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Article

Effect of Brassinosteroid and super micro plus Nanoparticle on growth and yield of Potato *Solanum tuberosum* L.

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ABSTRACT

The effect of Brassinosteroid and Super Micro Plus Nanoparticles on growth and yield components was evaluated in potatoes for the growing season 2020. In the Karbala Governorate, a Randomized Complete Block Design RCBD factorial field experiment of two factors (Brassinosteroid and super micro plus) was conducted with three replications. The Brassinosteroid was used at 0, 0.05, 0.10 and 0.15 $mg.L^{-1}$, where the super micro plus was also used with four levels of 0, 1, 3 and 5 gxL^{-1}. Interaction treatment of both factors at the highest concentrations (B3F3) resulted in the highest mean values of all the measured parameters including plant height (64.39cm), number of stem/plant (2.593), shoot dry weight (173.3 $g.plant^{-1}$), leave area ($51.05dc^2.plant^{-1}$), tuber weight (165.4g), plant yield (1948.41)g, tuber dry matter (14.88 %) and tuber content of starch (9.18%).

Keywords: Brassinosteroid, super micro plus Nanoparticle, potato, Yield quality

INTRODUCTION

Potato Solanum tuberosum L. belongs to the plant family Solanaceae, where its origin is believed to be in South America. Potato is very important due to its nutritive value, which contains carbohydrates, protein, vitamin C and vitamin B-6[1]. Foliar application was reported in many studies as an effective method to maintain plant growth and increase yield quality. Among the plant hormones auxin, gibberellins, cytokinin, abscisic acid, and ethylene, Brasinosteroids come in sixth place, with these hormones having a structure similar to animal steroid hormones[1,2]. Brassinosteroids actively participate in the vital activities of the plant in cell elongation and division, root growth, seed germination, photosynthesis, vascular system differentiation, and plant general immunity[3,4]. Brassinosteroids also regulate root metabolism, oxidation, root gravity response, ethylene synthesis, and plant response to environmental stress[5] and that caused by diseases[5,7].

Nanotechnology is still the focus of scientific research as it has achieved great progress in the applied field of most industrial fields and contributed significantly to economic development. Reducing nutrient losses in fertilization treatments inevitably leads to increased crop yields and reduced production costs[2]. One of these commercial products is the nano-fertilizer (Super Micro Plus), which contains most of the important elements for plant nutrition in different proportions, including nitrogen, phosphorous, potassium, iron, zinc, calcium, magnesium, manganese, copper, boron, molybdenum. According to several studies, compound fertilizers, especially NPK, Micronutrients and Brassinosteroids, can significantly increase the efficiency and acceleration of many physiological and biochemical processes in the plant, including increasing cell division, growth and metabolism. Foliar application with K, Zn, Mn and B in potato cultivation caused a remarkable increase in tuber yield[3]. Similarly, foliar spray with Fe, Mg, Cu and Zn resulted in higher tuber yield and quality[4].

The importance of the potato crop as an economic crop that contributes to solving the global food shortage problem has led to increased studies and scientific research to develop the cultivation of this crop and the use of modern technologies to increase production. On the other hand, the modern trend in agriculture is to move away from or reduce the use of environmentally harmful chemicals, which at the same time are high in cost. Also, the problem of high salinity in the soil or irrigation water leads to an inappropriate degree of soil interaction to absorb nutrients in the roots. Therefore, foliar fertilization is the best solution to provide nutrients to the plant directly while reducing the amount of fertilizer. Therefore, the study aimed to evaluate the efficiency of organic nutrients (Brassinosteroid and/or Super Micro Plus Nanoparticle) and determine the appropriate concentrations to improve the vegetative and fruitful growth characteristics of Desiree potato tubers and the response extent of this variety to foliar treatments.

