Table 4: Effect of two type of growth regulator at different rates with two sources of boron at two rates of macronutrients on micronutrients contents of sugar beet plants after 90 days from sowing.

Boron sources (B)	Macronutrients at 100% of recommended dose							Macronutrients at 75% of recommended dose						
	Control	Gibberellin (mg l^{-1})			Proline (mg l^{-1})			Control	Gibberellin (mg l^{-1})			Proline (mg l^{-1})		
		100	200	Mean	100	200	Mean		100	200	Mean	100	200	Mean
Zinc (mg kg^{-1})														
Control	13.66	15.06	14.88	14.53	15.70	17.35	15.57	12.40	15.01	13.90	13.77	14.92	18.56	15.29
Boric a.	15.48	18.42	17.36	17.09	16.96	19.84	17.43	13.85	20.44	19.60	17.96	18.14	22.40	18.13
B-NPs	17.08	24.92	20.38	20.79	20.62	23.81	20.50	15.54	27.30	21.02	21.29	21.65	26.74	21.31
Mean	15.65	19.47	17.59	17.52	17.76	20.33	17.87	13.93	20.92	18.17	17.67	18.24	22.57	18.25
Cupper (mg kg^{-1})														
Control	0.86	1.30	1.08	1.08	1.21	1.58	1.22	0.75	1.45	1.24	1.15	1.25	1.45	1.15
Boric a.	0.93	1.56	1.44	1.31	1.34	1.61	1.29	0.86	1.74	1.46	1.35	1.34	1.61	1.27
B-NPs	1.32	1.71	1.56	1.53	1.49	1.75	1.52	1.06	1.96	1.52	1.51	1.51	1.93	1.50
Mean	1.04	1.52	1.36	1.31	1.35	1.65	1.35	0.89	1.72	1.41	1.34	1.37	1.66	1.31
Iron (mg kg^{-1})														
Control	24.46	59.42	43.54	42.47	40.72	55.54	40.24	20.40	55.10	42.48	39.99	41.00	53.64	38.35
Boric a.	25.38	61.57	46.22	44.39	54.60	56.39	45.46	23.32	68.80	40.17	44.10	53.68	71.82	49.61
B-NPs	29.94	65.81	47.31	47.69	59.17	61.31	50.14	26.41	85.20	65.40	59.00	62.16	87.42	58.66
Mean	26.59	62.27	45.69	44.85	51.50	57.75	45.28	23.38	69.70	49.35	47.59	52.28	47.63	44.98
Manganese (mg kg^{-1})														
Control	17.70	20.16	18.76	18.87	18.86	20.94	19.17	16.18	22.58	20.44	19.73	21.68	23.08	20.31
Boric a.	19.72	25.48	23.78	22.99	21.98	25.52	22.23	18.42	28.16	25.36	23.98	24.80	27.90	23.71
B-NPs	21.02	27.32	25.02	24.45	24.86	26.94	24.27	19.92	30.78	27.78	26.16	26.76	30.50	25.73
Mean	19.48	24.32	22.52	22.11	21.90	24.47	21.92	18.17	27.17	24.53	23.29	24.41	27.18	23.25

L.S.D. at 0.05

	B	G	R	B x G	B x R	G x R	B x G x R
Zn	0.54	0.32	0.11	0.23	0.15	0.23	0.15
Cu	0.09	0.10	0.08	0.03	0.12	0.03	0.06
Fe	0.23	0.22	0.42	0.24	0.35	0.33	0.41
Mn	1.22	0.91	1.20	0.93	0.15	1.10	1.01

B = Boron sources; G = Plant growth regulator sources and R = Rate of Plant growth regulator.

Regard to macronutrient rates applied, data revealed that the full dose was superior compared to 75% this result may be due to the optimum rate of macronutrients increases photosynthetic processes, leaf area production, leaf area duration as well as net assimilation rate.

Finally, macronutrients applied at rate 75% with foliar application of gibberellin at rate 100 mg l^{-1} was more effective when accompanied with nano boron in micronutrients content of sugar beet roots compared to other treatments used.

d- Yield and sugar yield of sugar beet

Data in Table, 5 revealed that the foliar application of gibberellin at rate 100 mg l^{-1} and proline at 200 mg l^{-1} gave higher response in yield and sucrose yield.

Root yield and sucrose yield of sugar beet plants were affect to application of different boron sources as results obtained in Table, 5. Data showed that the application of B-NPs was more response than boric acid.

Moreover, the interaction between plant growth regulators and boron give higher response in root yield and sucrose yield.

Regard to macronutrient rates applied, data in Table 5 also, represented that the application of 100% macronutrients give better response this is due to the abundant availability of nutrients for prober sugar beet plants growth where the importance of each element during plant life.

