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GROWTH, YIELD , QUALITY AND NUTRIENT UPTAKE OF POTATO (*Solanum tuberosum, L.*) AS AFFECTED BY TWO NITROGEN SOURCES APPLIED AT VARIOUS RATIOS

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ABSTRACT

A field experiment was carried out at the Experimental Res. Farm of El-Kassasin Horticultural Research Station, Ismailia Governorate, (Around ٣٠°.٢٦' N ٣١°٥٩' E) during two successive seasons; ٢٠٠٩/٢٠١٠ and ٢٠١٠/٢٠١١ to study the effects of applying two different nitrogen sources ammonium sulphate (AS) and ammonium nitrate (AN), at the same rate of ١٤٠ kg Nfed$^{-١}$, and their ratios on growth, yield marketable, quality and nutrient uptake of potato (*Solanum tuberos*um L.; CV. Nicola). A completely randomized design was established with ٥ treatments, i.e., (AS) / (AN) ratios of ١٠٠/٠, ٠/١٠٠, ٧٥/٢٥, ٥٠/٥٠, ٢٥/٧٥ and. Each treatment had ٣ replications. Representative samples were taken after ٧٥ days and the yield was harvested after ١٢٠ days. Dry weights of tubers, at the harvest were increased significantly with all mixed nitrogen treatments as compared with single AS or AN. The enhanced growth with mixed nitrogen was greatest at ٢٥٪ (AS) Ammonium Sulphate + ٧٥٪ (AN) Ammonium Nitrate. Such treatment produced maximum dry matter (٢٤,٢٠٪), total **y**ield (١٣,٧٦٥ kg.fed$^{-١}$) and N,P and k uptake and marketable yield (%٨٦,٦) followed by the treatment having ٥٠٪ AS +٥٠٪ AN. Usage of ١٤٠ kg Nfed.$^{-١}$ applied as a mixture of ٢٥٪ AS+٧٥٪ AN achieved ١٧٪ and ١١٪ increment of total yield compared to ١٠٠٪ of AS application and ١٠٠٪ AN, respectively.

The study stressed on paying attention to selection of sources of N fertilizers and their ratios for potato plants grown in sandy soil.

Keywords: potato (Solarium tuberosum L.),nutrient uptake, Dry matter, N sources, Ammonium sulphate to ammonium nitrate ratio, Marketable yield.

INTRODUCTION

Potato (Solanum tuberosum, L.) is one of the most important world food crops.it comes after rice, wheat and maize. Among vegetable crops being planted in Egypt, potato occupies higher rank in terms of exportation and local consumption. It is consumed in different forms such as boiled or fried and many different processed products like chips, french fries, flakes, powder, potato papad etc. Quality attributes of potato tubers particularly size, dry matter, starch and sugar contents are of prime concern for potato growers, in order to attain good prices for their produce (Pandey and Sarkar, ٢٠٠٥; Pandey et al., ٢٠٠٩). Nitrogen fertilization is a key factor for potato quality processing, besides its influence on potato size preferred for fresh consumption.

Not only tuber size is affected by nitrogen but also by starch content and sugar content. Nitrogen as a major element being essential for plant growth, is available to plants in two forms namely nitrate nitrogen ($NO_{٣}^{-}$ -N) and ammonium nitrogen ($NH_{٤}^{+}$-N). Nitrogen forms affect plant growth and yield. Most plants get their nitrogen (N) from the soil as either nitrate or ammonium, with some species showing a strong preference for one ionic form over the other (Forde and Clarkson, ١٩٩٩). Nevertheless , plant growth decreases under excessive nitrogen supply. The growth of potato (Cao and Tibbtts, ١٩٩٨) and bean (Sánchez et al., ٢٠٠٤), are significantly inhibited due to application of excessive nitrogen. In this regard Wei et al., ٢٠٠٩ reported that under high nitrogen levels, most plant species show reduced growth, smaller leaves and stunted root systems, and in severe cases can lead to death of the plant. High nitrate levels in soil or nutrient solution will cause osmotic stress, which can cause oxidative damage and induce reactive oxygen species (ROS). They are highly toxic and can damage many important cellular components, such as lipids, protein, DNA and RNA. Increased levels of ammonium could be highly toxic for plant cells (Pilbeam and Kirkby, ١٩٩٢).

