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RESPONSE OF POTATO (*Solanum tuberosum* L.)YIELD TO ORGANIC AND INORGANIC MINERAL NITROGEN FERTILIZER RATES

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ABSTRACT

*In order to investigate the effect of organic and inorganic nitrogen fertilizer rates on growth, yield and tuber quality of potato (Solanum tuberosum L)**.** Two field experiments were accompanied through 2014 and 2015 seasons on a potato plant cv. Alpha This investigation included four farmyard manure rates (0, 5, 10 and 15 tons/ha) and four mineral nitrogen rates (80, 120, 160 and 200 kg N/ha).*

***Results revealed that** increasing farmyard manure rates up to 15 tons/ha meaning fully improved height of plant, dry weight g/plant and No. of tubers/plant, tuber weight g/plant, tuber yield t/ha. TSS%, tuber dry matter%, carbohydrate % and ascorbic acid* (mg/100g^{-1})*by 4.97, 17.84, 25.17, 18.64, 24.07, 8.62, 29.86, 6.89 and 14.35%, respectively, comparing without farmyard manure as average of both seasons. Whereas, increasing mineral nitrogen rates up to 200 kg N/ha. significantly increased plant height, dry weight g/plant and No. of tubers/plant, tuber weight g/plant, tuber yield t/ha, TSS%, tuber dry matter%, carbohydrate % and ascorbic acid* (mg/100g^{-1})*by 4.26, 4.75, 8.85, 5.66, 12.59, 5.73, 8.43, 11.0 and 5.67%, respectively compared with fertilizing at 80 kg N/ha. as an average of both seasons. The highest yield/ha was produced due to the interaction by application of highest both of farmyard manure rate (15 ton/ha.) and mineral nitrogen rate (200 kg N//ha.).*

***Conclusively,** it possibly will be recommended that increasing farmyard manure to 15t/ha. and mineral nitrogen rate to 200 kg N/ha.for potato plants out yielded by 28.4 % more than without farmyard manure and addition 80 kg N/ha.*

Key words: Potato, Farmyard manure**,** Mineral nitrogen**,** Tuber yield and its quality, Organic, Fertilizers**.**

INTRODUCTION

Potato is the industrial significant crop to the human consumption in Egypt and the world. Potato is an international food and industrial crop. Potato is a preferred crop and observed as one of the very imperative vegetable crops for human food. Potato is documented as a major of the best vegetable crops for both native feasting and exportation. In order to decrease soil pollution with nitrogen fertilization and to study the assess of its competence of organic and inorganic nitrogen fertilizer alone or in combinations. Potato plays a significant financial character as a food and an economic crop by potato imported by other countries (Pervez *et al.*, 2000).Deferent investigators consume exposed that inorganic nitrogen know how to enhanced parameters, of vegetative growth such as height of plants, tuber numbers, tuber weight/plant and tuber yield/ha (Kumar *et al*., 2007; Sincik *et al*., 2008; Zelalem *et al*., 2009).

The suitable fertilization of inorganic nitrogen might mainly to achievement of better growth and reflected improvement in tuber yield/ha. The extreme use of inorganic nitrogen fertilizer can principal to enhanced growth somewhat of tubers manufacture and postponement potato maturity (Love *et al*., 2005; Kumar *et al*., 2007) and reduces tuber quality (Zebarth and Rosen, 2007). Likewise, Ahmed et al. (2009) designated that growth parameters, yield of tuber/ha, percentage of marketable tubers and tuber quality were prejudiced by dissimilar levels of inorganic nitrogen fertilizer. Bashir and Qureshi (2014) decided that nitrogen fertilization at rate of 180 kg/ha inorganic fertilizer beside 24 ton/ haorganic fertilizer were produced maximum tuber yield/ha. Nitrogen, phosphorus and potassium concentrations in tubers were improved by increasing levels of organic and inorganic fertilizer. Moreover, organic and inorganic fertilizer application were improved the quality of potato.

