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Organic Fertilizers Tea and Boron Spray as Candidates for Improving the Growth, Yield and Quality Traits of Potato Plants (*Solanum tuberosum* L.).

ELsadany[1], H. E., M. H. Mohamed[1], H. F. Zahran[2] and A. S. Shams[1]

1- Horticulture Department, Faculty of Agriculture, Benha University, Moshtohor, 13736 Qalyubia, Egypt
2- Environment and Natural Materials Research Institute - City of Scientific Research and Technological Applications – New Borg El-Arab City, 21934 Alexandria, Egypt

Corresponding author: Mohandesa3062020@gmail.com

Abstract

A field experiment was carried out during the two successive summer seasons of 2017and 2018 in private sector farm at Kom Hamada city, Buhera Governorate, Egypt to investigate the effect of organic fertilizers tea (Chicken manure tea , Rabbit manure tea , Compost tea, Biochar tea and without organic fertilizers tea) as soil additions and foliar spray with boron at 0, 50 and 100 mg L^{-1} as well as their interaction on growth, yield and quality of potato tubers (*Solanum tuberosum* L.) cv. Beleny. Obtained results showed that, soil addition with chicken manure tea and foliar spray with high concentration of boron (100 mg L^{-1}) gave the highest values in vegetative growth parameters. Moreover, application of either chicken manure or rabbit manure tea with the recommended rate of NPK and foliar spray with boron at 100 mg L^{-1} recorded the highest increases in the tuber yield of potato. But the best chemical components of potato tubers (N, P, K, carbohydrates and starch) verified when using chicken manure tea and foliar spray with boron at 100 mg L^{-1} compared with all other treatments and in both seasons.

Keywords: Potato, Organic fertilizer tea, Boron, Chicken tea, Rabbit tea, Compost tea, Biochar tea and tuber quality

Introduction

Potato (*Solanum tuberosum* L.) is an economical food and it provides a source of low-cost energy to the human diet. It is a rich source of starch, vitamin C, B and minerals. It also contains the right amounts of essential amino acids (**Paul Khurana and Naik, 2003**). Potato is a strategic crop in Egypt not only to its local consumption but also to increase meeting income through its exportation among different countries in the world and contributes substantially in the agricultural income. According to the recorded data obtained from the Department of Agricultural Economics and Statistics, Ministry of Agriculture and Land Reclamation, Egypt, the cultivated area of potato in 2018/2019 reached about 356264 feddans, which yielded 4506739 tons of tubers with an average of about12.65 ton/fed. The potato exports reached around 673000 Tons last season (2018/2019).

Potato is highly responsive to NPK fertilizer, especially on sandy soils **(Errebhi et al., 1998)**. The potato is a plant with high nutrient demands because of forming abundant vegetative mass and a high quantity of tubers at the unit area. Chemical fertilizers have several negative impacts on environment and sustainable agriculture. However, about 40–70% of nitrogen of the applied normal fertilizers is lost to the environment and cannot be absorbed by plants, causing not only substantial economic and resource losses but also very serious environmental pollution. Since chemical fertilizers are becoming highly costly and the use of extremely high rates of chemical fertilizers could lead to soil pollution **(FAO, 2018),** the use of organic fertilizers may help in augmenting soil fertility and contributing in decreasing the cost of fertilizer application and pollution. The use of organic fertilizer helps in mitigating multiple nutrient deficiencies at the same time it provides better environment for growth and development of plants by improving chemical, physical and biological properties of soil **(Avitoli et al., 2012)**. Organic fertlizer is an agro technological factor which beneficially affects the chemical composition of potato tubers including their content of micronutrients and macronutrients **(Redulla et al., 2005; Wszelak et al., 2005; Griffiths et al., 2012)**. Such improvements may occur because of the following (1) the applied amendments may improve soil physical and chemical characteristics **(Farid et al., 2014)**, (2) enrich soils with nutrients that release upon organic matter decomposition **(Abdelhafez et al., 2018)**, (3) store the nutritive elements in chelated forms able to release these nutrients due to plant requirement over time **(Abdelhafez et al., 2018)**, especially within light textured soils and hence minimize nutrients losses through leaching from the top soil surface **(Lipczynska-Kochany, 2018)**, and/or (4) maintain optimal soil pH for nutrient availability in acid soil **(Aye et al., 2018)** hence increase the solubility of soil nutrients in alkaline and calcareous soils **(Hamidpour et al., 2016)**. The use of compost as organic fertilizer improves soil fertility, an excellent soil conditioner, thus improving the soil's physical, chemical and biological properties such as retention water, aggregation, porosity, increased the cation exchange capacity, increased fertility and increased life soil microbial activities (**Ahmad et al., 2008)**.