Usually plants are able to take up N as nitrate (NO٣-) and ammonium (NH٤ +), but some may prefer one source or another depending on plant species (Marschner, ١٩٩٥). N sources may affect plant growth via many processes within the soil plant system, and inside the plant (Wiesler, ١٩٩٧). The use of different N sources may directly affect the nutrition status of plants due to changes in the rhizosphere, as a result of modification in the ionic balance in that soil fraction. The use of N-NH٤+ causes an increasing H+ excretion, leading to a decrease in soil pH, whereas the use of N-NO٣- is associated with a decrease in H+ excretion and increasing rates of HCO٣ - or OH- resulting in a pH rise, especially when in combination with Ca٢+ (Marschner and Römheld, ١٩٩٦). However, when plants are growing in a similar way and supplied with N-NO٣- or N-NH٤+, they may differ in many aspects related to metabolic activity and ionic composition as a result of different physiological responses (Kandlbinder et al., ١٩٩٧). The reduction of N-NO٣- in plants consume great amount of reducing power. Considering the biochemical energy needed for NO٣- reduction, one could suppose that plant supplied with N-NH٤ would grow better than that supplied with N-NO٣- source, however in most cases the opposite occurs even altering the plant architecture of fast growing plants (Beltrano et al., ١٩٩٩). Some species show growth depression when supplied exclusively with N-NH٤+, but generally this causes a decrease in soil pH which may increase the availability of some mineral nutrients such as P, Fe, Mn, Cu, and Zn (Marschner, ١٩٩٥).

Improving the soil/plant relationship is depending on soil conditions. N transfer from roots to leaves can occur in different manners and its incorporation in different amino acids, proteins, and other N compounds are differentiated for each plant species and development stage (Pate, ١٩٧٣). The aim of this research was to study the effects of applying two different nitrogen sources AS and AN and their ratios on growth, yield marketable, nutrient uptake (N,P and K) and quality of potato (Solanum tuberosum L.).

MATERIALS AND METHODS

A field experiment was carried out at the Experimental Res. Farm of El-Kassasin Horticultural Research Station, Ismailia Governorate, (Around ٣٠°.٢٦′ N ٣١°٥٩′ E) on ١٥th of October during two successive seasons;

٢٠٠٩/٢٠١٠ and ٢٠١٠/٢٠١١ to study the effects of applying two different nitrogen sources AS and AN and their ratios on growth, yield marketable, quality and nutrient uptake (N, P, and K) of potato (Solanum tuberosum L.; CV. Nicola); grown under sprinkler irrigation. Some Physical and chemical characteristics for the soil under study were conducted according to (Page et al., ١٩٨٢) and (Klute, ١٩٨٦). The results are shown in table ١

Table ١: Some physical and chemical properties of the studied soil.

Particle size distribution (%)				Textural class	$CaCO_{٣}$ (%)	O.M (%)
Coarse sand	Fine sand	Silt	Clay			
٢,٣٨	٦٧,٤٢	١٨,٢	١٢,٠٠	Sandy loam	٢,١	٠,٨٥

pH	EC dS $m^{-١}$	%SP	Ion concentration in paste extract ($meqL^{-١}$)								Available (mg $kg^{-١}$)		
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_{٣}$	$HCO^{-}_{٣}$	Cl^{-}	$SO^{=}_{٤}$	N	P	K
٨,٢	٠,٨٧	٢٩	٣,٩٠	٢,٧٠	١,٨٥	٠,٥٥	٠,٠٠	١,٣٠	٤,٥٥	٣,١٥	٢٥,٤	١٠,٥٠	١٨٠,٥١

The experiment was laid out in factorial design based on complete randomized block design with three replications. Experimental factors included two N sources ammonium sulfate (AS); $NH_{٤}(SO_{٤})_{٢}$ having ٢٠,٦٪ N, and ammonium nitrate (AN), ($NH_{٤}NO_{٣}$) having (٣٣,٥٪ N). The two N sources were applied at the same amount of N namely ١٤٠ N kg/fed. Five (AS) / (AN) ratio were used: ١٠٠/٠, ٠/١٠٠, ٧٥/٢٥, ٥٠/٥٠ and ٢٥/٧٥.The experimental treatments were as follow:-

١٠٠٪ N as Ammonium Sulphate (AS).
١٠٠٪ N as Ammonium Nitrate (AN).
٧٥٪ AS + ٢٥٪ AN.
٥٠٪ AS + ٥٠٪ AN.
٢٥٪ AS + ٧٥٪ AN.

The tested nitrogenous fertilizers and their ratios were split into four doses and added at four stages namely; ٢٠٪ before planting, ٢٠٪ at plant establishment, ٣٠٪ at tuber initiation and ٣٠٪ at tuber bulking.

Phosphorus fertilizer was added at the recommended dose, ٧٥ kg $P_{٢}O_{٥}$ per fed. However, ٥٠٪ of the amount was applied to the soil in the form of calcium superphosphate (١٥,٥٪ $P_{٢}O_{٥}$) during soil preparation and the rest was fertigated in the form of phosphoric acid (٦٢٪ $P_{٢}O_{٥}$) split into equally dose during growth stages.

