg fed^{-1}
T_8- 24 kg K_2O fed^{-1} + 15 kg Mg fed^{-1}
T_9- 48 kg K_2O fed^{-1} + zero Mg
T_{10}- 48 kg K_2O fed^{-1} + 5 kg Mg fed^{-1}
T_{11}- 48 kg K_2O fed^{-1} + 10 kg Mg fed^{-1}
T_{12}- 48 kg K_2O fed^{-1} + 15 kg Mg fed^{-1}
T_{13}-24 kg K_2O fed^{-1} + 2.5 kg Mg fed^{-1} +1% K_2O + 0.63% Mg foliar spray
T_{14}-24 kg K_2O fed^{-1} + 5 kg Mg fed^{-1} + 1% K_2O + 0.63% Mg foliar spray T_{15}- 24 kg K_2O fed^{-1} + 7.5kg Mg fed^{-1} +1% K_2O + 0.63% Mg foliar spray

Both potassium and magnesium were applied potassium sulphate (48% K_2O) and magnesium sulphate (9.8 % Mg) respectively and added in two equal doses; 30 days after sowing and 30 days later. Foliar spray with 1% K_2O (2% K_2SO_4) and 0.63% Mg (6.4% $MgSO_4$ $7H_2O$) were made twice after 65 and 80 days from sowing in 400 L water fed^{-1}. All experimental plots received equal amounts of nitrogen and phosphorus. Phosphorus fertilizer in the source of ordinary calcium superphosphate (15% P_2O_5) was incorporated at the rate of 45 kg P_2O_5 fed^{-1} during land preparation. Nitrogen fertilizer in the source of ammonium nitrate (33.5% N) was banded at the rate of 160 kg N fed^{-1} in three equal doses, after four, six and eight weeks from sowing.

Plant sampling:

The 3rd, 4th and 5th fresh leaf blades from the apex were taken, from each plot after 94 days from sowing in both seasons. They were washed with distilled water and oven dried at 70 ˚C, ground and kept for chemical determination of N, P, K and Mg contents according to the method described by Chapman and Pratt (1961).

Yield and its attributes:

Potato plants were harvested after 120 days from sowing. Tubers were taken from the two middle ridges in each plot, collected, counted and graded to three sizes in accordance with its diameter (<35mm, 35-55 and >55mm). Each size grade was separately weighed according to Schild (1977) and the following parameters were calculated: number of tubers plant^{-1}, yield of tubers plant^{-1} (g), average tuber size (mm) and total tuber yield (ton fed^{-1}).

Tuber quality:

Dry mater % in tubers was determined according to Dogras *et al.,* (1991), total carbohydrate % was estimated according to A.O.A.C. (1990) and total soluble sugars was determined according to method described by Dubbois, *et al.,*(1956). Starch content was calculating the difference between total carbohydrate and total soluble sugar contents multiplying by 0.94 according to A.O.A.C. (1990).

Macronutrients uptake by potato tubers:

N, P, K and Mg concentrations were determined as outlined by Chapman and Pratt (1961) and N, P and

K as well as Mg uptake was calculated by multiplying the N, P& K as well as Mg % by dry weight of tubers (kg fed^{-1}).

Statistical analysis:

The obtained data was subjected to statistical analyzed according to Snedecor and Cochran (1980) and treatment means were compared against Least Significant Differences test (L. S. D.) at 0.05 level.

RESULTS AND DISCUSSION

Macronutrients concentration in potato leaves:

