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BIO-FARM BIOLOGIC FERTILIZER'S EFFECT ON THE PRODUCTION OF MINI-TUBERS OF POTATO CULTIVARS IN AEROPONIC SYSTEM

AHMAD ALI FARAHMAND BILEHSAVAR[1, 2], REZA SHAHRYARI[1, 2] AND DAVOUD HASANPANAH[3]

1-Department of Agricultural science, Ardabil Science and Research Branch, Islamic Azad University, Ardabil, Iran

2-Department of Agricultural Science, Ardabil Branch, Islamic Azad University, Ardabil, Iran

3-Horticulture Crops Research Department, Ardabil Agricultural and Natural Resources Research Centre, AREEO, Ardabil, Iran

Corresponding author: Reza Shahryari, **E mail:** rshbio@gmail.com*

ABSTRACT

This research attempted to determine the bio-farm biological impacts on the number and weight of two cultivars of potato mini-tubers in the Aeroponic system laboratory and greenhouse of Behparvar-e-Sabalan Co, Ardabil. This research, being based on Factorial experiment and completely randomized design was cultivated by two factors in three replications. The first factor included two cultivars (Agria and Caesar), the second one included two biological fertilizers (bio farm and the control). The measured traits were: plant height, number of main stems per plant, number of mini-tubers per plant, number of mini-tubers per square meter, tuber weight per square meter and the average weight of mini-tubers. The analysis of variance showed that there were significant differences between cultivars in terms of average weight of mini-tubers and the levels of bio-fertilizer for all traits except for mini-tuber weight; but in case of the impact of cultivar on bio-fertilizer, the difference was not statistically significant. Compared with the control, biological fertilizers, used in the study (Bio farm), increased the plant height to 17.31 percent, the number of main stems per plant to 29.33 percent, the number of mini-tubers per

plant to 26.27 percent, the number of mini-tubers per square meter to 26.81 percent and the tuber weight per square meter to 31.55 percent,.

Keywords: Potato, meristem culture, Aeroponic, mini-tubers

INTRODUCTION

According to the latest statistics of the Ministry of Agriculture, the area under cultivation for potato is about 149 thousand hectares with a production of about 4.03 million tons and average tuber yield of 27 tons per hectare. This value is significantly different from the average yield of European countries due to agricultural issues, lack of certified seed supplies, and lack of imported varieties' compatibility with different weather conditions. In the potato proliferation -using seed tubers- the viral infection gradually deteriorates seed tubers, over time. Healthy seed tubers are one of the important factors in health and production increase of the plant (Hassan Panah, 2011). Mini-tubers are small seed tubers which are produced by in-vitro proliferated plants and then transferred to the greenhouse. Mini-tubers are usually produced by direct transplanting of plants -obtained from in vitro cultures, in high density greenhouses (lumen and Struck, c1992). Production of mini-tubers in in-vitro conditions causes the rapid proliferation in the production program and reduces the number of generations of seed production on the farm (Ravalli et al., a1994). Considering that potato is propagated through tubers, the viral infection in the tubers increases annually, so, after a few years, the viral infection makes the potatoes useless in terms of quality and quantity (Rezai and Soltani, 1996). Considering the production of tissue culture plantlets' tubers, it is worth mentioning that; they can be produced in a laboratory and small tubers or in the greenhouses to. To produce tubers from the plantlets which are generated by tissue culture method, we have to transfer them to laboratories and produce small tubers or we can produce mini-tubers in the greenhouses. Due to the low cost of planting, rapid proliferation, high growth and providing the opportunity of direct planting in the field, the production of mini-tubers is superior to micro-tubers (Boyed, 2000). Mini Tubers, produced in vitro, are free from viral diseases (Priska, 2007). Thus, mini-tubers are produced in large-scale and are used in proliferation programs of potato tubers. Cultivation of proliferated plantlets in the soil can be an effective and quick method in the production of mini-tubers and seeds of potato tubers (Ahluwalia, 1994). The number of mini-tubers produced is rarely more than two. In-vitro produced plantlets are expensive and the low amounts of mini-tubers per plant increases the cost of production (Ritter et al., 2001). Greater numbers of mini-tubers per plant can be produced by the repletion of harvests during production season (Lumen and Struck, (1992 c), dense planting in the greenhouse beds (Jones, 1988), hydroponics (Moro et al., 1997), or aeroponics (Hassan Panah, 1390, Farrant and Mingo-castle, 2006, Kang and Han, 2005, Nichols et al., 2004, Ngaliyadde *et al*., 2005). Bio fertilizers include a sufficient number of species of beneficial soil organisms that are maintained in a bed of preservatives. The plant growth promoting rhizobacteria (PGPR) help plant in providing food, biological control, production of plant's hormone-like elements, reduction of plant ethylene levels and establishing resistance to environmental stresses such as lack of water and nutrients and reduction of the toxicity of heavy metals. These fertilizers strengthen plantlet's vigor, develop root system and root hairs, increase the dry weight of aboveground organs and root, optimally absorb the chemical fertilizers, turn nitrogen, phosphorus and potassium from an inactive from into an absorbable form. The Roots of the plants that have grown in in-vitro conditions are vulnerable and cannot develop favorably in in-Vivo14 conditions. Especially when the amount of transpiration is much. Effects of biological fertilizers are necessary for increasing the number of mini-tubers of potato Plantlets; these effects are studied in terms of root growth and development and increase in the absorption ability of the root. The results of this study could result in supplying the healthy seeds of potatoes which has been the main problem of farmers of the country. Hejran Kesh et al. (2013) studied the effects of organic Agro bio-alkanes and bird Hume fertilizers on the production of mini tubers of, Agria cultivar of potato, in greenhouse conditions; their experiment included a factorial design based on completely randomized plots with 3 replications. The average of traits indicated that organic Agro bio-Alkan fertilizers, in comparison to bio-organic fertilizers and bird Hume, resulted in the greatest number of mini-tubers in the plant, tuber weight per plant, number of mini-tubers per square meter and weight of mini-tubers per square meter, diameter of tubers per plant, plant height and number of compound leaves per plant. Also this fertilizer had the highest number of tubers per plant by the production of six tubers per plant. The results showed that the consumption of six grams of Agro