Inorganic fertilizer application at the rate of N180, FYM 24/h was recorded the maximum carbohydrate, crude protein and ascorbic acid.Ahmed *et al*. (2015) stated that maximum of tuber yield in ton/fed^{-1}, tubers numbers per plant and percentage of marketable tubers were produced from nitrogen using of organic manure at rate of 20 m^3/fed. Fertilization using inorganic fertilizer at the rate of N 210 kg/ha as ammonium nitrate in both seasons, whereas, the highest values of specific gravity, percentages of starch and dry matter were produced from application of organic fertilizer at the rate of 20 m^3/fed beside fertilization using ammonium nitrate at the rate of 120 N/fed. in both seasons.

Therefore, the study was initiated with the major aims of investigation the efficiency of mineral nitrogen and organic fertilizers rates as organic fertilizer rates alone or in mixtures with organic fertilizer on the growth, yield of tuber/ha and its quality.

MATERIALS AND METHODS

1.*Research time and location*:

Two field experiments were achieved in the extension field in Mit-Anter village, Dakahlia Governorate, Egypt during 2014 and 2015 seasons on potato plant cv. Alpha. This study included four farmyard manure treatments, i.e. 0, 5, 10 and 15 tons/ha., four mineral nitrogen rates, i e.80, 120, 160 and 200 kg/ha from inorganic nitrogen were used. The soil samples randomized were recorded from the experimental site before planting at the depth of 0 - 30 cm to estimate the physical and chemical properties rendering to standard method labelled by Jackson (1967). Soil is loamy clay with pH 8.2 and 8.4, organic matter was 1.86 and 1.75%, available nitrogen was 149.8 and 146.3 mg/100g soil for the first and second season, respectively. Experiments with four replicates were organized in a randomized complete block using split plot design. Four farmyard manure treatments, i.e. 0, 5, 10 and 15 tons/ha., were arranged randomly in the main plot, and the four mineral nitrogen rates, i.e. 80, 120, 160, and 200 kg/ha from inorganic nitrogen were assigned in the sub-plot. Chemical analysis of farmyard manure was shown in Table 1.Tuber seeds were sown at 25 cm apart on January 5th and 9th during the 1st and 2nd seasons, respectively. The area of experimental unit was 12.6 m^2. Each unite consisted of three rows with 6 m long and 70 cm diameter between the two rows. One row was used to measure the dry weight of different organs/plant and plant chemical analysis and the other two rows were used for yield determinations.

Table 1. Chemical analysis of farmyard manure.

Ec (ds/m-1)	pH	N%	P%	K%	Zn ppm	Fe ppm	Cu ppm	Organic matter%	Moisture
4.5	9.5	2.24	0.37	2.93	78	1790	62	21.5	16.8

2.*Agricultural practices:*

Experimental site was well arranged through ploughing two times then, ridging and detachment and alienated into the experimental units. The

farmyard manure treatments were added at above mentioned rates during soil preparation. During soil preparation calcium superphosphate (15.5 % P_2O_5) was incorporated at the recommended level of 240 kg/ha. Also, potassium sulphate (48% K_2O) as a source of potassium was applied during soil preparation at the recommended level of 120 kg/ha. Ammonium nitrate (33.3 % N) as inorganic nitrogen was added at the above rates in the form of. The amount of mineral nitrogen was distributed into two equal parts and applied during preparing the soil for planting, then 45 days after sowing, respectively. In addition, the other agricultural practices for planting potato plants were followed using the commendations of the Agriculture Ministry, except the studies factors in the experiment.

3.*Studied traits:*

Vegetative growth as plant height and plant shoot fresh and dry weight was determined after 70 days from planting.1-Plant height.2-Foliage dry weight g/plant: Total foliage of dry matter was dried the oven at 70°C till continuous weight. At harvest time, after 115 days plants were harvested from the three middle ridges from each plot and data were recorded 3-Number of tubers/plant.4-Average of tuber weight (g/plant).5-Total tuber yield (ton/ha.$^{-1}$).Quality parameters analyzed included, 6- Total soluble solids (TSS %) in tubers was determined using by refractometer according to (AOAC, 1990). 7-Tuber dry matter %: Dry matter was strong minded by drying small pieces of tubers at 80°C for 72 hours in an oven where the tuber dry weight% = (tuber dry weight at 80 °C /tuber fresh weight) *100. 8-Specific gravity %: It was determined according to the methods of Dinesh *et al*. (2005) by the formula: Specific gravity = The tuber weight in air/The tuber weight in air – the tuber weight in water. 9-Carbohydrate %: Carbohydrates were determined as described by the method of Hodge and Hofreiter (1962), 10-Ascorbic acid mg/100g^{-1}: calorimetrically using 2-4 dinitro phenyl hydrazine method (Anonymous, 1990) for estimating Ascorbic acid of potato tuber.