Nutrients from compost nutrients inadequate for good growth of plants. Therefore, most of vegetable crops need to supply with liquid organic nutrients such as compost tea during the growing season through irrigation system (**Gross et al., 2008**). Compost tea has been utilized in agriculture as a good source of organic matter and soil amendments that supplement plants with mineral nutrients and other benefits. In modern terminology compost tea is a compost extract produced from the fermented compost in water (**Litterick et al., 2004**). It contains soluble nutrients, therefore it can be applied to the soil through irrigation systems or to plant foliage, it is also very rich in plant phytohormones and growth regulators. It improves soil microorganisms that have a direct or indirect effect on the plant rhizosphere, besides, it improves soil physical and chemical characteristics as well as suppress some plant diseases pathogen (**Abbasi et al., 2002 and Meshref et al., 2010**).

Boron (B) is one of the important micronutrients that has basic role in stabilizing certain constituents of cell walls structure and function and activity of plasma membrane, improvement of cell division, tissue differentiation. So, boron could be directly joined with cell growth **(Goldbach et al., 1991)**. In addition, (**Rafeii and Pakkish 2014)** revealed that application of boron increased net photosynthetic rate that could be attributed to the increase in chlorophylls content of leaves. Also, boron has been involved in metabolism of nucleic acid, carbohydrate, protein, auxin and phenol. Moreover, boron has been role in sugar translocation, nucleic acids synthesis and pollen tube growth. Also, Boron plays a key role in higher plants by facilitating the short - and long- distance transport of sugar via the formation of borate- sugar complexes (**Bragg et al., 2008, Ozkutlu et al., 2017 and Rosa et al., 2018)**.

Therefore, the present study was an attempt to improve the vegetative growth, yield productivity and quality of potato tubers during the early summer season by using different organic fertilizer teas, i.e., Chicken tea, Rabbit tea, Compost tea, Biochar as a supplement with recommended dose of NPK and the foliar spray with different rates of boron.

Materials and Methods

A field experiment was carried out during the two successive summer seasons of 2017and 2018 in private sector farm at Kom Hamada city, Buhera Governorate, Egypt to investigate the effect of soil additions with different kinds of organic fertilizers tea (Chicken manure tea, Rabbit manure tea, Compost tea, Biochar tea and without organic fertilizers tea) and foliar spray potato plants with different concentration of boron (0, 50, 100 mg L^{-1}) as well as their interaction on vegetative growth characters, chemical constituents of plant foliage, yield and its components, physical and chemical quality of potato tubers (*Solanum tuberosum* L.) cv. Beleny. Physical according to **Jackson (1973)** and chemical according to **Black et al. (1982)** characters of the used soil as average of both seasons are shown in **Table a**. In addition, air temperature and relative humidity in Behera region are shown in **Table b.**

Table (a): Soil mechanical and chemical analyses of the used soil

Physical analysis		Chemical analysis			
		Cations meq/l		Anions meq/l	
Coarse sand	8.25%	Ca^{++}	3.5	CO_3^{--}	Zero
Fine sand	16.15%	Mg^{++}	1.2	HCO_3^-	5.38
Silt	24.60%	Na^+	6.53	Cl^-	5.93
Clay	51%	K^+	1.16	SO_4^{--}	5.9
Texture class clay					
		Available N	22.5	Soil pH	7.9
		Available P	9.1 mg/kg	E.C, dS/m	1.4
		Available K	120	Organic matter	1.1%

Table b. Monthly air temperature and relative humidity in Buhera region during two seasons of the experimental.

	First season 2017			Second season 2018		
	Temperature °C		R.H%	Temperature °C		R.H%
Months	**Max**	**Min**	**Average**	**Max**	**Min**	**Average**
January	**16.7**	**6.1**	**67**	**14.3**	**5.2**	**69**
February	**14.1**	**4.5**	**69**	**13.6**	**4.3**	**68**
March	**16.2**	**5.2**	**68**	**17.3**	**5.2**	**67**
April	**25.7**	**8.1**	**63**	**23.3**	**8.5**	**62**
May	**28.2**	**13.6**	**62**	**28.4**	**14.6**	**61**

Potato tubers were planted on 16th and 20th January in the first and second seasons, respectively. This experiment was set up in a split plot design with three replicates in both seasons of study. Soil addition (organic fertilizers tea) was randomly distributed in the main plots while boron foliar sprays were

randomly employed in the sub plots. Experimental plot included one row 17m length and 80 cm width with an area of 13.6 m^2. Potato tubers were planted 30 cm apart on one side of ridges. Cultural management, disease and pest control programs were followed according to the recommendations of the Egyptian Ministry of Agriculture. The experiment included 15 treatments resulted from the combinations of 5 organic fertilizers tea treatments with three foliar spray treatments as follows.

a. Organic fertilizers tea treatments: 1) Chicken manure tea. 2) Rabbit manure tea. 3) Compost tea. 4) Biochar tea. 5) Without organic fertilizers tea.

b. Foliar spray treatments: 1) 0 mg L^{-1} boron (distilled water only). 2) 50 mg L^{-1} boron. 3) 100 mg L^{-1} boron as Boric acid.