MATERIALS AND METHODS

The field soil was prepared and divided into three sectors, each sector containing 16 experimental units, each area (3 x 2.25 m2) consisting of three lines, each line containing 12 plants, the distance between every two plants was 25 cm and 36 plants for each experimental unit. The experiment was carried out using a randomized complete block design (RCBD) as a factorial experiment with three replications. Decomposed animal manure was added to all lines with the same amount two weeks before planting at a rate of 1 ton. ha-1 for field soil. Radomil was also added to the soil to prevent fungal diseases that may infect plants after planting and during their growth stages, and the treatments were randomly distributed to the experimental units.

The drip irrigation system was installed, and potato seeds were planted in the field pits on 1-2-2020. The treatments were sprayed in two batches. The first spray was for treatment (B) after 45 days of planting, then after 7 days, it was sprayed with treatment F, and in the same context, after 65 and 72 days of planting, the two treatments were sprayed respectively. After 110 days of planting the seeds, watering was cut off from the plants after signs of maturity appeared.

The potatoes were harvested on 1-6-2020 to end the experiment and take measurements that included the vegetative growth and yield component indicators. The growth indicators were the number of shoots per plant, Plant height, shoot dry weight (gm. plant -1), and leaf area of 5 leaves using Portable Leaf AM300 Area Meter (14). While including indicators of the yield of the number of tubers (tuber. plant-1). Average tuber weight (g), yield per plant (g), the percentage of dry matter in tubers (15), and tuber content (%) of starch (16). The treatments in the experiment included two factors: the first was sprayed with brassinosteroid growth regulator (B) at concentrations (0, 0.05, 0.10 and 0.15

mg.l-1), and the second was sprayed with nano-fertilizer (F) at four concentrations also (0, 1, 3 and 5 gm) .l-1). The experiment was factorial with 48 experimental units, 16 treatments with three replicates

RESULTS

The results showed that spraying with Brassinosteroid (B) alone or in combination with spraying with nano-fertilizer (F) led to a significant increase (P = 0.05) in the growth indicators under study compared to plants sprayed with distilled water (control). In general, the highest values of vegetative growth included the number of stems/plant, plant height, Shoot dry weight g.plant-1, and leaf area dm2.plant-1 were recorded in the interaction treatment (B3F3) of Brassinosteroid at a concentration of 0.15mg/L and nanofertilizer at a concentration of 3g/L.

It was also found that the yield components, tuber weight g, plant yield (g), and tuber content of dry matter % and starch % were significantly affected and increased by increasing the Brassinosteroid and nano fertilizer concentration. Regardless of some interaction treatments, the results showed that the highest yield indicators were recorded in the interaction treatment B3F3 with a significant difference from all the single treatments and most of the interaction treatments of other concentrations. The use of the foliar feeder by spraying on the leaves improved the characteristics of vegetative growth and the number of main stems, as it contains important nutrients involved in the process of carbon metabolism and respiration and the process of protoplasmic building. As it enters into RNA and DNA, the synthesis of nucleic

Treat-ments	**No. of the stem.plant^{-1}**				**Plant height**				**Shoot dry weight g.plant^{-1}**				**Leaf area (dcm^2.plant^{-1})**			
	Nano-Fertilizer g.L^{-1}															
Brassi-nostroide (B) mg.L^{-1}	F0 (0.0)	F1 (1)	F2 (2)	F3 (3)	F0 (0.0)	F1 (1)	F2 (2)	F3 (3)	F0 (0.0)	F1 (1)	F2 (2)	F3 (3)	F0 (0.0)	F1 (1)	F2 (2)	F3 (3)
B0 (0.0)	2.145	2.198	2.285	2.367	51.81	52.54	53.17	55.76	1325.	1404.	97.5	1528.	34.50	37.73	39.54	41.63
B1 (0.05)	2.177	2.238	2.321	2.392	52.10	52.97	54.51	56.58	1386.	1434.	1501.	1542.	36.69	38.72	40.56	42.49
B2 (0.10)	2.422	2.510	2.453	2.490	57.26	60.39	58.71	59.55	1567.	1634.	1588.	1613.	43.77	46.89	44.57	45.94
B3 (0.15)	2.555	2.531	2.572	2.593	62.42	61.79	63.60	64.39	1695.	1663.	1715.	1733.	48.56	47.32	49.44	51.05
LSD (P≤0.05)	B or F= 0.020 B*F=0.417				B or F= 0.22 B*F= 0.45				B or F= 17.6 B*F=35.2				B or F= 0.27 B*F=0.54			