2.4. *Experimental analysis:*

Data of both seasons was obtained tabulated for technique of analysis of variance (ANOVA) and statistically analyzed using the split-plot design to each experiment (row spacing), then combined analysis was completed between row spacing trails as published by Gomez and Gomez (1991) by using "MSTAT-C" computer software package developed by Russel (1986). For test the differences between treatment means at the 5 % level of

probability using the least significant difference (LSD) method according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1. ***Farmyard manure rates effects:***

Results accessible in Tables (2 and 3) clearly indicated that increasing farmyard manure rates significantly affected height of plant, dry weight g/plant and No. of tubers/plant, tuber weight g/plant, tuber yield t/ha, TSS%, specific gravity %, tuber dry matter%, carbohydrate % and ascorbic acid mg/100g^{-1} in both growing seasons. Results revealed that increasing farm yard manure rates up to 15 tons/ha was produced the tallest plants, dry weight g/plant and No. of tubers/plant, tuber weight g/plant, tuber yield t/ha., TSS%, tuber dry matter%, carbohydrate% and ascorbic acid mg/100 g^{-1}by 4.97, 17.84, 25.17, 18.64, 24.07, 8.62, 29.86, 6.89 and 14.35%, respectively comparing without farmyard manure as average of both seasons. Enhancement of potato plants growth parameters of as influenced by application of inorganic nitrogen fertilizer may be accredited to organic nitrogen fertilizer had inorganic nitrogen fertilizer and thus these characters was improved by the addition of organic nitrogen fertilizer. Adding the organic nitrogen fertilizer comprises other nutrients which are indispensable for plant growth and their tissues. The lack of tissue content of nutrients limits their potential growth. Consequently, the organic nitrogen fertilizer shows an important character in improving these trails by nitrogen fertilization. This might due to that organic fertilization as manure included most needed elements for growth; as a result, metabolic function is controlled and reflecting the better synthesis of carbohydrate, protein and fats. Similar results were recorded by of Mahmoud *et al.* (2003) and Singh *et al,* (2008). It could state that the improvement of tuber yield might attributed to increases in tuber numbers/plant due to added the important elements and enhancement the physic-chemical soil characters (Khan *et al.*,2000). Similarly, results were produced by several investigatorswere reported by Bashir and Qureshi (2014) and Ahmed *et al*. (2015).

2. ***Mineral nitrogen rates effects:***

Concerning to inorganic nitrogen fertilizer rates effect on plant height, dry weight g/plant and No. of tubers/plant, tuber weight g/plant, yield tubers per hectare., TSS%, dry matter percentage of tuber specific gravity%, carbohydrate % and ascorbic acid mg/100g^{-1}in both of 2014 and 2015 seasons, the results in Tables (2 and 3) clearly revealed that mineral nitrogen