Data in Table 2 show that N, P and K as well as Mg concentrations in potato leaves at 94 days from planting were influenced significantly by different application rates of potassium and magnesium solely or combined together as compared to the control treatment. Data reveal that twice spraying potato plants with 1% K_2O plus 0.63% Mg combined with soil application of (24 kg K_2O fed^{-1} plus 5 kg Mg fed^{-1}) or (24 kg K_2O fed^{-1} plus 7.5 kg Mg fed^{-1}) recorded significant increases in leaf N content relative to control treatment with no significant difference between the two treatments. Data also show that, all various treatments increased P, K and Mg content in potato leaves as compared to control. The most pronounced treatment which gave the highest significant increases of P and K content in leaves was 48 kg K_2O fed^{-1} applied solely. For Mg content in leaves, the highest significant value was obtained when 15 kg Mg fed^{-1} is applied individually. The sufficient effect of K and Mg supply on nutrients content may be due to the enhancing N-uptake and its utilization (Grzebisz *et al.,* 2010 and Noor, 2010). In this connection, Abd El- Kader *et al.,* (2007) showed that K content in leaves increased by increasing rate of both K and Mg application. Hemeid (2007) noted that leaf K content was significantly increased by foliar spray of 2 % K_2SO_4 + 24 kg K_2O fed^{-1} soil additions, and the superiority was for K rate of 48 kg K_2O fed^{-1} at Nubaria. Abd El-latif *et al.,* (2011) found that N and K content in potato leaves were affected significantly by K rates, while P content in leaves was not affected by K rates in both seasons. Salim *et al.,* (2014) indicated that all potassium treatments as foliar spray have strongly stimulating effect on mineral nutrients N, P, K and Mg concentration in potato leaves in both seasons.

Table 2. Macronutrients concentration in potato leaves after 94 days from sowing as affected by different rates of potassium and magnesium fertilization (average of 2014/015 and 2015/016 growing seasons).

Application rates K_2O & Mg (kg fed^{-1})	Macronutrients (%) N	P	K	Mg
0 & 0 (control)	3.00	0.163	3.94	0.944
0 & 5	3.13	0.176	4.88	0.997
0 & 10	3.25	0.184	4.75	1.113
0 & 15	3.13	0.198	4.32	1.260
24 & 0	3.25	0.193	4.51	0.975
24 & 5	3.38	0.197	4.76	1.100
24 &10	3.25	0.206	4.51	1.160
24 & 15	3.00	0.214	5.16	1.180
48 & 0	3.25	0.225	5.69	0.988
48 & 5	3.13	0.173	4.80	1.080
48 & 10	3.38	0.182	5.07	1.080
48 & 15	3.38	0.205	4.32	1.050
24 & 2.5 + foliar spray of 1% K_2O & 0.63 % Mg	3.25	0.193	4.44	1.094
24 & 5 + foliar spray of 1% K_2O & 0.63 % Mg	3. 75	0.196	4.75	1.072
24 & 7.5 + foliar spray of 1% K_2O & 0.63 % Mg	3.63	0.198	5.26	1.110
L.S.D. at 0.05	0.46	0.022	0.59	0.096

Tuber yield and its attributes:

As shown in Table 3 application of K and Mg solely and their combination had significant effect on number of tubers $plant^{-1}$, tuber yield $plant^{-1}$ (g), average tuber size and total tuber yield (ton fed^{-1}) of potatoes. Combined application of both nutrients (K and Mg) as 24 kg K_2O fed^{-1} plus 15 kg Mg fed^{-1} caused significant increases over the control with 35.27% for number of tubers $plant^{-1}$, 69.67% for tuber yield $plant^{-1}$, 86.14% for medium tuber sized yield (35-55mm) and 35.36% for total tuber yield (ton fed^{-1}). On the other hand, the yield of small tubers was significantly reduced with individual application of 10 kg Mg fed^{-1} over the check treatment with no specific trend. Data reveal also that the highest large tuber sized yield (>55mm) was obtained under the treatment received 48 kg K_2O fed^{-1} combined with 5 kg Mg fed^{-1} which did not differ significantly from treatment received 24 kg K_2O fed^{-1} plus 7.5 kg Mg fed^{-1} accompanied by twice foliar spray of 1% K_2O + 0.63% Mg. The percentage of increase for such two treatments over the control treatment amounted to be about 42.5 and 39% respectively. The positive effect of combined application of both K and Mg on yield and its attributes may be due to that both fertilizers contain the sulphate ion; sulfur supports nitrogen utilization at the same time stimulating yields and decreasing the risk of losses, i.e. the leaching of nitrate to ground water (Mengel and Kirkby, 2001). Or it may be as a result of the effect of potassium fertilizer on plant growth via increases leave expansion particularly at early stages of growth, extends leave area duration by delaying leave shedding near maturity. It also increased both the rate and duration of tuber bulking. Potassium application activates number of enzymes involved in photosynthesis, proteins, carbohydrate metabolism and assists in the translocation of carbohydrates to tubers resulting in increased tuber size and weight as stated by Imas and Bansal 1999 & Adhikary and Karki 2006. Also, the significant effect of increasing the rate of Mg fertilizer on yield increases were derived from an improved root growth, photosynthesis, enzyme activities and translocation of photosynthates (Marschner, 2012 and Shaul, 2002).Similar findings were confirmed by Abd El-Kader *et al.,* (2007) who indicated that the maximum tuber yield of potato was obtained when 96 kg K_2O fed^{-1} was combined with 18 kg MgO fed^{-1} grown in sandy soil. El-Zohiri and Asfour (2009) found that foliar spray of K_2SO_4 combined with $MgSO_4$ gave the highest values of tubers number, weight of tubers per plant as well as medium, large tubers and total yield of potato. Talukder *et al.,* (2009) revealed that Mg had significant effects on potato tuber yield. Tuber yields augmented over control by 18 and 31% when magnesium was applied 5 and10 kg ha^{-1}. Zelelew *et al.,* (2016) and Shunka *et al.,* (2017) showed that total tuber yield and yield components were significantly increased with increasing the level of potassium application.