Bio-alkane fertilizer in each pot, resulted in 300 mini-tubers per square meter. Nasiri Dashtaki et al. (2013) showed that Nitroxin and humic acid fertilizers, both have significant effects on the number of stems per plant and per unit area, and the consumption of Nitroxin, compared to the control group, significantly increased the number of stems per plant and unit. Jafarzadeh et al. (2013) evaluated the effects of nano-potassium fertilizer on yield of Chamran cultivar of wheat. The study was conducted in the city of Sabzevar. The results showed that soil application of potassium had a significant effect on plant height, number of fertile tillers per plant, thousand kernel weight, economic performance and biological yield, but it didn't have an effect on the panicle length and grain number per panicle. The soil application of nano potassium sulphate and nano potassium fertilizers improved growth and increased yield and yield components of wheat. Zardeh Nalus et al. (2013) studied the effects of biological and chemical fertilizers on yield and seed quality of two chickpea cultivars under rain-fed conditions. The results showed that, there were some significant differences between the two cultivars in terms of damage to cell membranes, seed weight, seed yield, biological yield and protein yield. Among the treatments used, the fertilizer treatments like nitroxin + Bio-superphosphate + 50% chemical fertilizer and also treatments like nitroxin + bio-superphosphate were superior to others, in terms of relative water content of leaves, pod number per plant, number of seeds per pod, seed yield, biological yield, protein yield, protein content and concentration of nitrogen fertilizer treatments. While the treatment didn't have a significant effect on seed weight. In all traits, the use of bio-fertilizers had a significant superiority, compared to the control (no fertilizer). The aim of this study was to increase the rate of proliferation of potato mini-tubers per plant, using a bio-fertilizer in the Aeroponic system.

MATERIALS AND METHODS

The research was carried out in 2014 in Behparvar-e- Sabalan laboratory and greenhouse, in the North East of Ardabil, km 7 of Ardabil-Astara in front of the airport of the city. This research, being based on factorial experiment and completely randomized design was cultivated by two factors in three replications. . The first factor included two cultivars (Agria and Kaiser), the second one included two biological fertilizers (bio farm and control).

