A Comparative Between Effect of Mineral Nitrogen Fertilizer and Nanotechnology Fertilizers on The Plant Growth, Yield And Yield Component of Potato

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ABSTRACT
Two field experiments were conducted during the summer season of 2015 and 2016 at EL-Nobaraya Region 71km, Alex-Cairo desert road, at Chipy Company farm in Beheira Governorate. This investigation aimed to study the comparison between the effect of mineral nitrogen fertilizer and nanotechnology fertilizers on the plant growth, yield, and yield component of potato. That there were no significant among cultivars for the number of shoot character weights of tuber/plant (kg) and the number of tuber/plant during two years but there were significant differences among the examined two cultivars for plant length, dry matter, and yield component during two years. Impact the mineral nitrogen fertilizer and nanotechnology fertilizer levels on the studied vegetative traits. It became clear from these data that there was no significant effect of mineral nitrogen fertilizer and nanotechnology fertilizers level of character number of the shoot during the two years of study and plant length in the first year, the weight of tuber/plant (gm) and the number of tuber/plant during the two years of study but there was a significant effect of mineral nitrogen fertilizer and nano technology fertilizers level of character average of tuber /plant (gm) and dry matter during two season.

Moreover that most of the morphologicall studied characters did not show any significant differences due to the interaction between cultivars and mineral nitrogen fertilizer and nanotechnology fertilizer level but there were significant differences due to the interaction between cultivars and mineral nitrogen fertilizer and nanotechnology fertilizers of yield component of potato cultivars.

INTRODUCTION
One of the most important solanaceous vegetable crops grown in Egypt is potato (Solanum tuberosum L.). Its tubers are rich in carbohydrates and contain considerable amounts of proteins, vitamins, and minerals. Potato is the fourth most important world crop, after rice, wheat, and maize (Spooner and Bamberg, 1994).

Carter and Bosma (1974) found that there may be adverse relations between tuber and plant aerial parts growth so that, nitrogen application stimulates the growth of aerial parts and delays tuber initiations. In addition, nitrogen has different effects on tuber.
Nitrogen is of vital importance for plant growth due to being a part of amino acid, protein, and chlorophyll molecule (Tisdale and Nelson 1956). Potato needs a large amount of nitrogen. Generally, tuber yield increased with increases in nitrogen fertilizer application (El Gamal, 1985, and Gebre et al 2005).

The overuse of different chemical fertilizers is one of the causes of the degradation of the environment and soil. Nano fertilizers are the newest and most technologically advanced way of supplying mineral nutrients to crops. Compared to chemical fertilizers, their supply nutrient for plant needs minimizes leaching and therefore improves fertilizer use efficiency (Subbarao et al, 2013). Fertilizer management is one of the most important factors in the successful cultivation of crops affecting yield quality and quantity (Tahmasbi et al, 2011). In the present century, environmental protection is more important for the agrarian, considering sustainable agriculture (Pepo et al, 2005). They add nanotechnology can have a profound impact on energy the economy and environment, by improving fertilizer products.

The present investigation was initiated to study the effect of nanotechnology in combination with different rates of mineral nitrogen on the growth, yield and quality character of potato.

**MATERIALS AND METHODS**

**Experimental Site:**

Two field experiments were carried out at EL-Nobaraya Region 71km, Alex-Cairo desert road, at in Beheira Governorate at Chipsy Company during the summer seasons of 2015 and 2016. Some of the physical and chemical properties of employed soil were determined before carrying out the experiments according to Jackson (1973). The determinations are presented in Table (1).

**Table 1.** The main chemical analysis of the experimental soil:

| PH | EC (ds/m) | Soluble anions (meq/l) | Soluble cations (meq/l) | Available nutrients (ppm) |
|----|-----------|------------------------|------------------------|--------------------------|
|    |           | Cl | HCO₃⁻ | Na⁺⁺ | Ca⁺⁺ | Mg⁺⁺ | K⁺⁺ | N | P | K | Zn | Cu | Mn | Fe |
| 7.98 | 2.85 | 6.7 | 3 | 12.8 | 6.8 | 7.05 | 1.02 | 11 | 9 | 151 | 0.85 | 1.01 | 1.83 | 3.6 |

**Planting Material:**

Certified potato seed named Hermes which imported from Netherland and Karozo which imported from Germany were tested on the first of January of both seasons in wet soil, using whole seed tubers. One hundred seed tubers for each cultivar were planted in two rows, 0.90m wide, 12.5m long, and 0.25m apart between hills, making an area of 22.5m² for each experimental plot. The experiments were laid out in a split-plot design with three replicates.

