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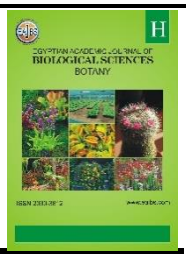

Growth and Quality of Sugar Beet and Its Relationship to Sowing Method, Nitrogen and Boron Fertilization

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ABSTRACT

Two field experiments were carried out at Itay El-Baroud Experimental station in El-Beheira Governorate, Agriculture Research Center, Egypt in the 2019/2020 and 2020/2021 winter seasons to study the effect of four different systems to display the ridge in the planting of sugar beet (ridge width 110 cm (Rw1), ridge width 100 cm (Rw2), ridge width 90 cm (Rw3) and ridge width 80 cm (Rw4), four nitrogen fertilizer levels (75 kg N /fed (N1), 90 kg N /fed (N2), 105 kg N /fed (N3) and 120 kg N /fed (N1) and three systems of boron foliar spray (zero boron (B0), foliar spray once of boron at 95 days from sowing (B1) and Foliar spray twice of boron at 95 and 125 day from sowing (B2) on growth, yield and quality characters of sugar beet. Results showed that planting sugar beet on a wider ridge of 110 cm recorded the highest chlorophyll content and crop growth rate while planting sugar beet on a narrow ridge of 80cm resulted in the highest leaf area index. Grown sugar beet on a narrow ridge of 90cm resulted in the highest root yield, sugar yield /fed and quality in both seasons. Increasing nitrogen fertilizer levels from 75 to 90, 105 and 120 kg N /fed significantly decreased root yield, sugar yield/fed and quality in both seasons. Whereas increasing foliar spray of boron from zero to one and twice foliar spraying increased root yield, sugar yield/fed and quality. It could be concluded from these results that planting sugar beet on ridge narrow of 90 cm, 75 kg N/fed and twice foliar spraying of boron are the suitable recommendation to maximize sugar beet productivity and quality.

INTRODUCTION

Sugar beet is one important of the most efficient converter of solar energy into chemical energy and has the potential for augmenting sugar production at a lower cost (Ahlawat *et al.*, 2002). In Egypt, it is the second sugar crop after sugarcane. The Egyptian Government imports large amounts of sugar every year to contribute to reducing the sugar deficiency gap. The area of sugar beet 720000 feddan it was productive 14409160 ton (The Ministry of Agriculture and Land Reclamation (2021).

Ridge width: 50cm widthx20cm between hills (42000plants/fed) significantly produced the highest root and sugar yields/fad, but the increasing ridge width from 60cm widthx20cm between hills (35000plants/fed) to 40 cm row width x15cm between

hills(70000plants/fed) decreased root length, root diameter and fresh weight of the individual roots, while sucrose and purity percentages increased (Nassar, 2001). The highest yield was obtained by planting 111111 plants per hectare, compared to the number of plants per hectare of 55,555 plants (Ramazan, 2002). Cultivation sugar beet at a plant density of 100000 plants ha^{-1} gave significant increases in root diameter, but it did not affect the root length and total soluble solids (Nemeat-Alla *et al.*, 2007).

Regarding nitrogen fertilizer, increasing nitrogen doses from 69 up to 119 kg/fad significantly increased root diameter, root fresh weight and root yield, but decreased sucrose percentage by 12.50 % (Ismail and Abo El-Ghait, 2005). The optimal use of nitrogen fertilizer has a positive effect on production. However, excessive nitrogen fertilization does not always lead to higher yields, and may in fact result in reduced growth and yield. Excessive nitrogen fertilization not only delays plant maturation but also limits the formation of storage organs, especially for tuberous crops (Najm *et al.*, 2013).

Boron is by far the most important spraying boron foliar or in the soil has the same efficacy, hence the fresh weight of the rootstock, and sucrose significantly increased by increasing the levels of boron (Jaszczolt, 1998). The highest root, top, sugar yields/fed and root quality were produced with 140 (N2) kg N/fed and 120 (B4) and/or 150 (B5) ppm boron (Mekdad, 2015).

The aim of this study is to evaluate the performance of some planting systems to show the width of the ridges under different N fertilizer levels with the efficiency of boron foliar spraying that achieves the highest productivity and quality.

MATERIALS AND METHODS

Two field experiments were carried out at Itay El-Baroud Experimental station in El-Beheira Governorate, Agriculture Research Center, Egypt in 2019/2020 and 2020/2021 winter seasons to study the effect of four systems for ridge width (growing sugar beet on ridge width 110 cm (Rw1), growing sugar beet on ridge width 100 cm (Rw2), growing sugar beet on ridge width 90 cm (Rw3) and growing sugar beet on ridge width 80 cm (Rw4), four nitrogen fertilizer levels (75 kg N /fed (N1), 90 kg N /fed (N2), 105 kg N /fed (N3) and 120 kg N /fed (N1) and three systems of boron foliar spray (Foliar spray of water (B0), Foliar spray once of boron at 95 days from sowing (B1) and Foliar spray twice of boron at 95 and 125 days from sowing (B2) on growth, yield and quality characters of sugar beet (*Beta vulgaris, L.*) Kawemira cv. as follow:

Sowing sugar beet on the two sides at 20cm between hills (one plant/hill) for all planting systems. In the system of ridge 110cm width was 38181plant /fed, in the system of ridge 100cm width was 42000 plant /fed, in the system of ridge 90 cm width was 46666 plant /fed and in the system of ridge 80cm width was 52500 plant /fed.