Executive operations

After disinfection of the young stems containing buds, using Binocolar, the coverages of the buds were separated carefully with tweezers and razor-sharp (scalpel), under sterile conditions of the inside of the hood. Then the lower growing part of stems were cut into 6-5 cm pieces and placed in a solution containing 2.5 percent of active sodium hypochlorite, under sterile conditions, for 20 minutes. Stem pieces were washed with distilled water for three to four times; 1.0 mm or smaller is separated from the terminal meristem, and placed in 10 ml of MS liquid medium containing 0.1 mg per liter NAA, 2.5 mg per liter gibberellic acid, two parts per million of calcium pantothenic acid, 0.6 percent agar and three percent sucrose on M-shaped paper. Meristem culture conditions included a periodic illumination of 3,000 lux for 16 hours in a growth chamber at 22 ° C, and eight hours of darkness at 17 ° C. Stems were propagated by single node cuttings method. After cultivation, samples were being transferred to the growth chamber and treated for 16 hours at a temperature of 22-18 ° C and illumination of 3000 lux, and then eight hours of darkness at 18-17 ° C and a relative humidity of 75-65 percent. When the plants reached a height of four cm, they were propagated again by single node cuttings method. After proliferation, plantlets produced by potato meristems of cultivars Agria and Kaiser were transferred to Aeroponic system. 286 ml of Bio-farm bio-fertilizer was added to one liter water, and then mixed properly, after that, gradually, the plantlets were removed from the compatibility room and their roots were impregnated with the prepared solution and then the transferred to culture boxes. Each experimental unit consisted of 20 plants. Medium of mini-tubers was dark, closed and with a height of one meter. After rooting, plantlets produced in the laboratory were transferred to the acclimation greenhouse, and after treatments with bio-fertilizers, they were placed in Aeroponic environment and cultivated in transplanting box. The nutrient solution was provided for plant roots regularly through pumping and mist irrigation. Until the final harvest, the roots were regularly exposed to nutrient solution. When the mini-tubers reached eight grams, they were harvested. During the test, Greenhouse's temperature was between 18 and 22 ° C and the illumination was about 20 to 22 thousand lux. During the growth, three per thousand Chloride Copper Fungicides (wettable powder of 35%), two kg per hectare chlorothalonil (wettable powder

75%) were used. PH and treated water were 7 and their EC was one milliSiemens per centimeter. In this study, plant height, number of main stems per plant, number of mini-tubers per plant, number of mini-tubers per square meter, tuber weight per square meter and the average weight of mini-tubers were evaluated.

Analysis

Variance analysis of data and comparison of means were carried out through LSD test at the level of 5% probability and using the 9.1 SAS software. Also the charts were prepared with 2010 Excel software.

RESULTS AND DISCUSSION

Plant height:

The results of the analysis of plant height's variance showed that there was a significant difference in terms of the biological treatments at 5% probability level, however, there wasn't any significant difference in cultivars and their interaction (Table 1). Hassan Panah (2014) assessed the potentials of producing mini-tubers of potato cultivars and clones of semi late potatoes in Aeroponic system; he found that there were significant differences between clones and cultivars in plant height. In this study, the use of bio-farm bio-fertilizer increased the plant height at a rate of 17.31% compared to control (Figure 1). Kamali Jamakani et al. (2011) compared the effect of nano-iron chelate and iron chelate fertilizers on savory and reported that there was a significant increase in plant height compared to control with respect to the treatments by nano iron chelated fertilizer. Heidari and Asghari Pour (2012) showed that potassium consumption had a significant effect on the sorghum plant's height, and the soil and foliar application of potassium and nano potassium fertilizer had a significant effect on plant height. Jafarzadeh et al. (2013) showed that the soil consumption of 150 kg per hectare of potassium sulphate caused a significant increase in plant height compared with non-use of soil potassium (Control). Nano Soil application of potassium fertilizer also increased wheat's height, but this increase was not statistically significant.

The number of main stems per plant:

The results of the analysis of the number of main stems per plant's variance showed that there was a significant difference in terms of the biological treatments at 1% probability level, however, there wasn't any significant differences in cultivars and interaction (Table 1). Hassan Panah (2014) assessed the potentials of producing mini-tubers of potato cultivars and clones of semi late potatoes in Aeroponic system; he found that there were significant differences between clones and cultivars in the number of main stems per plant. In this study, the use of bio-farm bio-fertilizer increased the number of main stems per plant at a rate of 29.33% compared to control (Figure 2). Nasiri Dashtaki et al. (2013) showed that the application of Nitroxin and humic acid, both had a significant effect on the number of stems per plant and per unit area, and Nitroxin consumption significantly increased the number of stems per plant and per unit area, compared to control.

