



Effect of Organo-nitrogen Fertilization on N-uptake and Growth Yield of Potatoes using ^{15}N

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Authors' contributions

This work was carried out in collaboration between both authors. Author AM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author MMI managed the analyses of the study and also managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Fertilization is an important and limiting factor for growth and tuber production of potatoes crop because plants non adsorption amounts of nutrients from the soil. Data obtained the tea compost spray or tea compost fertigation single or mixed with mineral-N. Resulted in grand mean the highest tuber yield of potatoes tea compost methods, the value of tuber yield value (42.34 tan ha⁻¹) which relatively increased by about 15.68%, 11.31% over the untreated addition compost to soil and tea compost fertigation. Also data show that grand mean the highest shoot dry weight of potatoes foliar compost tea methods, the value of tuber yield value (4.79 tan ha⁻¹) which relatively increased by about 41.54%, 24.43% over the untreated addition compost to soil and tea compost fertigation. Also data show under methods, fertigaion compost tea, with treatment 50% compost tea+ 50% mineral – N seems to be the best ones in nitrogen uptake by tuber potato plant (131.24 kg ha⁻¹). the compost tea fertigation, % Ndff, Ndfcompost in tuber was much higher for tea compost fertigation (57.74 kg ha⁻¹), (56.62 kg ha⁻¹) than for compost tea foliar methods (50.21 kg ha⁻¹), (51.84 kg ha⁻¹) and compost addition to soil (33.02 kg ha⁻¹), (27.82 kg ha⁻¹) respectively. The percentage nitrogen use efficiency (%NUE) by tuber ranged from %9.17 to %16.27 due to (MA1)+R2 and 100 % MF, respectively.

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1. INTRODUCTION

Fertilization is one of the most expensive agricultural productions and that provides higher economic return practices [1]. Foliar spraying complements the soil fertilization and is used when a given plant needs to recover quickly, in most cases of nutrient deficiencies. The fertigation method is another technique that allows the application of fertilizers. This technique enables the application of nutrients mixed with the irrigation water, ensuring uniform distribution of nutrients on the area, labor saving and high efficiency of nutrients utilization, allowing also the fertilizer to be applied in the region with higher concentration of roots, besides better fractionation of doses [2]. The use of fertilizers in liquid form via foliar spraying or fertigation is increasing in agriculture. Despite this increase, this practice is still considered new in agriculture, making it necessary the evaluation of the products available in the market for the correct indication of the best doses and application methods [3]. Potato (*Solanum tuberosum* L.) is grown in Egypt on a large area and is classified as the first vegetable crop for export and the domestic market. Potato is one of the most important export vegetable crops in Egypt and the second most important vegetable crop after tomato in economic value. Egypt is one of the 20 largest producer of potatoes all over the world and the top largest producer in Africa [4]. A total production of 4.8 million tons year⁻¹, including 637,434 ton for exportation with a market value of 250 million USD. About 19% of total area devoted for vegetable production is cultivated with potato [5]. Nowadays, potato cultivation is facing several challenges to maintain and improve production, from the point of view of both quality and quantity. The aim of the present study was to investigate the effect of organo- nitrogen fertilization on N-uptake and growth yield of potatoes grown on sand soil with application of ¹⁵N tracer technique.

2. MATERIALS AND METHODS

A field experiment was carried out at the Soils and Water Res. Dept., Nuclear Res. Center, Inshas, Egypt, on potato plants using the materials described below. physical and chemical properties of used sandy soil were 88.5% sand, Silt 2.7%, and 8.8% clay, EC(dSm⁻¹)0.27, pH(1: 2.5) 7.97, organic carbon %0.017,