Organic fertilizers in the solid shape prepared from the farm of faculty of agriculture and preparation of fertilizers tea occurred at the land of the experiment.

All treatments received the recommended dose of mineral NPK fertilizers, which were 150 kg N per fed. (added in the form of ammonium nitrate 33% N), 60 kg P_2O_5 (added in the form of Calcium superphosphate 16% P_2O_5) and 96 kg K_2O per fed. (added in the form of potassium sulphate 48% K_2O). N fertilizer was added at three equal doses i.e. after complete germination, and every two weeks by interval. Mineral P was divided at two equal parts during soil preparation and planting date. Mineral K fertilizer was divided at two equal parts i.e. two months after planting and after two weeks by interval.

The soil addition of teas treatments were added three times at rate 100 ml /plant started after 30 days from planting and every 15 days intervals. The chemical analysis of the used fertilizers tea in first and second seasons is shown in **Table c**. Fertilizers tea was prepared according to the method described in **Naidu et al (2010)**. While the foliar spray of boron were sprayed three times after 45 days from planting and every 15 days intervals.

Table (c): Chemical and microbiological analyses of organic fertilizers tea.

Parameter	pH	EC (dS/m)	Total N%	Total p%	Total k%	Total count of bacteria (cfu/ml)	Total count of fungi (cfu/ml)	Total count of actinomycetes (cfu/ml)
Chicken manure tea	**7.30**	**4.98**	**0.56**	**0.11**	**0.76**	**9.1×10^6**	**7.9×10^4**	**1.7×10^5**
Rabbit manure tea	**7.58**	**2.45**	**0.43**	**0.09**	**0.72**	**8.6×10^6**	**8.1×10^4**	**1.1×10^5**
Compost tea	**7.11**	**2.65**	**0.31**	**0.07**	**0.48**	**8.4×10^6**	**7.5×10^4**	**1.3×10^5**
Biochar tea	**8.27**	**3.04**	**0.12**	**0.04**	**0.48**	**6.5×10^6**	**5.4×10^4**	**2.2×10^5**

After 90 days from planting, three plants were taken as representative sample from each experimental plot and the following data were recorded.

1. Vegetative growth characteristics. Plant height (cm), Number of branches/plant, Number of leaves/plant, Fresh weight/plant (g), Dry weight/plant (g).

2. Tuber yield and its components: Tuber yield (g/ plant), Total tuber yield (t/fed)

3. Chemical quality:

Tubers samples were taken at harvest time and dried in an electric oven to constant weight at 70^0C. In addition, the digested dry matter of each sample was taken for chemical determination of total N, P, K, starch and total carbohydrate content were determined according to the methods described by **Pregl (1945), John (1970), Brown and Lilleland (1946), A.O.A.C. (2000),** respectively.

The obtained data in both seasons of study were subjected to the analysis of variance as a factorial experiment in split plot design. Duncan method was used to differentiate the significance among means according to the procedure outlined by Gomez and Gomez (1984). MSTAT-C program (1988) was used for statistical computations.

Results and Discussion

1. Vegetative growth parameters of potato plants

Results shown in Table 1 reveal that there are significant differences among the soil addition treatments (organic fertilizers tea) on plant height, number of branches, number of leaves, fresh weight, and dry weight of potato plants on first season as well as number of branches and leaves of potato plants in second season. Even so, the application tea of rabbit manure, compost, biochar or chicken manure teas increased significantly potato growth parameters (plant height, number of branches per plant, number of leaves per plant, fresh and dry weights per plant) compared to the recommended dose of mineral NPK without Organic fertilizers tea during the two seasons of study. Such increments in vegetative growth parameters in case of using chicken manure tea, rabbit manure tea, compost tea or biochar tea. Also, the increase in plant growth parameters was connected with the increase in photosynthetic pigments and determined macro-nutrient content and, in turn, increased plant growth. Obtained results are in the same direction with those reported by **Samet et al. (2018) and Kumar et al. (2021)**

Foliar spray by boron 50 or 100 mg L^{-1} improved significantly the investigated growth parameters as compared to level 0 mg B L^{-1} treatment except the plant height in first season and number of branches in second season. In this concern, spraying potato plant by 100 mg L^{-1} of boron obtained the highest increases in the plant height, number of branches per plant, number of leaves per plant, plant fresh weight and plant dry weight. While plants which received 50 mg L^{-1} of boron came in the second rank. Obtained data may be due to that boron has stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis, and chlorophyll formation**.** Obtained results are in agreement with those reported by **Tantawy et al. (2017)**

Table 1. Effect of organic fertilizers tea or boron foliar application on vegetative growth of potato plants during the summer seasons of 2017 & 2018.