Potassium fertilizer was fertigated at a rate of ١٢٠ kg $K_{٢}O$ in the form of Potassium sulfate (٥٠٪$K_{٢}O$) split into ٥ equal doses, one at soil preparation and the rest at ٣٥, ٤٥, ٥٥ and ٦٥ days after planting.

At ٧٥ days after planting four plants were taken randomly form each plot to determine plant height (cm) and number of main stems/plant.

Total tuber yield (kg.fed-١), and tuber weight/plant were determined at harvesting (١٢٠ days after planting).

N, P and K were determined in the leaves at ٧٥ days of planting and in tubers at harvesting time. Total nitrogen was determined in dry leaves and tubers using micro-kjeldahl methods as described by Ling (١٩٦٣), while P was determined calorimetrically and potassium was determined by using a flame photometer as described by Jackson (١٩٦٧).

Tuber Quality was appraised through testing some parameters namely; dry matter (%), starch content, carbohydrate fractions and specific gravity of tubers besides grading their size.

Starch content was determined according to A. O. A. C. (١٩٩٠) .Tuber dry matter (%) was determined by drying the tuber slices at ٦٥°C for ٧٢ hours according to the method of A. O. A. C. (١٩٩٠). Carbohydrate fractions were determined in tuber according to the method described by Miller (١٩٥٩). Specific gravity; SG of tuber was estimated using following formula outlined by Murphy and Goven (١٩٥٩);

SG = (tuber weight in the air)/ ((tuber weight in the air) - (tuber weight in the water)

Tubers were graded according their size to large size >٥٥, medium size; ٣٥-٥٥and small size;< ٣٥mm in diameter (Fattahalla, ١٩٩٧). All collected data were statistically analyzed according to the procedure described by Snedecor and Cochran (١٩٨٠). The statistical analysis was conducted for all yield parameters of the two seasons i.e. combined analysis.

RESULTS AND DISCUSSION

Effects of N-Sources and their ratios on the growth of potatoes plants:

Data in Table ٢ show the effect of using different sources of nitrogen and various ratios of them on plant height and number of stems per plant ; average means of both seasons. Data elucidate that plant height was significantly elevated as the plants received ٢٥٪AS+٧٥٪AN compared with the other treatments.

The shorter plant height (٤٩,٢ cm) was recorded when ١٠٠٪ (AS) was administered and no significant difference was observed in the plant height recorded for such treatment and that of ٧٥٪ AS+٢٥٪AN. Nevertheless, the longest plant height (٦٤,٥ cm) was recorded with the application of ٢٥٪ AS+٧٥٪ AN.

Table ٢: Effects of N-Sources and their ratio on the growth of potatoes plants. (average means of both seasons.)

N Sources and their ratios	Plant height cm	Mean No. of stems/plant
١٠٠٪ Ammonium Sulphate (AS)	٤٩,٢ d	٢,٧٥
١٠٠٪ Ammonium Nitrate (AN)	٥٢,٩ c	٢,٧٥
٧٥٪AS+٢٥٪AN	٥٠,٩ d	٢,٨٠
٥٠٪AS+٥٠٪AN	٥٥,٩ b	٣,٢٠
٢٥٪AS+٧٥٪AN	٦٤,٥ a	٣,٧٠
LSD ٠,٠٥	١,٩٩	N.S

AS=Ammonium Sulphate **AN=Ammonium Nitrate**

The data reveal that the lowest number of stems per plant (٢,٧٥ cm) was assigned for the plants received sole nitrogen source while plants received ٢٥٪AS+٧٥٪ AN gave the highest number of stems per plant (٣,٧). This parameter is of great importance because it is directly related to the total production of tubers. The more is the number of stems/plant the more is the number of tubers per plant. Number of stems per plant is also important for tuber size. (Marschner, ١٩٨٦) pointed out that the increase in plant height may be attributed to the beneficial effects of N on stimulating the meristmatic activity for producing more tissues and organs and N plays major roles in structural proteins and other several macromolecules related with growth plants. Walch-Liu et al., (٢٠٠٠) reported that excessive NH٤+ is harmful to tobacco plants and could result in hormonal imbalance and a strong decline of cytokinins in the xylem sap, which could then hamper growth and reduce yield.