organic matter%0.03, total nitrogen %0.007, carbon / nitrogen ratio 2.43, Calcium CO₃ %1.0. Tubers of potato cultivar (*Solanum tuberosum* L) (Burn), supplied by the Agric Res Centre (ARC), Giza, Egypt were used in the experiments carried out through the study. Tuber Burn plant was sown on 27th of January in seasons 2018 and spaced at 20 cm, deep 15 cm apart. The chemical properties of the analyzed compost used are PH (1: 5)6.70, EC ds/m12.70, carbon / nitrogen ratio12.62, organic matter %56.89, total nitrogen %2.83, Phosphors %0.84, and potassium % 0.692. Compost tea was obtained by extraction from a one-day compost treatment for a period of 90 days. The chemical properties of compost tea the used investigated were EC ds/m18.80, PH (1:5) 6.40, carbon / nitrogen ratio10.15, organic matter % 57.02, total nitrogen % 3.13; Phosphors % 0.51, potassium %1.617. A field experiment was carried out where the experimental was complete randomized block design with three replicates. The drip irrigation occupied the main plots. The experiment included (13 treatments of potato Burn) each 9 treatments of 3 replicate (1 treatment 360 kg ha⁻¹ Mineral fertilizer (ammonium nitrate as control), 1 treatments 360 kg ha⁻¹ organic manure (compost or tea compost) and 1 treatments 180 kg ha⁻¹ organic manure (compost or tea compost) + 180 kg ha⁻¹ Mineral fertilizer (ammonium nitrate) and three methods i compost applied to soil, ii tea compost fertigation, iii tea compost spray. Nitrogen, Phosphorus and Potassium were applied to each treatment (4 x 10 m²) at the rate of 360 kg ha⁻¹ as organic manure (compost tea or compost) or Mineral fertilizer (ammonium nitrate), 180 kg ha⁻¹ as phosphoric acid and 230.4 kg ha⁻¹ as potassium sulfate, respectively. Ammonium nitrate 15N (3% excess of 15N atom) was added as a source of mineral nitrogen (ammonium nitrate) in solution form (three periods) 18,30,50 days after cultivation. Dry weights of whole plants and different plant parts were recorded, total nitrogen measurement, Nitrogen derived from fertilizer (% Ndff), Nitrogen derived from soil (% Ndfs), Nitrogen derived from organic compost (% Ndf comp) and fertilizer use efficiency % FUE were calculated according to Training course series No 14,IAEA [6]. Potato crop harvested after 115 day and cut of shoots and tuber were dried at 70°C, weighed and digested.

Physical and chemical analyses of tested soil samples were determined according to Black [7] and Page [8].

Statistical analysis: Analysis of variance was determined an obtained data.

3. RESULTS AND DISCUSSION

Production yield tuber of potato plant as affected by compost and compost tea additions was presented in graphically illustrated by Fig (1). In this regard, yield tuber of potato was positively affected by compost or tea compost and mineral fertilizer treatments. Results showed that addition compost to soil alone none significantly increased tuber yield of potatoes compared other application to method, tea compost spray or compost tea fertigation single or mixed with mineral-N. Resulted in grand mean the highest tuber yield of potatoes foliar compost tea methods, the value of tuber yield value (42.34 tan ha⁻¹) which relatively increased by about 15.68%, 11.31% over the untreated addition compost to soil and compost tea fertigation. On the other hand, 100% MF resulted in slight by lower tuber yield values as compared with the corresponding ones. Also data show that the combination of compost or tea compost and mineral fertilizer (half +half) where the tuber yield was enhanced with compost or tea compost and the highest grand mean (45.86 tan ha⁻¹). When compared with organic treatment alone (31.25 tan ha⁻¹) or mineral nitrogen alone (37.30 tan ha⁻¹).

In our study the crop organs remained relatively constant by the internal Nitrogen concentration (significant differences) regardless of whether there was optimal or deficient Nitrogen available, the variation in plant uptake proved to depend on the utilization efficiency of the plant to develop biomass with an increasing supply of Nitrogen and methods application. Therefore, the increase in tuber production due to foliar compost tea methods and higher N- mineral or organo applications in Optimal and deficient Nitrogen situations was due to greater crop biomass development, generating more synthesis and translocation of photosynthates from the foliage to the tubers [9]. On the other hand, optimal and another methods Nitrogen availability conditions have proven to cause a decrease in potato crop yields (Morales et al. 2013) and may also have detrimental effects on tuber quality and the environment [10,11].

Methods of Addition (MA): Compost addition to soil (MA1), compost tea fertigation (MA2), compost tea foliar (MA3).

Rate of addition nitrogen (R): 100% compost (R1), 50% compost or compost tea + 50% mineral -N(R2), 100 % mineral -N (100% MF). Data in Fig (2) show that shoot dry weight of potatoes plant as affected by addition compost or tea compost and mineral -N. shoot dry weight of potatoes significantly increased by addition