Treatments	First Season					Second season				
	Plant Height (cm)	No. of branches	No. of leaves	Fresh weight(g)	Dry Weight (g)	Plant height (cm)	No. of branches	No. of leaves	Fresh weight(g)	Dry weight (g)
Organic fertilizer tea (OFT)										
Chicken manure	42.3A	2.0A	20.27A	170.8A	20.4A	50.0 A	1.90A	14.08A	157.3A	22.8A
Rabbit manure	42.8A	2.1A	19.34A	197.1A	24.3A	47.8 AB	1.60 AB	13.03AB	165.6A	23.3A
Compost	39.8AB	2.3A	22.67A	186.1A	23.0A	48.8 AB	1.50AB	12.92AB	163.3A	23.5A
Biochar	39.4AB	2.3A	21.51A	173.3A	20.6A	47.9 AB	1.70A	13.97 A	158.4A	23.3A
Without OFT	37.9B	1.1B	12.16B	122.3B	14.4B	46.8 B	1.20B	10.67B	142.0A	20.65 A
Boron foliar application										
0 mg B L^{-1}	38.9B	1.7B	16.90B	152.0 B	18.1B	45.8B	1.39A	11.45B	133.4B	19.5B
50 mg B L^{-1}	40.2B	1.9AB	19.30AB	172.2AB	21.0AB	48.6A	1.54A	12.49AB	153.5B	21.7B
100 mg B L^{-1}	42.2A	2.3A	21.40A	185.5 A	22.5A	50.4A	1.79A	14.85A	185.1A	26.9A

Means of the same column followed by the same letter were not significantly differed according to Duncan MRT at 5%.

The interactions between the studied factors were also of significant effect on increasing plant growth parameters (Table, 2). Generally, fertilization factor seemed to be the most significant one in determining plant growth parameters vs the foliar spray with different boron concentrations. In soils amended with chicken manure tea and foliar spray with high concentration of boron (100 mg L^{-1}) seemed to be superior compared to 0 mg B L^{-1} (distilled water).

Table 2: Effect of interaction between organic fertilizers tea and boron foliar application on vegetative growth of potato plants during the summer seasons of 2017 & 2018.

Treatments		First Season					Second season				
Organic fertilizer tea (OFT)	Boron foliar application	Plant length (cm)	No. of branches	No. of leaves	Fresh weight (g)	Dry weight (g)	Plant length (cm)	No. of branches	No. of leaves	Fresh weight (g)	Dry weight (g)
Chicken manure	0 mg B L^{-1}	39.20 bc	1.66 b-e	16.97 b-d	138.0 b-d	16.98 b-d	46.30 a-c	1.73 b-e	11.87 e-g	134.5 b-d	18.84 b-d
	50 mg B L^{-1}	41.53 a-c	2.06 bc	21.53 ab	172.6 a-cd	20.50 a-d	51.77 a	1.86 a-c	12.97 c-f	138.2 b-d	20.13 b-d
	100 mg B L^{-1}	46.07 a	2.20 ab	22.30 ab	201.7 a	23.80 ab	52.07 a	2.20 a	17.40 a	199.3 a	29.50 a
Rabbit manure	0 mg B L^{-1}	41.40 a-c	1.86 b-e	18.07 bc	194.7 ab	22.85 a-c	43.63 c	1.43 c-f	11.97 e-g	150.5 a-d	22.09 a-d
	50 mg B L^{-1}	43.30 ab	2.10 b	19.30 bc	196.2 ab	24.33 ab	47.97 a-c	1.40 d-f	12.07 e-g	165.0 a-c	23.35 a-d
	100 mg B L^{-1}	43.73 ab	2.30 ab	20.67 b	200.5 a	25.77 a	51.87 a	1.86 a-c	15.07 bc	181.4 ab	24.32 a-c
Compost	0 mg B L^{-1}	38.60 bc	1.96 b-d	19.73 b	162.8 a-d	20.38 a-d	47.83 a-c	1.40 d-f	12.50 d-f	149.8 a-d	22.32 a-d
	50 mg B L^{-1}	38.73 bc	2.00 bc	20.40 b	195.1 ab	24.23 ab	48.87 a-c	1.40 d-f	12.73 d-f	167.8 a-c	22.52 a-d
	100 mg B L^{-1}	41.97 a-c	3.067 a	27.87 a	200.3 a	24.43 ab	49.73 ab	1.63 b-e	13.53 c-e	172.2 ab	25.75 a-c
Biochar	0 mg B L^{-1}	38.53 bc	1.96 b-d	18.97 bc	146.8 a-d	16.4 b-d	46.53 a-c	1.40 d-f	11.07 fg	121.8 cd	18.08 cd