The diverse response of plant to N-NO٣ and N-NH٤ was interpreted by some researchers. Romero et al., ٢٠٠٦) explained that applying N-NO٣ may increase the plant highest, the acid-base balance that was broken, in which NO٣- increased the pH around the roots due to the efflux of HCO٣- or OH-, and NH٤+ decrease the pH due to the efflux of H+

Effect of AS/AN^{-} ratio on nutrients content in leaves and tubers

Table ٣ displays the effect of using different sources of N-fertilizers on N, P and K contents in leaves and tubers of potato. Nitrogen content in the leaves of potato exhibited remarkable difference due to diverse source of nitrogen and/or their combination. Application of ٢٥٪ AS+٧٥٪ AN gave the highest N% in the leaves (٥,٣٣٪). As the % of added ammonium sulfate (AS) was increased N content of the leaves significantly decreased. It is worth mentioning that the lowest % of N content was recorded in leaves of potato fertilized solely with AS (٣,٦٪). Interestingly similar trend was generally noticed in the case of P and k content in the leaves.

Higher concentration of P, and K were recorded in treatments received ٢٥٪AS+٧٥٪AN of nitrogen, which in turn resulted in higher concentration of P, and K in leaves. The highest percent of P (٠,٥٤) and K (٤,٠٩) were recorded with the application of nitrogen at ٢٥٪AS+٧٥٪ AN. These effects of N forms on tissue mineral composition were consistent with (Cao and Tibbtts, ١٩٩٣).

Table ٣: Effects of N-Sources on N, P and K content in potato plant. (average means of both seasons.)

Treatments	Nutrients content in leaves after ٧٥ day			Nutrients content in Tubers at harvest			Total uptake at harvest kg/fed.		
	% N	% P	% K	% N	% P	% K	N	P	K
١٠٠٪ Ammonium Sulphate (AS)	٣,٦ e	٠,٣٤ d	٣,٤٥ c	١,٨ b	٠,٢٨ d	١,٧٤ d	٢٠٧,٩ b	٣٢,٦ d	١٩٨,٤ d
١٠٠٪ Ammonium Nitrate (AN)	٤,٦٨ c	٠,٤٦ b	٣,٦١ b	١,٧ b	٠,٣٩ b	١,٨٥ b	٢١٤,١ b	٤٧,١٣ b	٢٢٠,٨ c
٧٥٪AS+٢٥٪AN	٤,١٤ d	٠,٣٩ c	٣,٦٨ b	١,٥٨ c	٠,٣٣ c	١,٧٨ c	١٩٠,٥ c	٣٩,٧ c	٢١٨,٤ c
٥٠٪AS+٥٠٪AN	٤,٩٩ b	٠,٤٩ b	٤,٠٥ a	١,٧ b	٠,٤٢ b	١,٩٣ a	٢٠٩,٧ b	٥٠,٧٥ b	٢٣٤,٨ b
٢٥٪AS+٧٥٪AN	٥,٣٣ a	٠,٥٤ a	٤,٠٩ a	٢,٠٥ a	٠,٤٥ a	١,٩٧ a	٢٨٣,٦ a	٦١,٦ a	٢٧١,١ a
LSD ٠,٠٥	٠,١٨٥	٠,٠٤٢	٠,١٢	٠,٠٩٧	٠,٠٣٥	٠,٠٤٦	٩,٥٧	٤,٣٥	٦,٩٢

Effect of AS and AN ratio on Yield and marketable yield of potatoes:

Different AS and AN ratios significantly affected the size distribution of potatoes (Table ٤). Regarding the size of potato the data clearly indicated that the source of N played indispensable role in obtaining desired marketable size. Applying ٢٥ AS+ ٧٥٪ AN gave significantly bigger sizes; medium and large , compared with those obtained due to sole application of ١٠٠٪ AS and/or ١٠٠٪ AN. The opposite was true regarding the small size. The maximum yield of ١٣،٧٦٦ kg fed.-١ was obtained in the treatment ٢٥٪AS+٧٥٪AN followed by those receiving ٧٥٪AS+٢٥٪AN (١٢،٢١٩ kg fed.-١ and ٥٠٪AS+٥٠٪AN (١٢،١٦٩ kg-fed).

Table ٤:The effects of N-Sources on Tuber marketable yield and size distribution(average means of both seasons.)