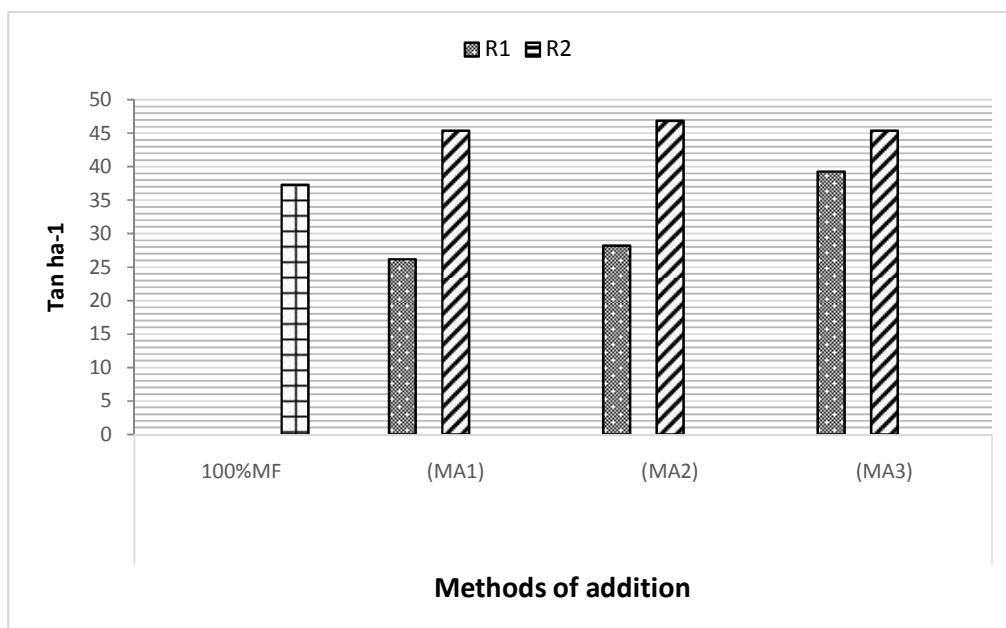


Fig. 1. Effect of organic manure and N- mineral on tuber of potato tan ha⁻¹

50%compost or tea compost plus 50% mineral – N . The rate of increase shoot dry weight of potatoes plant due to compost or tea compost mixed with mineral –N was 4.09,4.03 and 3.39 tan ha⁻¹ at the treatment 50% organic manure as compost or tea compost + 50% mineral – N ,100% mineral – N, and 100% compost or tea compost respectively. Addition compost to soil under all treatment compost or tea compost with mixed with mineral -N There is no significant increase compared to the other method, tea compost spray or tea compost fertigation under rate of compost or tea compost alone or combination with mineral –N. data also show that grand mean the highest shoot dry weight of potatoes tea compost spray methods, the value of tuber yield value (4.79 tan ha⁻¹) which relatively increased by about 41.54% ,24.43% over the untreated addition compost to soil and tea compost fertigation.

Fontes et al. [12], found that the high rate of Nitrogen application handicapped the emergence and further development of plant.

Nitrogen absorption by the tuber potato plant was greatly improved by tea compost or compost and mineral –N in Fig (3) data in grand main of rate nitrogen addition organic or mineral-N effected On nitrogen absorption by potato tubers addition rate 50% compost or tea compost + 50%mineral –N increased nitrogen uptake by tuber potatoes

under all methods as comparing to other rate. Under methods fertigaion tea compost, with treatment 50% compost tea+ 50% mineral –N seems to be the best ones in Nitrogen uptake by tuber potato plant (131.24 kg ha⁻¹). The lowest nitrogen uptake value was recorded by tubers with 100% compost. Spray tea compost method increased nitrogen absorption by tuber over those recorded with compost tea fertigation, compost addition to soil accumulated 124.14 ,109.37,100.55 kg ha-1 respectively.

A crop is total dry matter production and kg of N absorbed can be used to calculate the internal nitrogen requirement for that crop [13].

Tuber number per plant has been shown to increase, decrease or to be unaffected by N fertilization [14]. Tuber yield is responsive to fertilizer N addition in almost all cases [15]. Fertilizer N application increases yield primarily though an increase in tuber mass [16].

N uptake by shoots potato plant in Fig. (4) Data show that enhanced N uptake by shoot. It was apparently with the treatment tea compost spray as compared to other method. Under rate of nitrogen amendment to soil, the treatment compost tea plus mineral –N induced high and the best nitrogen uptake by shoots compared other to be completely fertilized with organic or mineral –N.