rates significantly affected these characters. Results revealed that mineral nitrogen rates up to 200 kg N/ha significantly increased plant height, dry weight g/plant and No. of tubers/plant, tuber weight g/plant, tuber yield t/ha., TSS%, tuber dry matter%, specific gravity%, carbohydrate % and ascorbic acid mg/100 $g^{-1}$by comparing with other mineral nitrogen rates. It could be noticed that increasing mineral nitrogen rates up to 200 kg N/ha. significantly increased plant height, dry weight g/plant and No. of tubers/plant, tuber weight g/plant, tuber yield t/ha., TSS%, tuber dry matter %, carbohydrate % and ascorbic acid (mg/100 g^{-1}) by 4.26, 4.75, 8.85, 5.66, 12.59, 5.73, 8.43, 11.0 and 5.67%, respectively compared with fertilizing at 80 kg N/ha. as an average of both seasons. Application of inorganic nitrogen to potato showed an increase in the value of tuber yield components. Sud *et al.* (1992) concluded that quality attributes in potato were improved due to increasing rates of inorganic nitrogen fertilizer. Increases in tuber yield might be due to causes the supplied with organic nitrogen fertilizer which had higher potassium percentages, suggesting that these have engrossed more potassium which had frolicked an improved character in carbohydrate synthesis, starch break down, synthesis of proteins and neutralization of physiologically important organic acids results in higher quality tuber. Zelalem *et al.* (2009) concluded that the significant increases in both total and marketable tuber yields/ha happened only from the inorganic nitrogen fertilization at the level of 138 kg N/ha. Jamaati-e-Somarin *et al.* (2010) quantified that on the substances of inorganic nitrogen fertilizer at the rate of 200 kg N/ha productivity of potato yield was lower, by 23% and 18% compared with those fertilized with inorganic nitrogen at rate of 160 and 80 kg N/ha., respectively. Kołodziejczyke (2014) concluded that fertilization using nitrogen at a rate of 180 kg N/ha produced a noticeable increase in both of the yield of marketable tuber, the average weight of the tuber and share of commercial and large tubers in total yields/ha.

3. *Interaction effects:*

The results clearly showed that the interaction among organic and inorganic nitrogen fertilizer rates insignificantly affected on height of plant, dry weight g/plant and No. of tubers/plant, tuber weight g/plant, TSS%, tuber dry matter%, specific gravity%, carbohydrate % and ascorbic acid mg/100g^{-1}in both of 2014 and 2015 seasons (Tables 2 and 3). The results clearly showed that the interaction among organic and inorganic nitrogen fertilizer rates significantly affected on tuber yield t/ha. in both growing seasons (Tables 2 and 3).

The results graphically illustrated in Figures 1 and 2 clearly showed that the interaction amongorganic and inorganic nitrogen fertilizer ratessignificantly affected on tuber yield t/ha. (33.480 t/ha.) in the first season and tuber yield t/ha. (32.912 t/ha.) during the second season. The highestyield/ha. was produced byapplication of highest farmyard manure rates (15 ton/ha.) and highest nitrogen rate (200 kg N//ha.).

However, the lowest tuber yield t/ha was obtained from without organic nitrogen manure fertilization and lowest nitrogen fertilization 80 kg N/ha.Asghari and Alizade Fard(2015) concluded that application of inorganic fertilizer at a rate of 40 t/ha. and inorganic nitrogen fertilizer at a rate of 200 kg/hawere producedthe maximum weight of tubers(97.44 g), and the average of tuber yield (40080 kg). These results clearly showed that it is essential and inevitable to use organic nitrogen fertilizerfor achieving the highest performance.Organic fertilization at a rate of 20 m^3/fed. besidefertilization of inorganic nitrogen fertilizer using ammonium nitrate form at a rate of 210 kg/fed enhancedand recorded the tallest plants, the heights number of stems/plant, number ofleaves/plant,leaf area/plant, leaf chlorophyll content,leaves fresh weight, shoots fresh weight,whole plant fresh weight, both dry weight of leaves and shoots and whole plant dryweight (Ahmed *et al* 2015). Bashir and Qureshi (2014) concluded that application of 180 kg N ha^{-1} along with 24 t FYM/ha gave significantly higher yield. Addition of N and FYM significantly enhanced the quality of potato.

The maximum of carbohydrate and ascorbic acid were decreased using the fertilization of inorganic nitrogen at a rate of 180 kg N/haand both organic nitrogen at a rate of 24 tonsFYM/ha.Ahmed *et al.* (2015)stated thatmaximum of tuber yield (ton/fed.), number of tubers/plant and percentages of marketable tubers wereobtained from organic nitrogen at a rate of 20 m^3/fed.In addition, fertilization using inorganic nitrogen fertilizer as ammonium nitrate at the level of 210 N kg/fed in both seasons while the highest values of specific gravity, carbohydrates and dry matter percentage were observed with the application of farmyard manure at the level of 20 m^3/fed. along with ammonium nitrate at the level of 120 N kg/fed in both seasons.