Table 3. Tuber yield and its attributes of potato as affected by different rates of potassium and magnesium fertilization (average of 2014/015 and 2015/016 growing seasons).

Application rates K_2O & Mg (kg fed^{-1})	No. of tubers plant^{-1}	Tuber yield plant^{-1} (g)	Tuber size (ton fed^{-1}) <35(mm)	35-55 (mm)	>55(mm)	Total tuber yield (ton fed^{-1})
0 & 0 (control)	5.67	521.60	3.54	3.68	2.00	9.22
0 & 5	6.00	538.10	2.89	4.39	2.16	9.44
0 & 10	4.00	444.00	2.52	4.15	1.89	8.56
0 & 15	7.00	652.20	3.62	4.53	2.36	10.51
24 & 0	5.83	492.50	2.99	3.73	2.25	8.97
24 & 5	5.00	757.48	3.45	5.46	2.59	11.50
24 &10	6.00	570.50	3.25	4.00	2.45	9.70
24 & 15	7.67	885.00	3.02	6.85	2.61	12.48
48 & 0	6.67	787.56	3.09	6.44	2.31	11.84
48 & 5	5.50	588.40	3.27	3.80	2.85	9.92
48 & 10	4.56	647.60	3.22	4.82	2.40	10.44
48 & 15	6.50	653.50	3.37	4.46	2.73	10.56
24 & 2.5 + foliar spray of 1% K_2O & 0.63% Mg	6.50	590.00	3.46	3.94	2.58	9.98
24 & 5 + foliar spray of 1% K_2O & 0.63% Mg	5.89	730.50	3.55	5.04	2.67	11.26
24 &7.5 + foliar spray of 1% K_2O & 0.63% Mg	6.00	781.00	3.60	5.35	2.78	11.73
L.S.D. at 0.05	1.63	64.71	0.32	0.31	0.16	0.54

Quality of potato tubers:

It can be noticed from data in Table 4 that the different tested treatments exerted positive effect on tuber quality of potatoes *i.e.*, dry matter, total carbohydrate and starch (%) except total soluble sugars (%), which showed opposite trend. The highest significant increase in dry matter (%) of tubers was obtained from treatments received (24 kg K_2O fed^{-1} + 5 kg Mg fed^{-1} along with 1% K_2O + 0.63% Mg as foliar spray) followed by that received (24 kg K_2O fed^{-1} + 7.5 kg Mg fed^{-1} as soil addition plus 1% K_2O + 0.63% Mg as foliar spray) with no significant difference between these two treatments. Whereas, application of 24 kg K_2O fed^{-1} combined with 15 kg Mg fed^{-1} exceeded significantly than all other treatments in respect of (carbohydrate and starch %) in tubers. While, applying 24 kg K_2O fed^{-1} combined with 5 kg Mg fed^{-1} produced the lowest significant value of total soluble sugars (%) over the check treatment. The favorable effect of K and Mg in quality formation is related to its role in promoting synthesis of photosynthates in leaves and their transport to the tubers and to improve their conversion into starch, vitamins and protein. Also, its application enhanced the dry matter content of tubers, which is highly essential for processing into chips and fries as stated by Feltran *et al.,* (2004) & Bansal and Trehan (2011). In this connection, El-Zohiri and Asfour (2009) showed that using K_2SO_4 plus $MgSO_4$ as foliar spray at three times produced the highest values of starch and total sugars percentage in potato tubers during the two growing seasons. Bansal and Trehan (2011) found that starch content in tubers positively correlated to application of potassium. Pushpalatha *et al.,* (2017) note that application of 100 kg K_2O ha^{-1} significantly increased total sugars and carbohydrates (%) in tubers of sweet potato.