**Field Experiment:**

Phosphorus fertilizer was applied at the rate of 46.5 kg P₂O₅/fed. in the form of superphosphate (15.5% P₂O₅), added once in the opened row at planting time to all of the experimental plots. Nitrogen fertilizer was added at the rate of 120 unit/fed., in the form of ammonium nitrate (33.5%), 60, 120 and 150 unit N/fed in the form of nanotechnology (from Geolife company, India).

Potassium was added at the rate of 120 kg K₂O/fed. which were added on three equal doses the first one was during soil preparation and the 2nd and 3rd at 45 and 60 days after planting in the form of potassium sulphate (48% K₂O).
The Recorded Data, Foliage Measurements:
The number of main stems/hill was determined using the average number of main stems per hill after planting. Plant height (cm) was determined using the average height of the main stem of 10 plants at 75 days after planting.

Yield and Its Component:-
Total tuber yield: Another ten random plants were used at harvest to determine plant tuber yield (kg). Tuber yield was determined in weight and number of all tubers per plant.

Tuber Quality:-
Random samples of 10 tubers per treatment for each replicate were randomly used to determine the tuber quality characters

1-Tuber dry matter (%): Was carried out by weighing a certain weight of fresh tubers and then dried

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\text{Dry matter} \% = \frac{\text{dry weight}}{\text{fresh weight}} \times 100
\]

2-Tuber starch percentage (%) was determined using a sample of 1 g of a fresh tuber, according to the method described in A.O.A.C. (1970).

3-A Known mass (5 g) of fresh tuber was taken to determine reducing sugars, using sulphuric acid and phenol (5%); then they were calorimetrically determined, according to the method of Dubios et al. (1956).

Experimental Design And Statistical Analysis:
The used experimental layout was arranged as a split-plot in a randomized complete blocks design (R.C.B.D.), with three replicates. Two potato cultivars were considered as main plots and four treatment of nitrogen fertilizer (120 unit/fed., in the form of ammonium nitrate (33.5%), 60, 120, and 150 unit N/fed in the form of nanotechnology) for every cultivar as sup plots. Collected data of the experiments were statistically analyzed, using the analysis of variance method. Comparisons among the means of different treatments were done. Using Duncan's multiple range test procedures at p=0.05 level of significant, as illustrated by Snedecor and Cochran (1980). Computation was done using SAS (2001).

RESULTS AND DISCUSSION

Morphological Characters:
Data presented in table (2), clearly, showed that there were no significant among cultivars for the number of shoot characters for two years but there were significant differences among the examined two cultivars for plant length during two years. Data of table(2) Impact the mineral nitrogen fertilizer and nanotechnology fertilizers levels on the studied vegetative traits. It became clear from these data that there was no significant effect of mineral nitrogen fertilizer and Nanotechnology fertilizers level of character number of the shoot during the two years of study and plant length in the first year of experiment moreover the lowest values of a number of shoots/plant and plant length were obtained by using 60 unit N/fed in the form of nanotechnology. Melek Ekinci et.al.(2014) reported that nanotechnology liquid fertilizer gives the highest plant length in cucumber. Ekinci et al.2012 reported that nanotechnology liquid fertilizer improved plant growth of tomatoes. In another study, it was shown that nano-preparation coated nitrogen fertilizer improved plant growth in rice (Wang et al.2001).
Nitrogen, which is one of the most important nutrients in agricultural production, might be given only very few parts to plant and soil need, although it has been reported that the use of very small nano fertilizer particles is more effective than this rate. This effect is also provided with other plant nutrients. The nutrients which are available for the plant can be encapsulated in nanomaterial which coated with thin protective polymer film or added as particles or emulsions of the Nano scale (Srilatha 2011). As a result of this study, it can be expressed that the fertilizer used in this study showed this effect and becomes available for cucumber plants. Amin Farnia and Abbas Ghorbani indicated that yield and yield components of red bean increased with the application of N biofertilizer and KKCNFand could be replaced chemical fertilizers by these fertilizers. Amin Farnia and Abbas Ghorbani (2014) reported that nano fertilizer might have helped seed produces more vigorous plants. However, our results showed that yield and yield components of red bean increased with the application of N biofertilizer and Knano-fertilizer.