	50 mg B L^{-1}	**39.07 bc**	**2.43 ab**	**22.40 ab**	**178.1 a-c**	**21.79 a-d**	**47.33 a-c**	**1.76 a-d**	**14.63 b-d**	**161.9 a-c**	**23.01 a-d**
	100 mg B L^{-1}	**40.53 bc**	**2.50 ab**	**23.17 ab**	**195.1 ab**	**23.47 a-c**	**49.87 ab**	**1.96 ab**	**16.20 ab**	**191.6 a**	**28.75 a**
Without OFT	**0 mg B L^{-1}**	**36.67 c**	**1.00 e**	**10.97 d**	**117.8 d**	**13.9 d**	**44.97 bc**	**1.00 f**	**9.86 g**	**110.5 d**	**15.92 d**
	50 mg B L^{-1}	**38.27 bc**	**1.10 de**	**12.73 cd**	**119.2 cd**	**14.29 d**	**46.97 a-c**	**1.30 ef**	**10.07 g**	**134.4 b-d**	**19.58 b-d**
	100 mg B L^{-1}	**38.63 bc**	**1.20 c-e**	**12.77 cd**	**130.1 cd**	**15.1 cd**	**48.63 a-c**	**1.30 ef**	**12.07 e-g**	**181.1 ab**	**26.45 ab**

Means of the same column followed by the same letter were not significantly differed according to Duncan MRT at 5%.

2. Yield and its components of potato tubers.

Data in Table 3 show that there was significant effect of soil addition treatments (organic fertilizers tea) on plant yield (g), total yield per fed. (ton) during both seasons. Where, application of either chicken manure tea or rabbit manure tea increased significantly the tuber yield of potato and its components (total yield per plant, average tuber yield) when compared to the application of either biochar tea or without organic fertilizers tea (OFT).

Such increments in produced total yield per plant, total yield per fed, average tuber weight as a result of adding either chicken manure or rabbit manure teas may be due to the increasing of vegetative growth parameters (Table, 1) which in turn might affect positively number and weight of tuber produced by plant and consequently increased the total produced yield per feddan. Obtained results are in agreement with those reported by **Baniuniene and Zekaite (2008), Monirul et al. (2013) and Samet et al. (2018).**

Foliar spray with boron at concentration 100 mg L^{-1} recorded the highest increases in the above mentioned yield components, followed by concentration 50 mg L^{-1} recording comparable results during both seasons study. Generally, the efficiency of the used concentrations of boron can be arranged according to their capability for increasing the tuber yield of potato and its components as follows: 100 mg B L^{-1}>50 mg B L^{-1} >0 mg B L^{-1}. In this regard, the superiority of using boron on total produced yield and its components may be attributed to the photosynthesis stimulation, transpiration reduction and increasing plant resistance to biotic and abiotic stresses which lead to increased plant growth and consequently increased tubers formation. Obtained results are in agreement with those reported by **Tantawy et al. (2017)**.

Data presented in Table, 4 show that the average tuber weight, it was found that the highest increases were recorded for either of biochar or chicken manure tea and foliar spray with 100 mg B L^{-1}. Such increases did not vary significantly with those that received either rabbit manure tea or compost teas during the first season only. In case of the total yield per plant, the highest increases were recorded for chicken manure tea +50 or 100 mg B L^{-1} and rabbit manure tea+100 mg B L^{-1} during the first season of study, with no significant variations among these treatments. In the second growing season, only chicken manure tea+100 mg B L^{-1} recorded the highest increases in the total yield per plant exceeding those attained for the other treatments.

Chicken manure tea+100 mg B L^{-1} recorded the highest increases in total yield per feddan in the first growing season, while compost tea+100 mg B L^{-1}, chicken and rabbit manure teas (irrespective to the rate of applied B foliar spray) recorded the highest increases in the second growing one.

Table 3. Effect of organic fertilizers tea or boron foliar application on yield and its components of potato plants during the summer seasons of 2017 & 2018.