Conclusively, it could be concluded that increasing farmyard manure up to 15t/ha. and mineral nitrogen rate of 200 kg N/ha. out yielded by 28.4 % more than without farmyard manure and addition of 80 kg N/ha.

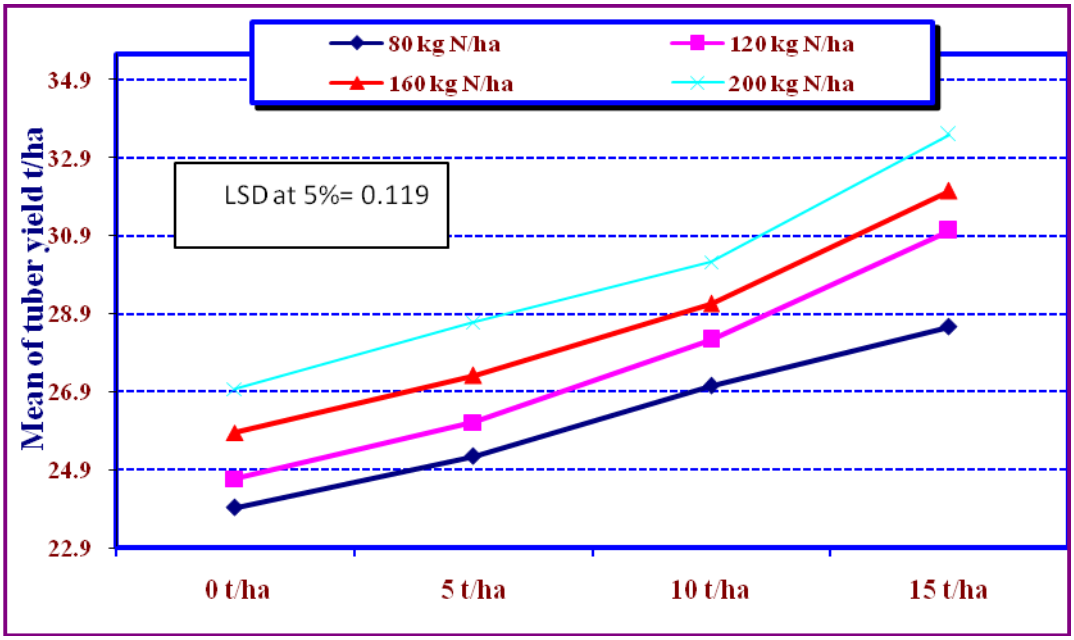

Figure 1: Mean of tuber yield t/ha. as affected by the interaction between farmyard manure and mineral nitrogen rates during 2014 season.