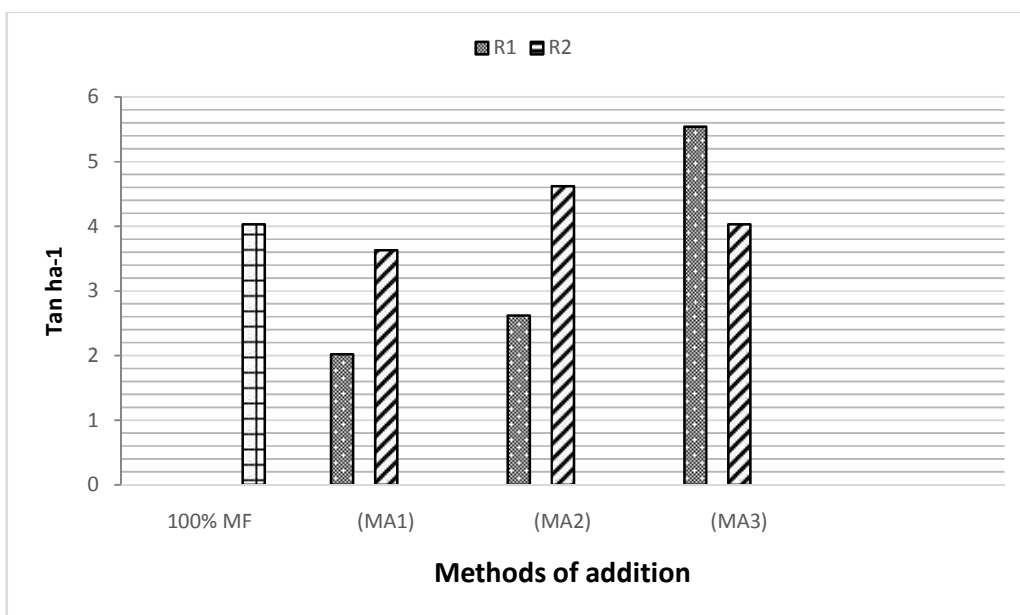


Fig. 2. Effect of organic manure and N- mineral on shoot dry matter of potato tan ha⁻¹

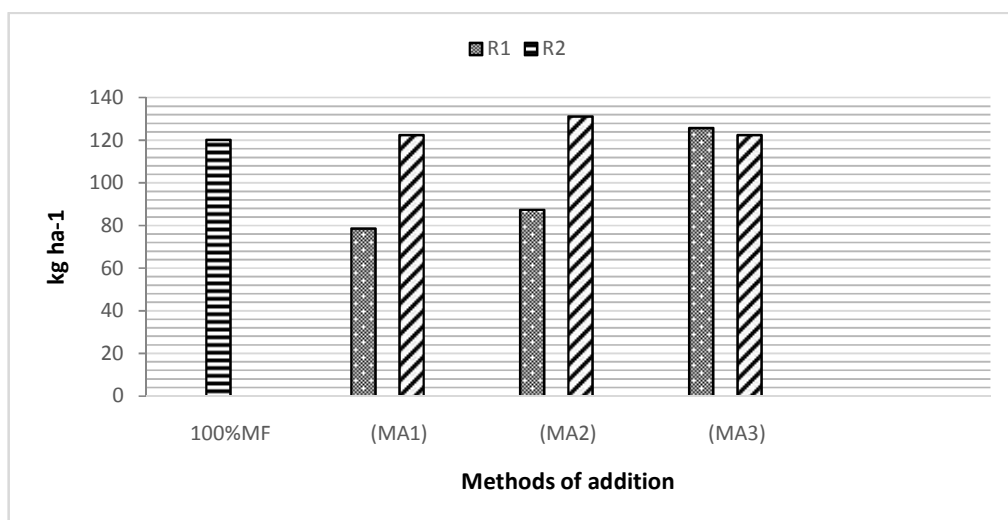


Fig. 3. Effect of organic manure and N-mineral on N uptake kg ha⁻¹ of tuber potato