Table 2:- Effect of mineral nitrogen fertilizer and nanotechnology fertilizers on plant growth of the potato.

| Treatments | 2015 | 2016 |
|------------|------|------|
|            | No of shoot | Plant height | No of shoot | Plant height |
| **Cultivars** |      |      |      |      |
| Hermes     | 4.8a  | 67.93a | 4.4a  | 70.93a |
| Karozo     | 4.5a  | 63.2b  | 4.47a  | 64.13b |
| **Fertilization** |      |      |      |      |
| *M* units  |      |      |      |      |
| 120        | 5.17a | 68.1a  | 4.67a  | 70.98a |
| 60         | 3.83b | 55.52b | 3.67b  | 58.18c |
| 90         | 4.83a | 67.4a  | 4.67a  | 69.81ab |
| 120        | 4.8a  | 68.08a | 4.67a  | 69.72ab |
| 150        | 5.33a | 68.33a | 4.66a  | 68.95b |
| **N* units** |      |      |      |      |
| 120        | 5.33a | 70.9a  | 5a     | 74.5a |
| 60         | 3.33b | 59.1b  | 3.33b  | 62.17ab |
| 90         | 5a    | 69.4a  | 4.33a  | 71.73a |
| 120        | 5.33a | 70.86a | 4.67a  | 73.9a |
| 150        | 5a    | 69.4a  | 4.67a  | 72.37a |
| **Cultivars x fertilization** |      |      |      |      |
| **Hermes** |      |      |      |      |
| 120        | 5.33a | 70.9a  | 5a     | 74.5a |
| 60         | 3.33b | 59.1b  | 3.33b  | 62.17ab |
| 90         | 5a    | 69.4a  | 4.33a  | 71.73a |
| 120        | 5.33a | 70.86a | 4.67a  | 73.9a |
| 150        | 5a    | 69.4a  | 4.67a  | 72.37a |
| **Karozo** |      |      |      |      |
| 120        | 5a    | 65.3a  | 4.33a  | 67.47a |
| 60         | 3b    | 51.9b  | 3.33b  | 54.2b |
| 90         | 4.67a | 65.4a  | 4.33a  | 67.9a |
| 120        | 5.33a | 66.6a  | 4.367a | 65.53a |
| 150        | 4.67a | 66.76a | 4.33a  | 65.53a |

M* = Mineral nitrogen units
N* = Nano nitrogen units

**Yield and Yield Component:-**

Data presented in table (3), clearly, showed that there were no significant among cultivars for the weight of tuber/plant (gm) and a number of tuber/plant character during two years with exception weight of tuber/plant (gm) in the first season and average of tuber/plant (gm) and dry matter during two years. Data on table (3) Impact the mineral nitrogen fertilizer and nanotechnology fertilizer levels on the studied yield and its component traits. It became clear from these data that there was no significant effect of mineral nitrogen fertilizer and nanotechnology fertilizers level of character weight of tuber/plant (gm) and number of
tuber/plant during the two years of study but there were significant effects of mineral nitrogen fertilizer and nanotechnology fertilizers level of character average of tuber/plant (gm) and dry matter during two moreover the highest values of the number of weight of tuber/plant (gm), number of tuber/plant, an average of tuber/plant(gm) and dry matter were obtained by using 90 unit N/fed in the form of nanotechnology but the lowest values weight of tuber/plant (gm), number of tuber/plant, an average of tuber/plant(gm) and dry matter were obtained by using 60 unit N /fed in the form of nanotechnology.