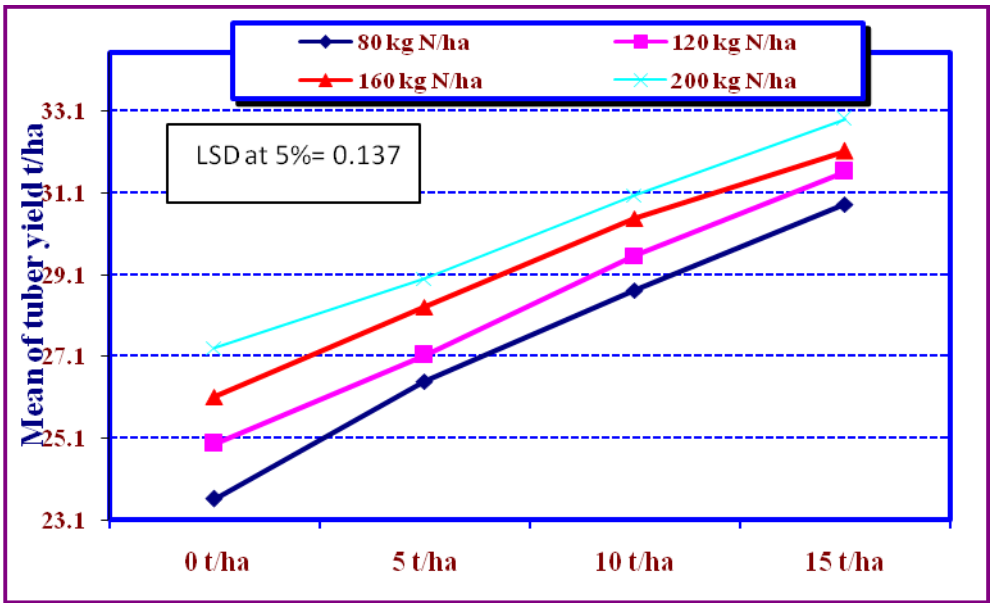

Figure 2: Mean of tuber yield t/ha. as affected by the interaction between farmyard manure and mineral nitrogen rates during 2015 season.

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إستجابة محصول نباتات البطاطس لمعدلات السماد العضوي وغيرالعضوي"النتروجين المعدني"

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أجريت تجربةحقليةخلال موسمي ٢٠١٤،٢٠١٥على نباتات البطاطس صنف ألفا بهدف دراسة تأثيرالسماد العضوي وغير العضوي (النتروجيني)على النمو والمحصول والجودة في البطاطس وتكونت التجربة من اربعة معدلات من السماد العضوي هي (صفر ، ٥ ، ١٠ ، ١٥ طن / هكتار والتي تمثل القطع الرئيسية وأربعة معدلات من السماد الغيرعضوي (النتر وجين المعدني) وهي: (٨٠ ، ١٢٠ ، ١٦٠ ، ٢٠٠ كجم نتروجين / هكتار) والتي تعبر عن القطع تحت الرئيسية والتجربة في أربعة مكررات وصممت التجربة بنظام القطع المنشقة.

وكانت أهم النتائج التى تم الحصول عليها كما يلي :

- بزيادة معدلات السماد العضوي حتى معدل ١٥ طن / هكتار كانت هناك زيادة معنوية في صفات ارتفاع النبات(سم)،الوزن الجاف / نبات جم ،عدد الدرنات على النبات،وزن الدرنات / النبات جم ،محصول الدرنات (طن/ هكتار)وكل من المادة الصلبة الذائبة الكلية%، المادة الجافة للدرنات%، الكربوهيدرات% وحمض الأسكوربيك(مجم/١٠٠ جم$^{-1}$) بنسبة ٤,٩٧% ، ١٧,٨٤% ، ٢٥,١٧% ، ١٨,٦٤% ، ٢٤,٠٧% ، ٨,٦٢% ، ٢٩,٨٦% ، ٦,٨٩% و ١٤,٣٥% مقارنة بعدم إضافة السماد العضوي خلال الدراسة.

-كما وجد أنه بزيادة معدلات النتروجيني المعدني حتى ٢٠٠ كجم نتروجين / هكتار كانت هناك زيادة معنوية في كل من الصفات الآتية : إرتفاع النبات (سم)، الوزن الجاف/النبات جم، عدد الدرنات / النبات، وزن الدرنات / النبات (جم)، محصول الدرنات(طن/ هكتار) بالإضافة إلى كل من المادة الصلبة الذائبة الكلية%، المادة الجافة للدرنات%، الكربوهيدرات%،حمض الإسكوربيك (مجم/١٠٠ جم$^{-1}$)، كانت هناك زيادة معنوية على الترتيب كما يلي :٤,٢٦ % ، ٤,٧٥% ، ٨,٨٥% ، ٥,٦٦% ، ١٢,٥٩% ، ٥,٧٣% ، ٨,٤٣% ، ١١%و٥,٦٧% مقارنة بالتسميد بمعدل ٨٠ كجم نتروجين معدني / هكتار كمتوسط لكلا الموسمين .

التوصية: وجد ان أعلى محصول يمكن الحصول عليه تحت ظروف هذه التجربة كان بإضافة أعلى معدل سمادالعضوي (١٥ طن / هكتار) مع إضافة أعلى معدل نتروجيني معدني (٢٠٠كجم نتروجين/ هكتار) وكانت الزيادة بمعدل ٢٨,٤% مقارنة بعدم إضافة السماد العضوي مع إضافة معدل٨٠ كجم نتروجين معدني/هكتار.