Tubers dry weight and its uptake of macronutrients:

Data in Table 5 indicate that, tubers dry weight and N, P, K and Mg uptake in tubers were significantly affected with application of K and /or Mg. The highest values of dry weight of tubers and N, P, K and Mg uptake were obtained from plants fertilized with (24 kg K_2O fed^{-1} + 15 kg Mg fed^{-1}) over the control treatment. The significant beneficial effects of both K and Mg on N, P, K and Mg uptake as well as dry weight of tubers may be attributed to its role in building nutrient absorption capacity of potato crop especially, nitrogen as well as accelerating translocations of assimilates from leaves to sinks (tubers) consequently, dry weight of tubers increased as confirmed by Grzebisz *et al.,*

(2010) & Noor (2010).These results are in accordance with those of Abd El- Kader *et al.,* (2007) and El-Zohiri and Asfour (2009) found that applying K_2SO_4 combined with $MgSO_4$ gave the highest values of nutrients content in potato tubers. Abd El-latif *et al.,* (2011) note that N, P and K content in tubers were increased significantly by potassium application.

Finally, under the current experimental conditions, it can be concluded that application of 24 kg K2O fed-1 combined with 15 kg Mg fed-1 is an optimum rate for boosting potato production (cv. Alpha) and improving its quality.

Table 4. Tuber quality of potato as affected by different rates of potassium and magnesium fertilization (average of 2014/015 and 2015/016 growing seasons).

Application rates	Tuber quality (%)			
K_2O & Mg (kg fed^{-1})	Dry matter	Total carbohydrate	Total soluble sugars	Starch
0 & 0 (control)	18.51	72.55	2.39	65.94
0 & 5	19.71	74.24	2.11	67.80
0 & 10	20.76	73.25	2.44	66.56
0 & 15	20.30	76.35	2.28	69.63
24 & 0	17.89	73.88	2.21	67.37
24 & 5	19.38	75.90	1.89	69.57
24 & 10	20.05	75.37	2.01	68.96
24 & 15	20.70	77.61	2.24	70.84
48 & 0	19.20	76.56	2.06	70.02
48 & 5	20.34	75.67	1.92	69.32
48 & 10	19.90	75.93	2.04	69.46
48 & 15	20.24	76.37	2.17	69.74
24 & 2.5+ foliar spray of 1% K_2O & 0.63% Mg	20.54	75.70	2.42	68.89
24 & 5+ foliar spray of 1% K_2O & 0.63 % Mg	21.56	76.42	2.19	69.77
24 &7.5 + foliar spray of 1% K_2O & 0.63 % Mg	20.85	76.69	2.33	69.90
L.S.D. at 0.05	1.33	3.71	0.34	3.51

Table 5. Tubers dry weight and its uptake of macronutrients as affected by different rates of potassium and magnesium fertilization (average of 2014/015 and 2015/016 growing seasons).

Application rates	Dry weight of tubers	Macronutrients uptake (kg fed^{-1})			
K_2O & Mg (kg fed^{-1})	(ton fed^{-1})	N	P	K	Mg
0 & 0 (control)	1.71	29.17	4.11	27.62	11.29
0 & 5	1.86	32.55	4.17	33.23	14.64
0 & 10	1.78	31.49	4.06	30.48	12.66
0 & 15	2.13	37.34	4.51	36.88	17.87
24 & 0	1.61	32.13	4.40	29.58	11.24
24 & 5	2.23	42.74	4.96	40.75	17.73
24&10	1.94	36.41	4.23	33.76	14.18
24 & 15	2.58	49.37	5.82	47.81	22.15
48 & 0	2.27	43.54	5.47	41.83	16.34
48 & 5	2.02	36.94	4.90	36.53	16.68
48 & 10	2.08	40.38	4.44	38.96	16.75
48 & 15	2.14	37.40	4.54	36.32	15.35
24 & 2.5 + foliar spray of 1% K_2O & 0.63 % Mg	2.05	39.29	3.83	37.41	14.21
24 & 5+ foliar spray of 1% K_2O & 0.63% Mg	2.43	43.13	5.14	40.90	17.49
24 &7.5 + foliar spray of 1% K_2O & 0.63% Mg	2.44	44.74	4.65	43.20	16.92
L.S.D.at 0.05	0.17	4.27	0.81	4.66	2.46