Treatment	**First Season**			**Second season**		
	Average tuber weight(g)	**Total yield/plant (g)**	**Total yield/fed (ton)**	**Average tuber weight(g)**	**Total yield/plant (g)**	**Total yield/fed (ton)**
Organic fertilizer tea (OFT)						
Chicken manure	**235.0 A**	**871.1 A**	**14.97 A**	**233.2 A**	**831.1 A**	**15.78 A**
Rabbit manure	**195.0 A**	**857.8 A**	**14.18 AB**	**187.1 C**	**797.3 B**	**15.27 A**
Compost	**192.2 A**	**750.1 B**	**13.56 BC**	**218.2 B**	**773.8 BC**	**13.11 B**
Biochar	**200.4 A**	**662.7 C**	**13.03 C**	**223.8 AB**	**758.6 C**	**11.30 C**
Without OFT	**196.6 A**	**573.7 D**	**9.70 D**	**139.2 D**	**579.9 D**	**9.54 D**
Boron foliar application						
0 mg B L^{-1}	**177.8 B**	**719.5 B**	**11.41 C**	**161.5 C**	**681.8 C**	**12.00 B**
50 mg B L^{-1}	**202.7 AB**	**740.6B**	**13.2 B**	**194.4 B**	**746.4 B**	**13.02 AB**
100 mg B L^{-1}	**231.0 A**	**769.1A**	**14.66 A**	**244.9 A**	**816.2 A**	**13.99 A**

Means of the same column followed by the same letter were not significantly differed according to Duncan MRT at 5%.

Table 4: Effect of interaction between organic fertilizers tea and boron foliar application on yield and its components of potato plants during the summer seasons of 2017 & 2018**.**

Treatments		First Season			Second season		
Organic fertilizer tea (OFT)	**Boron foliar application**	**Average tuber weight(g)**	**Total yield/plant (g)**	**Total yield/fed (ton)**	**Average tuber weight(g)**	**Total yield/plant (g)**	**Total yield/fed (ton)**
Chicken Manure	**0 mg B L^{-1}**	213.8 a-e	836.4 cd	12.65 d	189.3 f	723.1 d	14.61 a-c
	50 mg B L^{-1}	231.0 a-c	873.5 a-c	14.50 bc	223.7 de	825.4 bc	15.85 a
	100 mg B L^{-1}	260.1 a	903.5 a	16.66 a	286.6 a	944.7 a	16.89 a
Rabbit manure	**0 mg B L^{-1}**	178.9 b-e	836.4 cd	12.46 d	147.8 i	714.0 d	14.33 a-c
	50 mg B L^{-1}	188.9 b-e	842.5 b-d	14.21 bc	171.1 gh	810.3 bc	15.03 ab
	100 mg B L^{-1}	217.3 a-d	894.5 ab	15.27 b	242.3 bc	867.6 b	16.46 a
Compost	**0 mg B L^{-1}**	187.8 b-e	717.3 fg	12.42 d	188.4 fg	713.8 d	11.97 c-e
	50 mg B L^{-1}	189.7 b-e	739.4 ef	13.42 cd	211.6 e	767.1 cd	12.94 b-d
	100 mg B L^{-1}	199.2 a-e	793.5 de	14.77 b	254.7 b	840.4 b	14.41 a-c
Biochar	**0 mg B L^{-1}**	147.6 e	663.3 gh	12.37 d	166.9 h	712.7 d	10.72 d-f
	50 mg B L^{-1}	205.2 a-e	658.4 h	12.79 d	230.2 cd	733.0 d	11.25 de
	100 mg B L^{-1}	248.3 ab	666.4 gh	14.56 bc	274.3 a	830.3 b	11.92 c-e
Without OFT	**0 mg B L^{-1}**	160.8 de	544.2 i	9.41 e	115.3 j	545.5 e	8.35 f
	50 mg B L^{-1}	198.9 a-e	589.4 i	10.39 e	135.4 i	596.0 e	10.01 ef
	100 mg B L^{-1}	230.1 a-c	587.4 i	10.46 e	166.9 h	598.1 e	10.25 d-f

Means of the same column followed by the same letter were not significantly differed according to Duncan MRT at 5%.

3. N, P, K contents in potato tubers as well as carbohydrate and starch contents.

It is clear from data in Table 5 that, chemical components of potato tubers (N, P, K, carbohydrate and starch) increased significantly with added chicken manure tea to the soil in both seasons, while treatment without organic fertilizers tea (OFT) recorded the least significant effect on NPK contents as well as carbohydrate and starch percentages in potato tubers among the investigated fertilization treatments. All foliar spray boron (50 or 100 mg L^{-1}) recorded significant increases in the above mentioned chemical components as compared with the foliar spray of distilled water. Such increases can be arranged, generally, in the following descending order: 100 mg B L^{-1}>50 mg B L^{-1}>0 mg B L^{-1}. Such results may be due to the main role of boron on assimilation and formation of carbohydrates, phosphor and potassium content. Obtained results are coincided with those reported **Baniuniene and Zekaite (2008).**

Table 5. Effect of organic fertilizers tea or boron foliar application on tuber quality (chemical constituents) of potato plants during the summer seasons of 2017 & 2018.