Treatments	Yield kg fed$^{-١}$ Small size *	% Yield Small size	Yield kg fed$^{-١}$ Medium size **	% Medium Yield	Yield kg fed$^{-١}$ Large size ***	% Yield Large size	% Marketable size	Total Yield kg fed$^{-١}$	Total Yield kg/plant
١٠٠٪ Ammonium Sulphate (AS)	٢٠٢٣ a	١٧,٨	٩١٧٥ e	٨٠,٢	٢٢٥ d	٢,٠	٨٢,٢	١١٤٢٣ d	٠,٨٨٧ c
١٠٠٪ Ammonium Nitrate (AN)	١٩١٢ b	١٦,٠	٩٧٨٧ c	٨١,٧	٢٨١ c	٢,٤	٨٤,١	١١٩٨١ c	٠,٩٥٨ b
٧٥٪AS+٢٥٪AN	٢٠٦٥ a	١٧,٤	٩٤٣١ d	٨٠,٠	٧٢٣ b	٢,٥	٨٢,٥	١٢٢١٩ b	٠,٩٤٣ b
٥٠٪AS+٥٠٪AN	١٩٠٠ b	١٤,٦	١٠١٦١ b	٨٢,٢	١٠٨ e	٣,٢	٨٥,٢	١٢١٦٩ b	٠,٩٥٣ b
٢٥٪AS+٧٥٪AN	١٨٠٣ c	١٤,١	١١٢٠٣ a	٨٣,٥	٧٥٠ a	٣,١	٨٦,٦	١٣٧٦٦ a	١,٠٥٥ a
LSD ٠,٠٥	٥٤,٤		٦٦,٨٧		١٦,١١			١٠٥,٩	٠,٠٥٢

*** small size;< ٣٥mm, **medium size; ٣٥-٥٥, *** large size; >٥٥, Marketable; large +medium size**

The yield was lowest (١١,٤٢٣ kg fed.-١) in the treatment receiving١٠٠٪ (AS). Usage of combination of ٢٥٪AS+٧٥٪AN achieved ١٧٪ and ١١٪ increment of the total yield compared to ١٠٠٪ of AS application and ١٠٠٪ AN, respectively. But, it was only ٩٪ with ٧٥٪ AS+٢٥٪ AN and ٨٪ with ٥٠٪ AS+٥٠٪ AN. It is worthy to note that differences arise from diversity of the fertilizer prices of the studied N sources have no impact on the production cost of potato. The present results are in harmony with those reported by (Wang et al., ٢٠٠٩) who stressed the usage of mixed nitrogen sources for obtaining higher yield. Moreover, Cao and Tibbitts ١٩٩٣ demonstrated that dry weights of shoots, tubers, and whole plant at the harvest were increased significantly with all mixed nitrogen treatments as compared with single NH٤+ or NO٣- form. The enhanced growth with mixed nitrogen was greatest at ٨٪ to ٢٠٪ NH٤+-N. Also, the concentrations and accumulation of total N in the shoots and roots were greater with mixed nitrogen than with separate NH٤+ or NO٣- nutrition.

On the contrary (Ge, ٢٠٠٢; and Wang et al., ٢٠٠٥) reported that the highest yield of plant was produced at ٠:١٠٠ of AS to AN.

In the current study higher sulphur content, present in the fertilizer applied seems to have a detrimental effect on the growth of potato. In this concern, many workers reported that although sulphur plays substantial role in potato production through its role in better partitioning of the photosynthates in the shoots and tubers, yet heavy application of sulphur can result in yield reduction (Sud and Sharma٢٠٠٢ and Lalitha et al. ٢٠٠٢). Their findings are in consonance with Nasreen et al. (٢٠٠٧) on onion.

Effect of nitrogen sources and their ratios on tubers quality of potato

Table ٥ summarizes the results of the some quality tests done on potatoes grown under different treatments (average means of both seasons).

Table ٥: The effects of N-Sources and their ratios on qualitative characters of potato (average means of both seasons).

Treatments	% NS Sugar	% Total Sugar	%D.M	specific gravity	%Starch
١٠٠٪ Ammonium Sulphate (AS)	٣٤,٨١ c	٣٧,٢٥ e	١٧,٥٤ d	١,٠٥٢ e	١٤,٦٢ e
١٠٠٪ Ammonium Nitrate (AN)	٣٣,٢٢ d	٣٥,٦٨ d	٢٢,٣٥ b	١,٠٥٧ d	١٥,٩٣ d
٧٥٪AS+٢٥٪AN	٣٦,٠٨ c	٣٨,٥ c	١٩,٨٧ c	١,٠٦٤ c	١٧,١٨ c
٥٠٪AS+٥٠٪AN	٣٧,١٨ b	٣٩,٦٩ b	٢٢,١٤ b	١,٠٧٣ b	١٨,٨٤ b
٢٥٪AS+٧٥٪AN	٤٠,٨٢ a	٤٣,٥٠ a	٢٤,١٤ a	١,٠٨٢ a	٢٠,٧٥ a
LSD ٠,٠٥	٠,٧٢	٠,٧٤	١,٠٤	٠,٠٠١٩	٠,٩٢

Tubers quality, such as starch, specific gravity, D.M soluble sugar, non-soluble sugar and total sugar % were significantly (P≤٠,٠٥) affected by AS and AN ratio. Starch, specific gravity, D.M. and total sugar % differed significantly due to the studied N fertilization management. Regardless the effect of ١٠٠٪ of ammonium nitrate on the dry matter the assigned higher value recorded for these parameters followed the order:

٢٥٪AS+٧٥٪AN >٥٠٪AS+٥٠٪AN >٧٥٪AS+٢٥٪AN >١٠٠٪ (AN) >١٠٠٪ (AS).