Table1. Effect of Brassinosteroid and super micro plus Nanoparticle on some Potato Solanum tuberosum L growth parameters. Values are means of three replications (10 plants each)

Treat-ments	**Tuber weight (g)**				**Plant yield (g.plant^{-1})**				**Tuber content of dry matter (%)**				**Tuber content of starch (%)**			
	Nano-Fertilizer g.L^{-1}															
Brassi-nostroide (B) mg.L^{-1}	F0 (0.0)	F1 (1)	F2 (2)	F3 (3)	F0 (0.0)	F1 (1)	F2 (2)	F3 (3)	F0 (0.0)	F1 (1)	F2 (2)	F3 (3)	F0 (0.0)	F1 (1)	F2 (2)	F3 (3)
B0 (0.0)	10 1.8	12 8.5	13 5.6	14 0.7	624. 03	1198 48.	1332 95.	1293 03.	12. 23	13. 53	13. 75	13. 96	7.2 5	7. 81	8. 04	8. 23
B1 (0.05)	12 5.7	13 1.3	13 7.6	14 2.8	1138 84.	1276 24.	1232 90.	1320 90.	13. 37	13. 68	13. 88	14. 05	7.7 4	7. 92	8. 11	8. 31
B2 (0.10)	14 4.5	15 4.2	14 8.4	15 1.8	1364 08.	1566 67.	1448 38.	1514 96.	14. 16	14. 47	14. 21	14. 33	8.4 8	8. 77	8. 53	8. 65
B3 (0.15)	16 0.7	15 7.8	16 3.8	16 5.4	1788 59.	1647 43.	1893 53.	1948 41.	14. 66	14. 52	14. 74	14. 88	8.9 2	8. 85	9. 07	9. 18
LSD (P≤0.05)	B or F= 1.6 B*F= 3.2				B or F= 1.13 B*F=2.26				B or F= 0. 24 B*F=0.48				B or F=0.03 B*F=0.06			

Table 2. Effect of Brassinosteroid and super micro plus Nanoparticle on some Potato *Solanum tuberosum L yield component.* Values are means of three replications (10 plants each)

acids necessary for cell division, and then the increase in plant height[5]. It is clear that the Brassinosteroid growth regulator has a role in inducing plant growth in the developing tops through elongation and division of cells and thus led to an increase in plant height[6] as well as the active role of nano-fertilizers in stimulating the increase in plant height[7].

DISCUSSION

Increasing the leaf's nutrients led to an increase in the vegetative total, which increased the process of photosynthesis and the accumulation of dry matter in the plant and increased the transfer of those products from the leaf manufacturing center to the tuber storage centers[8,9]. This is reflected positively in the volume of processed nutrients needed to build plant tissues and then increase the dry weight, which positively affects the yield of the plant[10]. Also, after their decomposition and absorption through the plant leaves, the added fertilizers increase the availability of nutrients to the plant[11]. This leads to an increase in the percentage of dry matter, which in turn leads to an increase in the percentage of starch, which makes potato tubers the main storage places in the plant[12].

CONCLUSION

The findings of this study showed the possibility of increasing potato production by nourishing the plants with foliar spray. It is also clear from the results that Brassinosteroids alone or in combination with the nano-fertilizer (Super Micro Plus) improved all growth and yield characteristics under study, especially when using both factors with relatively high concentrations. In addition, the qualitative yield components, tuber content of dry matter and starch, were also positively affected when using either or both factors

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