The number of mini-tubers per plant:

The results of the analysis of the number of mini-tubers per plant's variance showed that there was a significant difference in terms of the biological treatments at 1% probability level, however, there wasn't any significant differences in cultivars and interaction (Table 1). Ostaki et al. (1992) reported that the application of zero to 300 kg nitrogen per hectare increased the number and size of tubers. Acording to an anonymous source (as stated in Tisheh, 2013) using potassium Humate reduces production costs and increases product quality. Seed treatment before planting and foliar application in the germination stage with potassium Humate have good results and creates a strong root system for the plant. Treatment of potato tubers with Humate potassium before planting and foliar application causes the excessive germination of the tubers on the plant, increased root system, and increased yield of tuber by 22 percent and increased number of tubers per plant to 90-60 tubers. Using bio-farm bio-fertilizer increased the number of mini-tubers per plant by 26.27% compared to control (Figure 3). Imani et al (2014) investigated the effect of different concentrations of bio-fertilizers on the production of mini-tubers of potato micro-tubers- Agria cultivar-, they concluded that there was a significant difference between Hum Firth and nitro-Kara bio-fertilizer and the interaction of them in terms of number, weight of mini-tubers per square meter, the average size of mini-tubers and plant height.

The number of mini-tubers per square meter:

The results of the analysis of the number of mini-tubers per plant's variance showed that there was a significant difference in terms of the biological treatments at 1% probability level, however, there wasn't any significant differences in cultivars and interaction (Table 1). Using bio-farm bio-fertilizer increased the number of mini-tubers per square meter to 26.81% (165 mini-tubers) compared to control. The amount of increase is roughly equivalent to production of mini-tubers in normal conditions (earthen bed); researchers reported that about 200 mini-tubers were obtained per square meter (Figure 4). Hassan Panah (2011) reported that the increased number of mini-tubers per square meter were 493 mini tubers, compared to the normal Aeroponic system. Hassan Panah (2014) assessed the potentials of producing mini-tubers of potato cultivars and clones of semi late potatoes in Aeroponic system; he found that there were significant differences between clones and cultivars in the number of mini-tubers per square.

Tuber weight per square meter (g):

Although some researchers believe that the number of tubers per plant is more effective than tuber weight in tuber yield (Barqi, 2013 (b)); It should be noted that the number of tubers also affects the performance by weight, this means that although the number of tubers have great impact on performance, but this impact is applied through the weight. The results of the analysis of plant height's variance showed that there was a significant difference in terms of the biological treatments at 5% probability level, however, there wasn't any significant difference in cultivars and interaction (Table 1). Using bio-farm bio-fertilizer increased the weight of mini-tubers per square meter to 31.55% compared to control (Figure 5). Jafarzadeh et al (2013) showed that the soil consumption of 150 kg per hectare of potassium sulphate caused a significant increase in the tuber's weight compared with non-use of soil potassium (Control). The soil application of potassium had a significant effect on the thousand kernel weight (40.67 g) which showed a of 19.02 % increase in comparison with the control. Farrukh et al (2009) also reported a significant effect of potassium on thousand kernel weight of rice.

The average weight of mini-tubers (g):

The results of the analysis of the average weight of mini-tubers' variance showed that there was a significant difference in factor a (cultivars) at 1% probability level, and there weren't any significant differences in terms of biological treatment levels and the impacts of biological fertilizers (Table 1). Average levels of factor a (cultivars) showed that Agria, with an average of 7.27 grams, and Kaiser with an average weight of 6.78 allocated the highest and lowest weights of mini-tubers, respectively (Figure 6). Hassan Panah (2014) assessed the potentials of producing mini-tubers of potato cultivars and clones of semi late potatoes in Aeroponic system; he found that there were significant differences between clones and cultivars in the average weight of mii tubers. The increase in the Weight of mini-tubers, when comparing the conventional farming with the

Aeroponic system, have also been reported by other researchers (Hassan Panah, 2011).

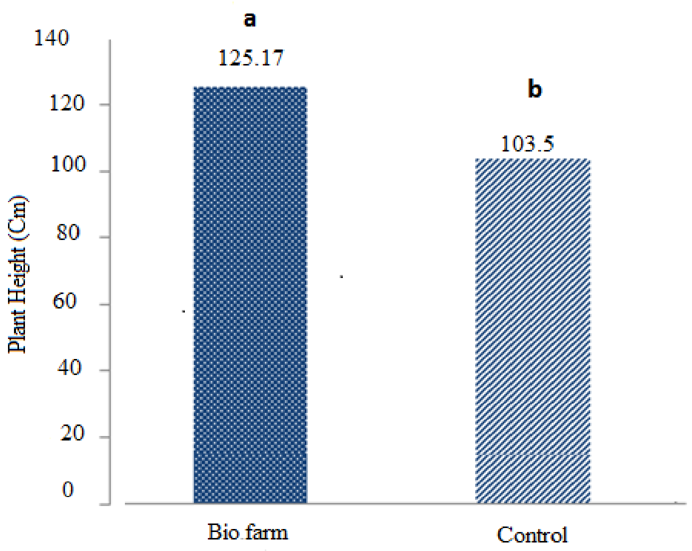

Figure 1: Mean levels of biological fertilizer for plant height (cm)