The obtained results concerning the effects of AS and AN ratio on Tubers quality of potato was in accordance with Dong et al. (٢٠٠٤) who reported that increasing the ratio of AS/AN (٢٥, ٥٠ and ٧٥٪) in the treatments led to a significant decrease in Starch, and D.M content.

The specific gravity is a measure of quality in potato tuber which is related to the dry matter contents in the tubers. The specific gravity is also associated with starch content, total solids and mealiness of potato tubers (Teich and Menzres ١٩٦٤). They also reported a reduction in specific gravity due to fertilizer treatment and its influence on crop quality. The higher is the specific gravity the better is the quantity of dry matter and greater is the yield of produce. Potatoes with high specific gravity are preferred for manufactured processes.

(Lalitha et al, ٢٠٠٢) exeplained that sulphur being a component of sulphur containing amino acid as well as involved in sulpho-hydral bonds in polypeptides, also component of protein enzyme involved in chlorophyll, starch and protein synthesis. Involvement of sulphur in these biochemical processes in plant metabolism may be the cause for increased starch synthesis and production of large size tubers.

Based on the above mentioned information it may be concluded that application of ٢٥٪AS+٧٥٪AN gave the best quality under experimental trails.

CONCLUSIONS

Different AS and AN ratios in treatments not only affected plant growth, but also affected yield marketable and tubers quality of potato. The maximum yield and quality of potato was obtained as ٢٥٪ of N was added in the the form of ammonium sulphate and the other ٧٥٪ in the form of ammonium nitrate. Nonetheless, the lowest yield and quality was recorded as potato was fertilized with ١٠٠٪ Ammonium sulphate. This research drew the attention to the usage appropriate ratio of ammonium sulphate to ammonium nitrate for potato fertilization grown in Egypt rather than relying on sole source of them. Besides extra care should be given to higher content of sulphate in fertilization management of potato as higher content of such element could reduce its yield. More researches are needed to be carried out concerning such topic.

REFERENCES

A.O.A.C. (١٩٩٠).Official Methods of Analysis. ١٥th Ed. Washington DC, USA.

Beltrano, J.; Ronco, M. G.; Barreiro, R. and Montaldi, E. R. (١٩٩٩), Plant architecture of *Paspalum vaginatum* Schwartz modified by nitrate and ammonium nutrition, *Pesquisa Agropecuária Brasileira*, ٣٤, ١١٥٩-١١٦٦

Cao, W. and Tibbitts, T.W. (١٩٩٣). Study of various NH٤+/NO٣- mixtures for enhancing growth of potatoes. Journal of Plant Nutrition. Sep; ١٦(٩):١٦٩١-٧٠٤.

Cao W.X, and Tibbitts, T.W. (١٩٩٨). Response of potatoes to nitrogen concentrations differ with nitrogen forms. J. Plant Nutr. ٢١: ٦١٥–٦٢٣.

Chapman, H. D. and P.F. Pratt, (١٩٦١). Methods of Analysis for Soils, Plant and Waters. Univ. of California, Div.Agric. Sci., ٦٠.

Dong, C.X., Shen, Q.R. and Wang, G. (٢٠٠٤). Tomato growth and organic acid changes in response to partial replacement of NO٣¯ -N by NH٤ +-N. Pedosphere. ١٤(٢): ١٥٩-١٦٤.

Eddins, A.H., ١٩٣٤. Effect of inoculated sulphur, lime and mercury compounds on the yield of potatoes. Am. J. Potato Res., ١١: ٢٩٥-٣٠٢.

Fattahalla, M.A. (١٩٩٧). Performance evaluation of some potato cultivars under the conditions of the new reclaimed land in Egypt .Zagazig J.Agric. Res., ٢٤: ٧٦٩-٧٨٤.

Forde ,B.G. and Clarkson, D.T. (١٩٩٩). Nitrate and ammonium nutrition of plants: physiological and molecular perspectives. Adv. Bot. Res. ٣٠: ١-٩٠.

Ge, X.G. (٢٠٠٢). Vegetable garden soil and fertilization Agriculture Press of China, Beijing. p. ٢١٢.