Yet, the interaction between all treatments and parameters of sugar beet roots under study gave high values at the combination between applications of macronutrients at rate 75 % with nano boron and gibberellin at rate 100 mg l^{-1} and proline at 200 mg l^{-1} in both yield and sugar yield of sugar beet plants at harvest stage.

Table 5: Effect of two type of growth regulator at different rates with two sources of boron at two rates of macronutrients on yield and sugar yield of sugar beet plants at harvest stage.

Boron sources (B)	Macronutrients at 100% of recommended dose							Macronutrients at 75% of recommended dose						
	Control	Gibberellin (mg l^{-1})			Proline (mg l^{-1})			Control	Gibberellin (mg l^{-1})			Proline (mg l^{-1})		
		100	200	Mean	100	200	Mean		100	200	Mean	100	200	Mean
Root yield (Mg ha^{-1})														
Control	57.44	70.34	67.36	65.05	66.10	70.59	64.71	56.11	75.19	70.71	67.34	66.52	71.58	64.74
Boric a.	60.19	77.96	71.82	69.99	68.05	73.19	67.14	57.63	78.49	73.04	69.72	71.11	75.80	68.18
B-NPs	61.94	84.26	76.11	74.10	69.67	75.16	68.92	59.60	87.22	77.76	74.86	71.96	84.57	72.04
Mean	59.86	77.52	71.76	69.71	67.94	72.98	66.93	57.78	80.30	73.84	70.64	69.86	77.32	68.32
Sucrose yield (Mg ha^{-1})														
Control	9.24	11.61	10.89	10.58	10.84	11.75	10.61	8.98	13.27	11.89	11.38	11.28	12.17	10.81
Boric a.	9.92	13.21	11.89	11.67	11.30	12.35	11.19	9.41	14.36	12.34	12.04	12.16	13.11	11.56
B-NPs	10.34	14.62	12.71	12.56	11.70	12.79	11.61	9.78	16.49	13.69	13.32	12.26	15.01	12.35
Mean	9.83	13.15	11.83	11.60	11.28	12.30	11.14	9.39	14.71	12.64	12.25	11.90	13.43	11.57

L.S.D. 0.05	B	G	R	B x G	B x R	G x R	B x G x R
Root yield	0.32	0.15	0.31	0.21	0.11	0.24	0.18
Sucrose yield	0.91	0.11	0.21	0.16	0.22	0.15	0.19

B = Boron sources; G = Plant growth regulator sources and R = Rate of Plant growth regulator

Discussion

Economic conditions in modern agriculture demand high crop yields in order to be profitable and consequently meet the high demand for food that comes with population growth.

The previously data showed that the foliar application of plant growth regulators showed increase in the nutritional status, sucrose yield and productivity of sugar beet at 100 mg l^{-1} of gibberellin and 200 mg l^{-1} of proline This may be due to the gibberellin plays an important role in internode elongation (Ross *et al.*, 1997), stimulates cell division, expansion and increases the use efficiency of nutrients in response to light or dark (De Lucas *et al.*, 2008; Gallego-Bartolomé *et al.*, 2011). Proline, a multifunctional amino acid, besides acting as an excellent osmolyte and stabilizing subcellular structures such as proteins and cell membranes, scavenging free radicals, balancing cellular homeostasis and signaling events and buffering redox potential under stress conditions (Hayat *et al.*, 2012). It could be reflecting on maintaining the nutrient status in roots. This report is in conformity with the increased nitrate content of roots by exogenous application of proline (Alyemeni *et al.*, 2016). Moreover, gibberellin is endogenously synthesized hormone that regulates stem cell elongation. Gibberellin acts through its nucleus-localized receptor, GID1 (Gibberellin-Insensitive Dwarf1), and like auxin, this binding induces degradation of transcriptional repressor proteins, DELLA which have a characteristic conserved motif Asp-Glu-Leu-Leu-Ala, at the amino terminus (Haruta and Sussman, 2017).

Eid and Abou-Leila (2006) reported that the gibberellin application increased the N, P, K, Mg, Fe, Zn, Mn and Cu content of plants, thereby increasing the mineral nutrient status of the plant. The increased nutrient content enhanced photosynthetic potential of leaves, source strength and increased the mineral nutrient levels of plant roots and shoots (Al-Rumaih, Rushdy and Warsy, 2003). Since GA_3 is increasing the efficiency of plants in terms of photosynthetic activity, enhancing nutrients uptake, nutrients translocation and improving its mobilization, thus GA_3 might be increased the yield (Ali *et al.*, 2019). According to (Nilanjan, 2013) who stated that boron nano as fertilizers of embodiments herein a sharp increase in crop yield and quality.