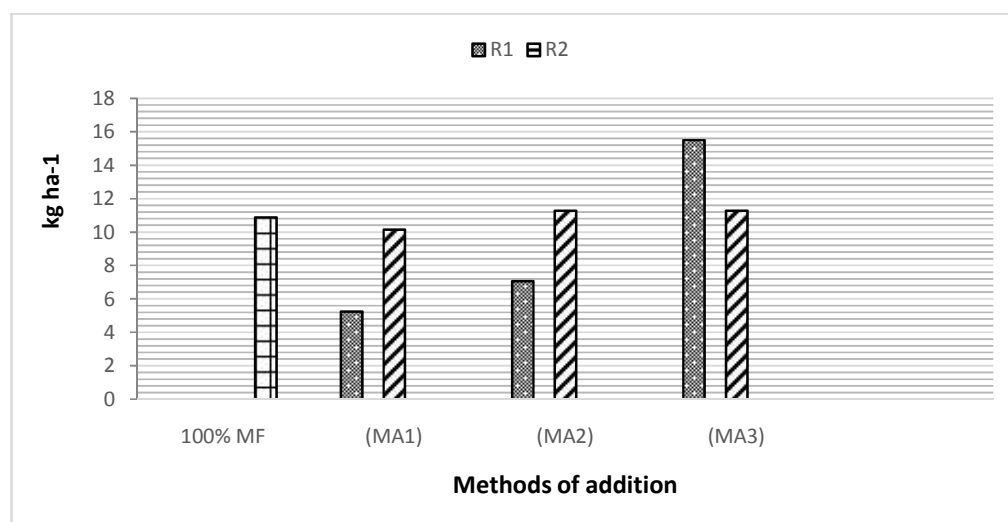


Fig. 4. Effect of organic manure and N-mineral on N uptake kg ha⁻¹ of shoot dry weight potato

Table 1. Effect of organic manure and N- mineral on Ndff, Ndffcompost kg ha⁻¹ and % NUE of potato varieties

Source of applied nitrogen (R)	Methods of addition compost or compost tea (MA)							
	Tuber				Shoot			
	Ndff kg ha ⁻¹				Ndffcompost or compost tea kg ha ⁻¹			
	(MA1)	(MA2)	(MA3)	Mean	(MA1)	(MA2)	(MA3)	Mean
(R2) 100%M F	33.02	57.74	50.21	46.99	33.6	45.12	32.88	37.20
	Ndffcompost or compost tea kg ha ⁻¹							
(R2)	27.82	56.62	51.84	45.43	43.15	31.92	48.96	41.34
	%NUE							
(R2) 100%M F	9.17	16.04	13.95		9.33	12.53	9.13	
	16.27				13.33			

Also, nitrogen mineralized from sources organic of soil could be more relevant than the type of fertilizer applied in the nitrogen availability in soil during season growing of the plant, being a determining factor to consider in fertilizer strategies. Agroecosystems to avoid N losses [17].

Nitrogen derived from fertilizer (%Ndff) nitrogen derived from compost (% Ndfcompost) in tuber potatoes higher than these recorded with shoots, also mean of rate of 50% mineral -N combination with 50% compost or compost tea greater than those for treatment compost addition to soil table (1) data show the compost tea fertigation, %Ndff, Ndfcompost in tuber was much higher for compost tea fertigation (57.74 kg ha⁻¹), (56.62 kg ha⁻¹) than for compost tea foliar methods (50.21 kg ha⁻¹), (51.84 kg ha⁻¹) and compost addition to soil (33.02 kg ha⁻¹), (27.82 kg ha⁻¹) respectively. The percentage nitrogen use efficiency (%NUE) in tuber of potato was higher compared than those recorded with shoots under all treatment and methods. (%NUE) by tuber ranged from %9.17 to %16.27 due to (MA1)+R2 and 100 % MF, respectively. Improving nitrogen use efficiency is especially important for potato plants because of their relatively low ability to take up available soil mineral nitrogen [18]. Furthermore, it is important to investigate the potato nitrogen uptake efficiency and risks of N fertilizer application before and at planting, considering the efficacy of these timing strategies in minimizing N losses [19]. Therefore, we propose that it is necessary to validate the parameters for the reasoned fertilization of potato crops (*Solanumtuberosum L.*) under the dryland conditions of the Valdivia agro-ecosystem. Kumar et al. [9] Found that the increase in total tuber yield due to higher N applications in deficient and optimal N situations was due to greater crop biomass development, generating more synthesis and translocation of photosynthates from the foliage to the tubers.

Three N availability situations were established (deficient, optimal and supra-optimal), where the behavior of the evaluated parameters allowed us to estimate when the N use efficiency of potato crops decreased due to excess fertilization, causing excessive increases in the residual N in an soil [20]. Kołodziejczyk [21] determined that each increase in the rate of nitrogen fertilization caused a decrease in the N use efficiency.

4. CONCLUSION

Data show that grand mean the highest tuber yield of potatoes foliar compost tea methods. the compost tea fertigation, %Ndff, Ndfcompost in tuber was much higher for compost tea fertigation compared to compost tea foliar methods. The percentage nitrogen use efficiency (%NUE) by tuber ranged from %9.17 to %16.27 due to (MA1)+R2 and 100 % MF, respectively.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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