Jackson, M.L., (١٩٦٧). Soil Chemical Analysis. Prentice-Hall, India, pp: ١٤٤-١٩٧.

Kandlbinder**,** A.; Cruz, C. and Kaiser, W. M. (١٩٩٧), Response of primary plant metabolism to the N source. *Z. Pflanzenernähr. Bodenk*., ١٦٠, ٢٦٩-٢٧٤.

Klute, A. (١٩٨٦). Methods of Soil Analysis: part I. physical and mineralogical method (٢nd Ed.) Amer. Soc. Agron. Monograph No. ٩. Madison-Wisconsin. USA.

Ling, E. R. (١٩٦٣).Determination of total nitrogen by semi micro- kjeldahl method. Dairy Chem., ١١:٢٣-٨٤.

Lalitha, B.S., K.H. Nagaraj and T.N. Anand, ٢٠٠٢. Effect of source propagation, level of potassium and sulphur on potato (Solanum tuberosum L.). Mys. J. Agric. Sci., ٣٦: ١٤٨-١٥٣.

Marschner, H. (١٩٨٦). Mineral Nutrition in Higher Plants. Academic Press, Harcount Barace, Javonovish Publisher, pp.٦٧٤

Marschner, H. ١٩٩٥. Mineral nutrition of higher plants. ٢nd ed. Academic Press, London, UK. pp. ٢٢٩_٢٤٢.

Marschner H. and V. Römheld. ١٩٩٦. Root-induced changes in the availability of micronutrients in the rhizosphere. p. ٥٥٧-٥٧٩. In Y. Waisel, A. Eshel and U. Kafkafi, eds., Plant Roots: The Hidden Half. M. Dekker: New York.

Miller, G. L. (١٩٥٩).Use of dinitrosalicylic acid reagent for determination of reducing sugars. Anal.Chem.; ٣١:٤٢٦-٤٢٨.

Murphy,H.G.and M.J.Goven (١٩٥٩).Factors affecting the specific gravity of white potato in Main. Main Agric.Exp.Stat Bull.٥٨٣.

Nasreen, S., M.M. Haque, M.A. Hossam and A.T.M. Fand, ٢٠٠٧. Nutrient uptake and yield of onion as influenced by nitrogen and sulphur fertilization. Bangladesh J. Agric. Res., ٣٢: ٤١٣-٤٢٠.

Page, A. L.; R. H. Miller and D. R. Keeny (١٩٨٢). "Methods of Soil Analysis" part II. Chemical and microbiological properties (٢ndEd.) Amer. Soc. Agron. Monograph No. ٩. Madison-Wisconsin, USA.

Pandey, S.K. and Sarkar D. (٢٠٠٥) Potato in Indian emerging trend challenges in the new millennium. Potato J., ٣٢: ٩٣-١٠٤.

Pandey, S.K.; Marwaha R.S.; Kumar D.and Singh S.V. (٢٠٠٩). Indian potato processing story: Industrial limitation, challenges ahead and vision for the future. Potato J., ٣٦: ١-١٣.

Pate, J. S. (١٩٧٣), Uptake, assimilation and transport of nitrogen compounds by plants. *Soil Biol. Biochem*., ٥, ١٠٩-١١٩.

Pilbeam DJ.and Kirkby EA. (١٩٩٢). Some aspects of the utilization of nitrate and ammonium by plants. In: Mengel K, Pilbeam DJ (Eds.), Nitrogen Metabolism of Plants. Clarendon Press, Oxford pp. ٥٥-٧٠.

Romero, F.R, Taber, H.G.and Gladon, R.J. (٢٠٠٦). Nitrogen source and concentration affect growth and performance of bedding-plant impatiens. J. Plant Nutr. ٢٩: ١٣١٥-١٣٢٦.

Sánchez E.; Rivero RM.; Ruiz JM. and Romero L. (٢٠٠٤). Changes in biomass, enzymatic activity and protein concentration in roots and leaves of green bean plants (*Phaseolus vulgaris* L. cv. Strike) under high NH٤NO٣ application rates. Sci. Hortic. ٩٩: ٢٣٧–٢٤٨.

Snedecor, W.G. and G.W. Cochran, (١٩٨٠). Statistical Methods. ١٧th Ed., Iawa State Univ. Press, Ames,USA., pp: ٥٠.

Sud, K.C. and R.C. Sharma, ٢٠٠٢. Sulphur needs of potato under rainfed conditions in Shimla hills. In: Potato Global Research and Development, Khurana, S.M.P, G.S. Shekhawat, S.K. Pandey and B.P. Singh (Eds.). Vol.٢. Indian Potato Association, Shimla, pp: ٨٨٩-٨٩٩.