This results was in agreement with (Soad, 2005) who to gibberellin foliar application. Also, the exogenous application of plant growth regulators improve crop productivity and the nutritional quality of crop plants through improved photosynthesis and nutrient uptake and through accumulation within the plant body (Niu *et al.*, 2016). Moreover, proline also functions as a sink for energy to regulate redox potentials (Blum and Ebercon, 1976) as a hydroxyl radical scavenger, solute that protects macromolecules against denaturation (Schobert and Tschesche, 1978), reducing the acidity in the cell (Venekamp *et al.,* 1989) and acts as storage compound and nitrogen source for an after-stress rapid growth (Singh *et al.*, 1973).

Also, result attribute to gibberellin is growth promoter which has the ability to increase mitosis in the sub apical regions of apical meristems, stimulating cell divisions in the intercalary meristems and causing elongation of cell, cell division and increasing the length of internode (Thomson *et al.,* 2015). Also, the foliar spray of proline caused an increase in apical meristem and cell division, which improved the plant height (Ali *et al.*, 2013). Plant growth regulators may be employed to improve crop performance in terms of yield and seed nutritional quality through the modulation of plant growth and physiological processes such as the photosynthetic efficiency and nutrient dynamics within the plant body (Anjum *et al.*, 2016).

Regard to the boron sources the obtained data revealed that the foliar application of B-NPs was more response than boric acid this results may be due to (Dewdar *et al.*, 2018) who reported that nanofertilizer can either provide nutrients for the plant or aid in the transport or absorption of available nutrients resulting in better crop growth, nano-fertilizers have great impact on the soil, can reduce the toxicity of the soil and decrease the frequency of fertilizer application. Also, Allen and Pilbeam (2007) emphasized that sugar beet crop has high requirements for boron when adequate boron nutrition is critical for high yield and quality of crops. They also reported that boron increases the rate of transport of sugars from source to sink. Abido (2012) stated that the advantage of boron application may be due to the function of boron in increasing plant metabolism, development and growth. Liu and Lal (2015) who reported that utilization of nanoparticles to plants can be advantageous for development and advancement because of its capacity for more noteworthy absorbance and high reactivity. Additionally, Nanotechnology can be used in crop production to improve growth and increase yield (Reynolds, 2002). Abbas M. Mahmoud (2020) .found that foliar application at 20 ppm of nano silver had the highest figures of fruit yield per gm and fruit yield per kg. Addition of nano silver in foliar application at 20 ppm gave the highest figures of yield characteristics compared with other treatments.

Moreover, macronutrient rates applied the results showed that the application of macronutrients at full dose was more effective than at 75% where, Lošák *et al.*, (2010) confirmed that under various patterns of N supply, plants have shown elaborate reaction in relation to physiological and morphological levels to regulate their development and growth. Pavlíková *et al.*, (2012) reported that phytohormones are strongly connected to nitrogen signaling. These results were confirmed by (Abdelaal, 2015) who stated that shoot and root fresh weight, toot length and root radius significantly decreased as a result of 75% macronutrients compared to the application of full dose. This can result from the nutrient being a raw material for synthesis of a product but also from its involvement in enzymatic activities will lead to increased amount of proteins due to increased activation of enzymes that metabolize carbohydrates for synthesis of amino acids and proteins (Njira and Nabwami, 2015). Also Pavlíková *et al.* (2012) suggested that cytokinin metabolism and translocation were adjusted by N nutritional status in plants. The primary macronutrients play a significant role during the entire plant life by performing various beneficial activities in plant metabolism. Nitrogen is also regarded as the essential component of all proteins and enzymes and further performs in various metabolic processes of energy transformation. Therefore, sufficient amount of N availability in plants is required, because it is one of the major key factors of crop production (Nadeem *et al.*, 2014). Phosphorus plays an important role in an array of cellular processes, including maintenance of membrane structures, synthesis of biomolecules and formation of high-energy molecules. It also helps in cell division, enzyme activation/inactivation and carbohydrate metabolism (Razaq *et al.*, 2017). Potassium has two main functions, it plays an important role in activation of basic enzymes for protein production and sugars, also potassium protects the water content in plants by help in maintain the turgor of the cells which protect vitality of the leaf and consequently, photosynthesis proceeds efficiently (Çalişkan and Çalişkan, 2019).

Conclusion

From the presented study, it might be concluded that the application of 75% macronutrients was the best treatment for plant growth parameters (fresh and dry weigh), micro nutrients content and total yield of roots with yield production of sucrose of sugar beet plants (*Beta vulgaris* L. *var.* Sara poly) when accompanied with nano boron as an nano micronutrient fertilizer source with proline at rate of 200 mg l^{-1} than 100% with boric acid and proline 100 mg l^{-1} and control treatment of sugar beet quality grown in clay soil.

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