Treatment	First Season					Second season				
	N (mg g^{-1})	**P (mg g^{-1})**	**K (mg g^{-1})**	**Carbohydrate %**	**Starch %**	**N (mg g^{-1})**	**P (mg g^{-1})**	**K (mg g^{-1})**	**Carbohydrate %**	**Starch %**
Organic fertilizer tea (OFT)										
Chicken manure	**28.5 A**	**7.2 A**	**29.4 A**	**17.99 A**	**14.24 A**	**29.4 A**	**5.9 AB**	**30.2A**	**18.86A**	**14.75 A**
Rabbit manure	**26.9 B**	**5.5 B**	**28.1 B**	**16.98 B**	**13.50 B**	**27.7 B**	**6.5 AB**	**29.2B**	**18.13B**	**14.16 B**
Compost	**25.7 BC**	**4.4 C**	**26.8 C**	**15.39 C**	**12.71 C**	**26.8 C**	**6.9 A**	**28.4BC**	**16.52C**	**13.35 C**
Biochar	**24.4 C**	**6.0 B**	**26.1C**	**14.00 D**	**11.63 D**	**25.8 D**	**6.5 AB**	**27.6C**	**15.40D**	**12.50 D**
Without OFT	**21.8 D**	**6.0 B**	**24.4 D**	**12.59 E**	**10.97 E**	**22.7 E**	**5.8 B**	**25.6D**	**13.65E**	**11.97 E**
Boron foliar application										
0 mg B L^{-1}	**24.2 C**	**4.9C**	**25.9B**	**13.91C**	**12.02C**	**25.2C**	**5.4C**	**27.2C**	**15.00C**	**12.95C**
50 mg B L^{-1}	**25.4 B**	**5.7B**	**27.0A**	**15.60B**	**12.64B**	**26.5B**	**6.2B**	**28.2B**	**16.71B**	**13.30B**
100 mg B L^{-1}	**26.7A**	**6.9A**	**28.0A**	**16.66A**	**13.18A**	**27.8A**	**7.4A**	**29.2A**	**17.83A**	**13.79A**

Means of the same column followed by the same letter were not significantly differed according to Duncan MRT at 5%.

It is evident from data in Table 6 that, interactions between the studied factors recorded also significant effects on chemical composition of potato tubers (P>0.05). Such relations highlighted the significance of fertilization (source) on tuber chemical components which played probably more significant effects in this concern than spraying plants with the investigated foliar boron. This is because the increases in NPK contents as well as carbohydrate and starch percentages recorded in potato tubers that received chicken manure tea and foliar spray by 100 mg L^{-1} of boron were the highest among the studied fertilization treatments, this results are similar with **Tantawy et al. (2017).**

Table 6. Effect of interaction between organic fertilizers tea and boron foliar application on tuber quality (chemical constituents) of potato tubers during the summer seasons of 2017 & 2018.

Treatments		First Season					Second season				
Organic fertilizer tea (OFT)	Boron foliar application	N (mg g^{-1})	P (mg g^{-1})	K (mg g^{-1})	Carbohydrate %	Starch %	N (mg g^{-1})	P (mg g^{-1})	K (mg g^{-1})	Carbohydrate %	Starch %
Chicken manure	0 mg B L^{-1}	27.0 bc	5.42 b-d	28.1 b-d	16.12 c-f	13.76 bc	28.2 bc	5.3 de	29.3 a-d	17.59 c-e	14.25 cd
	50 mg B L^{-1}	28.6 ab	6.6 b	29.7 ab	17.98 a-c	14.12 b	29.4 ab	5.6 c-e	30.1 ab	18.76 b	14.87 ab
	100 mg B L^{-1}	29.8 a	9.4 a	30.5 a	19.87 a	14.85 a	30.5 a	6.8 bc	31.1 a	20.23 a	15.14 a
Rabbit manure	0 mg B L^{-1}	25.6 c-e	4.6 c-e	26.5 c-f	15.25 e-h	13.12 cd	26.3 c-e	4.6 e	27.8 c-f	16.49 fg	13.83 d
	50 mg B L^{-1}	26.7 b-d	5.6 bc	28.4 a-c	17.52 b-d	13.46 b-d	27.8 b-d	6.6 b-d	29.7 a-c	18.14 bc	14.19 cd
	100 mg B L^{-1}	28.3 ab	6.2 b	29.3 ab	18.17 ab	13.93 b	29.1 ab	8.2 a	30.2 ab	19.77 a	14.47 bc
Compost	0 mg B L^{-1}	24.6 ef	3.6 e	25.9 e-h	13.97 g-i	12.19 ef	25.7 d-f	5.6 c-e	27.3 d-g	14.71 hi	13.05 e
	50 mg B L^{-1}	25.5 c-e	4.1 de	26.8 c-f	15.64 d-g	12.82 de	26.4 c-e	6.8 bc	28.4 b-f	16.98 d-f	13.14 e
	100 mg B L^{-1}	27.1 bc	5.5 b-d	27.8 b-e	16.57 b-e	13.13 cd	28.3 bc	8.4 a	29.6 a-c	17.87 b-d	13.85 d
Biochar	0 mg B L^{-1}	23.2 fg	5.6 bc	25.2 f-h	12.56 ij	10.96 h	24.5 e-g	6.0 b-d	26.5 f-h	13.76 i	12.18 gh
	50 mg B L^{-1}	24.7 de	5.7 bc	26.1 d-g	14.25 f-i	11.67 f-h	26.0 d-f	6.2 b-d	27.7 c-f	15.79 g	12.36 gh
	100 mg B L^{-1}	25.4 c-e	6.7 b	27.1 c-f	15.18 e-h	12.25 ef	26.8 cd	7.3 ab	28.7 b-e	16.66 e-g	12.96 ef
Without OFT	0 mg B L^{-1}	20.8 h	5.3 b-d	23.8 h	11.64 j	10.07 i	21.4 h	5.4 de	24.9 h	12.47 j	11.46 i
	50 mg B L^{-1}	21.6 gh	6.1 b	24.2 gh	12.63 ij	11.12 gh	22.7 gh	5.6 c-e	25.3 gh	13.88 hi	11.92 h
	100 mg B L^{-1}	23.0 fg	6.3 b	25.1 f-h	13.49 h-j	11.73 fg	24.1 fg	6.5 b-d	26.6 e-h	14.61 hi	12.53 fg