Teich, A.H. and J.A. Menzres. (١٩٦٤). NPK on specific gravity, ascorbic acid, and chipping quality of potato tubers. *Am. Potato J*., ٤١: ١٦٩-١٧٣.

Walch-Liu, P., Neumann, G.; Bangerth, F. and Engels, C. (٢٠٠٠). Rapid effects of nitrogen form on leaf morphogenesis in tobacco. J. Exp. Bot. ٥١:٢٢٧-٢٣٧.

Wang J.; Sun Xx, Shen Q, and Zhou, Y. (٢٠٠٥). Effects of some Replacement of nitrate by ammonium on the biomass yield and quality of spinach. Soil, ٣٧(٦): ٦٠٥-٦٠٨

Wang, J.; Zhou, Y., Dong,C.; Shen,Q.and Putheti,R.(٢٠٠٩). Effects of NH٤ +-N/ NO٣ --N ratios on growth, nitrate uptake and organic acid levels of spinach (*Spinaciaoleracea* L.). African Journal of Biotechnology ,٨ (١٥), pp. ٣٥٩٧-٣٦٠٢.

Wei GP.; Yang LF.; Zhu YL.and Chen G. (٢٠٠٩). Changes in oxidative damage, antioxidant enzyme activities and polyamine contents in leaves of grafted and non-grafted eggplant seedlings under stress by excess of calcium nitrate. Sci. Hortic. ١٢٠: ٤٤٣-٤٥١

Wiesler, F. (١٩٩٧), Agronomical and physiological aspects of ammonium and nitrate nutrition of plants.*Z. Pflanzenernähr. Bodenk*., ١٦٠, ٢٢٧-٢٣٨.

تأثير إضافة مصدرين للنيتروجين بنسب مختلفة على النمو والمحصول والجودة فى نبات البطاطس

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اجريت تجربة حقلية فى محطة بحوث القصاصين – محافظة الاسماعيلية خلال موسمي الزراعة ٢٠٠٩/٢٠١٠ و ٢٠١٠/٢٠١١ على نبات البطاطس صنف (نيكولا) لدراسة تأثير نسب مختلفة من مصادر الاسمدة النتروجينية (سلفات الامونيوم ونترات الامونيوم) وأضيفت بمعدل ثابت ١٤٠ كجم/ف على صفات النمو الخضري والمحصول القابل للتسوق وامتصاص النيتروجين والفوسفور والبوتاسيوم وجودة الدرنات ، صممت التجربة في قطاعات كاملة العشوائية بثلاث مكرارت. اشتملت التجربة علي ٥ معاملات كالاتى :

١٠٠% كبريتات الامونيوم.

٧٥١٠٠% نترات الامونيوم.

٧٥% كبريتات الامونيوم + ٢٥% نترات الامونيوم.

٥٠% كبريتات الامونيوم + ٥٠% نترات الامونيوم.

٢٥% كبريتات الامونيوم + ٧٥% نترات الامونيوم.

أخذت عينات نباتية ممثلة بعد ٧٥ يوم، و تم حصاد المحصول عند ١٢٠ يوم من الزراعة.

اوضحت النتائج أن تسميد النباتات بمخلوط الاسمدة النيتروجينية ادى إلى زيادة معنوية فى وزن الدرنات والمحصول مقارنة بالنباتات التى سمدت بمصدر واحد من النيتروجين .

وقد أعطى تسميد النباتات بالمعدل ٢٥% كبريتات امونيوم + ٧٥% نترات امونيوم أعلى مادة جافة ٢٤,٢%، , ومحصول كلي (١٣,٧٧ كجم/ف) وامتصاص للنيتروجين والفوسفور والبوتاسيوم، و أعلى محصول قابل للتسوق بنسبة (٨٦,٦%) ومحتوي الدرنات من النشا (٢٠,٧٥%) ومحتوى النيتروجين فى الورقة (٢,٠٥%) تليه المعاملة بـ ٥٠% كبريتات آمونيوم + ٥٠% نترات آمونيوم ، مقارنة بالتسميد بمصدر نتروجينى واحد. تبين أن التسميد النيتروجيني بمعدل ١٤٠ كجم للفدان وبمخلوط يحتوي عل ٢٥% سلفات آمونيوم مع ٧٥% نترات آمونيوم حقق زيادة في المحصول الكلي وصلت الى ١٧% ، و١١% مقارنة ب١٠٠% سلفات آمونيوم ، و ١٠٠% نترات آمونيوم على التوالي.

وجهت الدراسة النظر إلى الاهتمام بانتقاء نوعية مصادر التسميد النيتروجيني ونسب خلطها لمحصول البطاطس النامي في أراضي رملية.