Values of table (3) revealed that most of the yield studied characters did not show any significant differences due to the interaction between cultivars and mineral nitrogen fertilizer and nanotechnology fertilizers level one exception average of tuber/plant (gm) in the first season. moreover, the highest values number of weight of tuber/plant (gm), number of tuber/plant, an average of tuber/plant(gm) and dry matter were obtained by using 90 unit N/fed in the form of nanotechnology with karozo cultivar but the lowest values of the number of weight of tuber/plant (gm), number of tuber/plant, an average of tuber/plant(gm) and dry matter were obtained by using 60 unit N /fed with herms cultivar in the form of nanotechnology. Melek Ekinic et al. (2014) showed that the fertilizer treatments (nanotechnology liquid fertilizers) significantly improved the yield compared to control. According to the average of years, the highest yield occurred by foliar nanotechnology liquid fertilizers. This study suggested that the foliar application of Nano liquid fertilizer could improve plant growth and yield. Also, that added nanotechnology liquid fertilizer effect on the average fruit weight, diameter, fruit length, TSS, plant length. The highest values of these parameters were obtained from plants applied with nanotechnology liquid fertilizers. The lowest values of these parameters were recorded in the control. We observed the highest average fruit weight, fruit length, and dry matter from nanotechnology liquid fertilizers. Ekinci et al. (2012) reported Nano application improved the yield.
Table 3:- Effect of mineral nitrogen fertilizer and nanotechnology fertilizers on yield of potato.

| Treatments | 2015   | 2016   | 2016   | 2016   | 2016   | 2016   | 2016   | 2016   | 2016   | 2016   | 2016   | 2016   | 2016   | 2016   |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Cultivars  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Hermes     | 557.13b| 4.13a  | 134.77a| 21.18b | 634.34a| 4.67a  | 133.98b| 21.83b |        |        |        |        |        |        |
| Karozo     | 706.33a| 4.66a  | 148.14a| 24.09a | 694.32a| 4.46a  | 151.39a| 23.07a |        |        |        |        |        |        |
| Fertilization |      |        |        |        |        |        |        |        |        |        |        |        |        |        |
| *M         | 120    | 708.33a| 4.5a   | 161.a  | 23.48a | 750.5a | 5a     | 150.1a | 23.62a |        |        |        |        |        |
| 60         | 310b   | 3.83ab | 80.69c | 19.84b | 288.33b| 3.5b   | 83.33b | 20.02c |        |        |        |        |        |        |
| 90         | 708.33a| 4.83a  | 146.08b| 23.15a | 754.16a| 4.83a  | 156.6a | 22.65b |        |        |        |        |        |        |
| 120        | 714.17a| 4.5a   | 161.08a| 23.37a | 753.33a| 4.66a  | 162.42a| 23.62a |        |        |        |        |        |        |
| 150        | 725.33a| 4.33ab | 161.02a| 23.13a | 775.33a| 4.83a  | 160.99a| 22.76b |        |        |        |        |        |        |
| N* units   |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| 120        | 605.0a | 4a     | 159.33b| 22.8a  | 720a   | 5a     | 144bc  | 24.43a |        |        |        |        |        |        |
| 60         | 293.33b| 4a     | 73.33e | 19.23b | 310b   | 3.6b   | 85.56c | 20.8b  |        |        |        |        |        |        |
| 90         | 626.6a | 4.67a  | 134.17c| 22.24a | 720a   | 5a     | 143.2bc| 23.06a |        |        |        |        |        |        |
| 120        | 637.33a| 4a     | 155.85b| 22.64a | 706a   | 4.67a  | 153.14b| 23.75a |        |        |        |        |        |        |
| 150        | 623.33a| 4a     | 151.17b| 22.56a | 715a   | 4.33a  | 144bc  | 23.29a |        |        |        |        |        |        |
| Cultivarsx|        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Hermes     |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| 120        | 796.67a| 5a     | 162ab  | 22.56a | 781a   | 5a     | 156.2b | 23.62a |        |        |        |        |        |        |
| 60         | 326.6b | 3.67b  | 88.06d | 24.43a | 266.67b| 3.3b   | 81.11c | 20.05b |        |        |        |        |        |        |
| 90         | 790.0a | 5a     | 158b   | 23.06a | 830.66a| 4.67a  | 170a   | 22.65a |        |        |        |        |        |        |
| 120        | 813.33a| 5a     | 161ab  | 23.75a | 800a   | 4.67a  | 171.67a| 23.19a |        |        |        |        |        |        |
| 150        | 805a   | 4.67a  | 171a   | 23.29a | 793.33 | 4.67   | 177.99a| 22.76a |        |        |        |        |        |        |