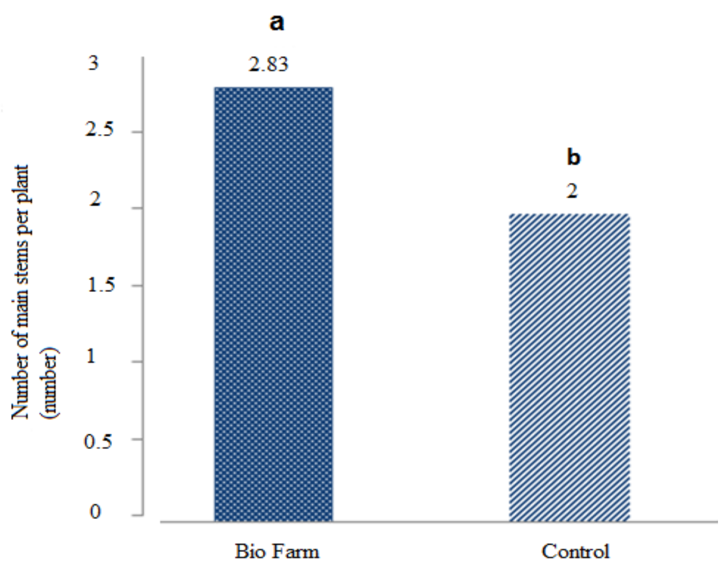

Figure 2: Average levels of biological fertilizer for number of main stems per plant (number)

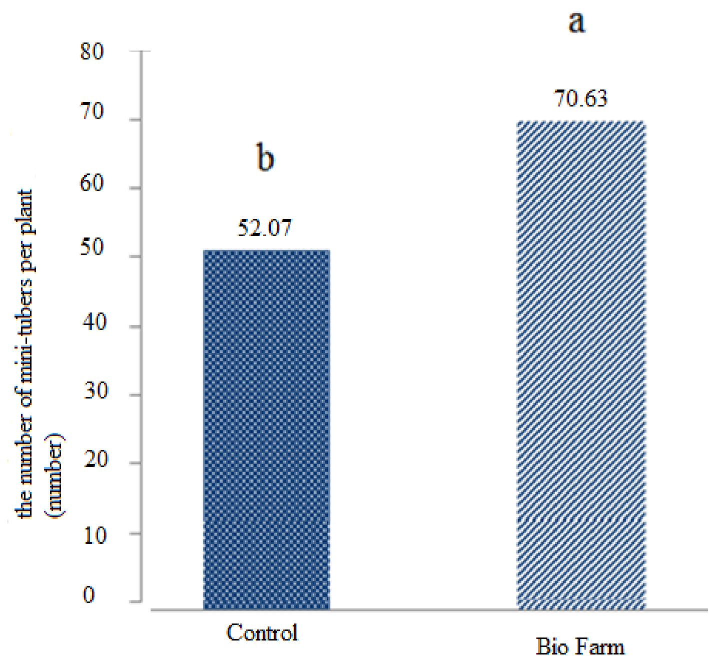

Figure3. Average levels of biological fertilizer for the number of mini-tubers per plant (number)