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تحسين إنتاجية وجودة درنات البطاطس من خلال التسميد المتكامل

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نمو النباتات صحياً ضروري للحصول على أعلى نمو للدرنات وهذا يتطلب الأمداد بجميع المغذيات الأساسية وبالمعدلات المثلى. لذا أجريت تجربتان حقليتان فى أرض جيرية فى محطة البحوث الزراعية بالنوبارية- محافظة البحيرة- مصر(الواقعة بين خطى عرض 30 - 54- 220, 48شمالاً وخطى طول 29-51 -643 ,50 شرقاً) خلال موسمين شتويين 2014 / 2015و2015 / 2016 وذلك لتقييم تأثيرأضافة السماد البوتاسي والماغنسيومي منفرداً أومشتركين معاً على محصول درنات البطاطس (صنف ألفا) وبعض صفات جودتة. نفذت التجربتان فى قطاعات كاملة العشوائية فى ثلاث مكررات وأشتملت على خمسة عشرة معاملة هي : صفر, 24و48 كجم أكسيد بوتاسيوم/فدان وصفر, 5 ,10 و15 كجم ماغنسيوم/فدان. وتحتوي الثلاث معاملات الأخيرة على 2,5, 5 و7,5 كجم ماغنسيوم / فدان بأشتراك 24 كجم أكسيد بوتاسيوم/فدان وأضافة الرش بي 1% أكسيد بوتاسيوم +0,63% ماغنسيوم .وقد أوضحت النتائج أن أشتراك العنصرين معاً (البوتاسيوم والماغنسيوم) بمعدل24 كجم أكسيد بوتاسيوم/فدان +15كجم ماغنسيوم / فدان زاد معنوياً كلا من عدد الدرنات للنبات , محصول الدرنات للنبات, محصول الدرنات متوسطة الحجم (قطر35 -55 مم) والمحصول الكلى للدرنات وأيضاً جودة الدرنات من حيث النسبة المئوية للكربوهيدرات الكلية والنسبة المئوية للنشا, الوزن الجاف للدرنات والممتص من النيتروجين, الفوسفور, البوتاسيوم والماغنسيوم بواسطة الدرنات مقارناً بالكنترول (لم تسمد باى من البوتاسيوم والماغنسيوم). ومن ناحية أخرى سجل أعلى محصول من الدرنات كبيرة الحجم (قطرأكبر من 55 مم) من المعاملة 48 كجم أكسيد بوتاسيوم /فدان بأشتراك 5 كجم ماغنسيوم / فدان ولم تختلف معنوياً عن المعاملة 24 كجم أكسيد بوتاسيوم / فدان + 7,5 كجم ماغنسيوم / فدان مصحوباً بالرش الورقي 1% أكسيد بوتاسيوم + 0,63% ماغنسيوم وأيضا سجلت الأضافة الارضية (24 كجم أكسيد بوتاسيوم / فدان + 5 كجم ماغنسيوم/فدان) أو(24 كجم أكسيد بوتاسيوم / فدان + 7,5 كجم ماغنسيوم/فدان) بمرافقة الرش الورقي 1% أكسيد بوتاسيوم + 0,63% ماغنسيوم أعلى زيادة معنوية فى محتوى الأوراق من النيتروجين والنسبة المئوية للمادة الجافة فى الدرنات مقارناً بمعاملة الكنترول مع عدم وجود فرق معنوى بينهما. سجلت معاملة النباتات عند 48 كجم أكسيد بوتاسيوم /فدان منفرداً أعلى قيمة فى محتوى الأوراق من الفوسفور والبوتاسيوم بينما أعطى أضافة 15كجم ماغنسيوم/ فدان منفرداً أعلى قيمة معنوية فى محتوى أوراق البطاطس من الماغنسيوم .