M* = Mineral nitrogen units  
N* = Nano nitrogen units

Data presented in table (4), clearly, showed that the cultivar herms give the highest value of character component during two years. Data of table,... Impact the mineral nitrogen fertilizer (120unit/fed.) and nanotechnology fertilizers(120unit/fed,)Give the highest value of character components for two years.

Values of table (4) revealed that most of the character component studied show significant differences due to the interaction between cultivars and mineral nitrogen fertilizer and Nanotechnology fertilizers level moreover the highest values of starch content total sugar and reducing sugar were obtained by using 120unit N/fed in the form of nanotechnology with Hermes cultivar but the lowest values of the number of starch content, total sugar and reducing sugar by using 60 unit N /fed in the form of Nanotechnology with karozo cultivar.
Table 4: Effect of mineral nitrogen fertilizer and nanotechnology fertilizers on component yield of potato.

| Season | 2015  | 2016  |
|--------|-------|-------|
| Treatments | Starch content | Sugar content | Reducing sugar | Starch content | Sugar content | Reducing sugar |
|          |       |       |            |       |       |            |
|          |       |       |            |       |       |            |
| Hermes   | 11.96b | 5.86b | 2.04b      | 12.16b | 5.33b | 1.95b        |
| Karozo   | 13.05a | 6.15a | 2.11a      | 12.58a | 6.06a | 2.11a        |

| Fertilization | *M units |  |  | N* Units |  |  |
|---------------|----------|  |  |          |  |  |
|               |          |  |  |          |  |  |
| 120           | 12.79b   | 6.03ab | 2.19ab    | 12.09b | 5.75b | 2.16a        |
| 60            | 11.69c   | 5.87b  | 1.85d     | 11.8b  | 5.48d | 1.76c        |
| 90            | 11.78c   | 5.89b  | 1.98c     | 11.91b | 5.57c | 1.91b        |
| 120           | 14.46a   | 6.19a  | 2.22a     | 14.12a | 5.95a | 2.19a        |
| 150           | 11.82c   | 6.02ab | 2.12b     | 11.93b | 5.75b | 2.13a        |

* = Mineral nitrogen units  
** = Nano nitrogen units

| Season | 2015  | 2016  |
|--------|-------|-------|
| Treatments x fertilizer | Starch content | Sugar content | Reducing sugar | Starch content | Sugar content | Reducing sugar |
|          |       |       |            |       |       |            |
|          |       |       |            |       |       |            |
| Hermes   | 13.36b | 6.18b | 2.14bc     | 12.52b | 6.21ab| 2.22b        |
| Karozo   | 12.23c | 5.93cd | 1.73f    | 11.81bcd | 5.85c | 1.83d        |
|          | 12.24c | 5.94cd | 1.95e    | 11.86bcd | 5.83c | 2.0c         |
|          | 15.16a | 6.53a | 2.26a     | 14.21a | 6.29a | 2.32a        |
|          | 12.29c | 6.14bc | 2.09cd   | 12.49bc | 6.12b | 2.16b        |

| Karozo | 12.23c | 5.87d | 2.15bc | 12.05bcd | 5.36e | 2.15b |
|        | 11.15d | 5.82d | 1.93e  | 11.34d  | 5.1f  | 1.69e |
|        | 11.28d | 5.84d | 2.02de | 11.65d  | 5.28e | 1.83d |
|        | 13.76b | 5.92cd | 2.23ab | 14.03a | 5.6d | 2.16b |
|        | 11.40d | 5.85d | 2.18abc | 11.73cd | 5.32e | 1.92cd |

M* = Mineral nitrogen units  
N* = Nano nitrogen units

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