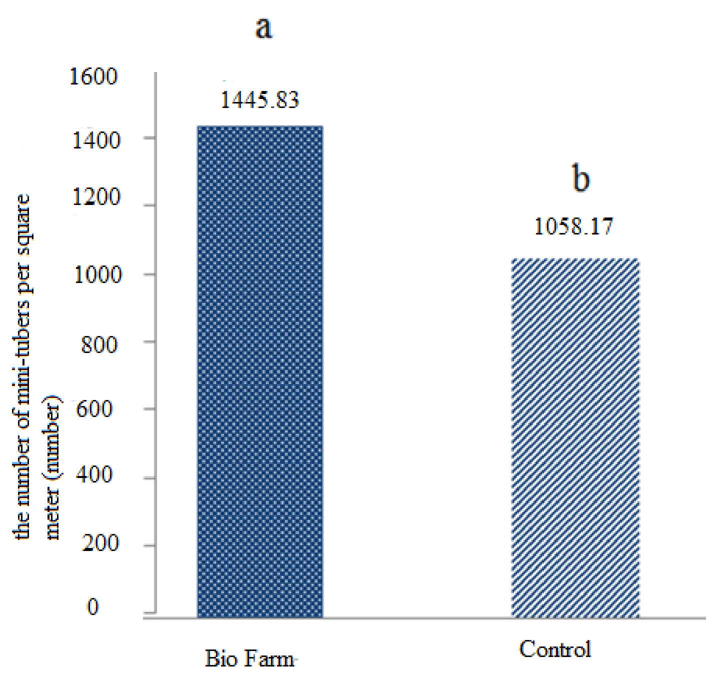

Figure4. Mean levels of biological fertilizer for the number of mini-tubers per square meter (number)

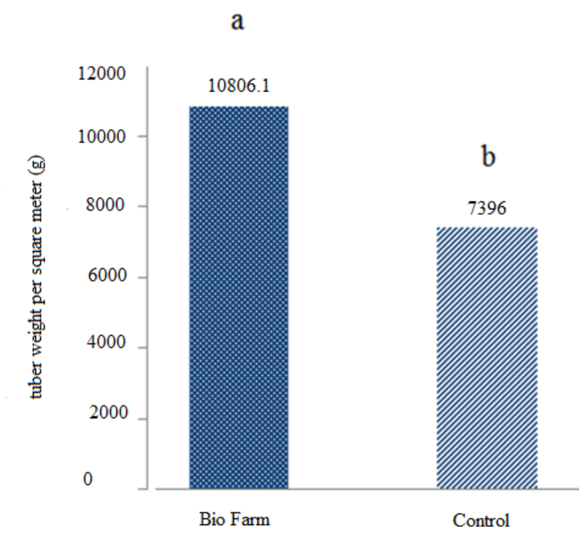

Figure 5: The average level of bio-fertilizer for tuber weight per square meter (g)

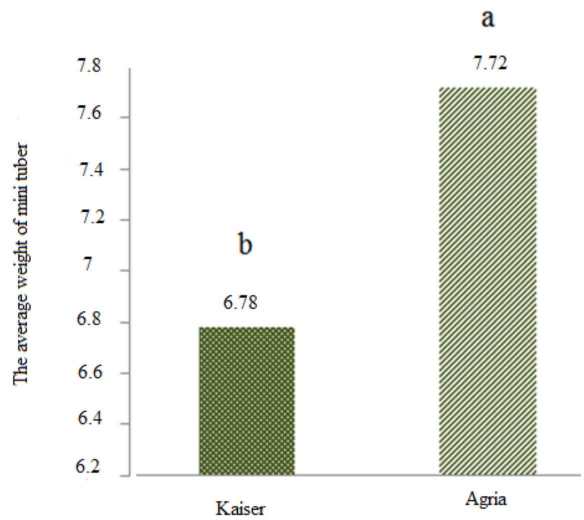

Figure 4.6 comparisons of the measured cultivars for average weight of mini-tubers (g)

Table1: Analysis of variance assessment

Resource changes	Degree of freedom	Average of squares					
		plant height	The number of main stems per plant,	The number of mini-tubers per plant	The number of mini-tubers per square meter	Tuber weight per square meter	The average weight of mini-tubers
Cultivar	1	12	0.083	248.43	82005.33	10272.6	2.61**
Biological fertilizer levels	1	1408.33*	2.08**	1032.304**	450856.33**	34886687.04**	0.65
Cultivar × levels of biological fertilizer	1	176.33	0.083	18.5	13200.33	2042782.6	0.56
Error	8	163.5	0.083	73.03	29978	2283122.95	0.207
Coefficient of variation		11.18%	11.94%	13.92%	13.82%	16.6%	6.28%
*Shows significance on 5%.level							

CONCLUSION

It could be concluded that biological fertilizer, used in the study (Bio farm), increased the plant height to 17.31 percent, the number of main stems per plant to 29.33 percent, the number of mini-tubers per plant to 26.27 percent, the number of mini-tubers per square meter to 26.81 percent and the tuber weight per square meter to 31.55 percent, compared with the control.

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