Means of the same column followed by the same letter were not significantly differed according to Duncan MRT at 5%.

Under such condition it may be recommended by application of either chicken manure or rabbit manure teas, with foliar spray by boron at 100 mg L^{-1} recorded the highest increases in the tuber yield of potato and its components, chemical components of potato tubers (N, P, K, carbohydrates and starch) increased significantly with added chicken manure tea as a soil addition combined with foliar spray with B at 100 mg L^{-1}.

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شاي الأسمدة العضوية ورش البورون كمرشحين لتحسين خصائص النمو والإنتاجية و الجودة لنباتات البطاطس (*Solanum tuberosum* L)

همت ابراهيم السعدني1 ومصطفي حمزه محمد1 وهدي فاروق زهران2 وعبد الحكيم سعد شمس1.

1- قسم البساتين – كلية الزراعة – جامعة بنها

2- معهد بحوث البيئة والمواد الطبيعية – مدينة الأبحاث العلمية والتطبيقات التكنولوجية – مدينة برج العرب الجديدة

أجريت تجربة حقلية خلال موسمي الزراعه الصيفي المتتالين لعامي 2017 – 2018 بمزرعه خاصة بمدينة كوم حماده محافظة االبحيره– جمهورية مصر العربية. لدراسة تأثير الاضافات الارضية بانواع مختلفه من شاي الاسمده العضويه (شاي سماد الدواجن-شاي سماد الارانب شاي سماد الكمبوست –شاي البيوشار). مع الرش الورقي بالبورون عند تركيز صفر ملليجرام فى اللتر و 50 ملليجرام فى اللتر و100 ملليجرام فى اللتر وكذلك التفاعل بينهما وتأثير ذلك علي النمو الخضري والتركيب الكيميائي للمجموع الخضري للنبات، والمحصول الكلي للدرنات والتركيب الكيميائي وصفات الجوده لدرنات البطاطس (صنف بيليني) .

اوضحت النتائج المتحصل عليها ان اعلي القيم تم الحصول عليها عند الاضافه الارضيه بشاي سماد الدواجن مع الرش بالتركيز الاعلي من البورون 100(ملليجرام فى اللتر) حيث اعطت اعلي القيم في كل من صفات النمو الخضري. علاوه علي ذلك فان استخدام شاي سماد الدواجن او الارانب مع النيتروجين والفوسفور والبوتاسيوم بالكميات الموصي بها فى وجود الرش بالبورون عند تركيز(100 ملليجرام فى اللتر) سجل اعلي زياده في محصول درنات البطاطس، وان أفضل محتوي كيميائى للدرنات من النيتروجين والفوسفور والبوتاسيوم والكربوهيدرات والنشا تحقق عند استخدام شاي سماد الدواجن مع الرش بالبورون عند تركيز (100 ملليجرام فى اللتر) مقارنة بباقى معاملات التجربة وفى كلا الموسمين.

الكلمات الداله : بطاطس – شاى السماد العضوى – بورون – شاى سماد الدواجن – شاى الكمبوشت – شاى البيوشار – جوده البطاطس