Nitrogen was added in the form of urea (46.5% N). In the level, 75 kg N/fed has added 161.29 kg urea /fed, in the level 90 kg N/fed has added 193.55 kg urea /fed, in the level 105 kg N/fed was added 225.81 kg urea /fed and in the level 120 kg N/fed has added 258.06 kg urea /fed, which were added on the two equal doses, immediately before the first and second irrigation. Phosphorous was added to 100 kg /fed from calcium super phosphate (15.5% P_2O_5) when preparing the land for planting and Potassium was added to 50 kg/ fed from potassium sulfate (48% K_2O), before the first irrigation direct. The three systems of boron foliar spray in the form of boric acid at a rate of 1 liter/fed. The foliar solutions volume was 200 L/fed conducted by hand sprayer.

Table 1: Mechanical and chemical analysis of experimental soil was carried out before planting in 2018/2019 and 2019/2020 seasons.

Soil properties	Soil texture	Sand %	Silt %	Clay %	PH	Organic matter%	Available N mg/kg	Available P mg/kg	Available K mg/kg	EC 1:2, water extract)
2019/2020	Clay	28.3%	38.oo%	33.7%	7.8	2.25%	21	31mg/kg	300mg/kg	1.13 ds/m
2020/2021	Clay	28.53%	37.83%	33.64%	7.81	2.24%	22	30mg/kg	301mg/kg	1.14 ds/m

A split split-plot design with three replications. Four systems of ridge width were allocated in the main plots, four nitrogen fertilizer levels were distributed at random in the sub-plots and three systems of boron folia spray were arranged at random in the sub-sub-plot. The area per sub-sub-plot is fixed in all plots (3 ridges, 3.30 ridges, 3.67 ridges and 4.11 ridges in 110 cm, 100 cm, 90cm and 80 cm ridges width, respectively) the length was 3.50 m (plot area was 11.55 m^2). All the other culture treatments were done according to the recommendation of the Ministry of Agriculture and Land Reclamation.

The preceding crop was maize in the first and second seasons, while sugar beet was planted on 15th and 17th Oct. and harvested on 15th and 17th May in the first and second seasons, respectively.

Studied Characters:

Growth Parameters:1- Chlorophyll content, at the age of 90 days, determined according to the method described by (CCM-200).

After 60, 90 and 120 days from planting, was taken a sample of each subplot to estimate the percentage of:2- Crop growth rate (CGR), (g / plant/day). CGR was calculated according to the following formula.

$$\text{CGR} = \frac{Dry\ mater}{Number\ of\ days\ to\ physiological\ maturity} \quad g/plant/day.$$

3- Leaf area index, (L.A.I.) was determined according to the following formula.

$$\text{Leaf area index} = \frac{\text{Leaf area /plant } (cm^2)}{\text{Ground area/plant}(cm^2)}$$

Yield Attributes:

1- Root yield (ton /fed), 2- Top yield (ton /fed) and 3-Biological yields (ton /fed) were taken at random from the whole sub-sub-plot. 4-Sugar yield (ton /fed): it was computed according to the following formula: White Sugar yield (ton/fed.) = root yield (ton/ fed) x (Z B) white sugar percentage.

where, ZB= pol –{0.343(k+Na)+0.094 and N+ 0.29}.

Chemical Components and Quality:1- Total soluble solids percentage (T.S.S. %) of roots, was measured in the juice of fresh root using a hand refractometer according to (A.O.A.C. 1990), 2- Sucrose %, which was used saccharimeter according to Le-Decote (1972), 3- Juice purity %, it was calculated according to Carruthers and Oldfield (1961) as follows:

$$\text{Juice purity\%} = \frac{\text{Sucrose\%}}{\text{T.S.S.\%}} \text{x}100$$

,4- Sugar extractable%. Extracted sugar (white sugar) from beets: was calculated from non-sugar beets K, Na and α-amino N (expressed as equivalent of a mill / 100 g of beets) according to Lee Harvey and Dutton (1993) as follows:

ZB = pol- [0.343 (K + NA) + 0.094 AmN + 0.29]

where: ZB = extractable white sugar, Pol = Gross sugar % and AmN = α-amino-N determined by the "blue number method" and 5-Alpha amino nitrogen (α- amino N), sodium (Na) and potassium (K) concentrations in juice (mill equivalent / 100 g of beets) according to Lee Harvey and Dutton (1993).

Statistical Analysis:

The obtained data were analyzed according to Snedecor and Cochron (1988). The treatment means were compared by using the least significant differences (L.S.D.) at 5% of probability. was computed using CoStat V 6.4 (2005) program.

RESULTS AND DISCUSSION

1- Growth and Yield Characteristics of Sugar Beet:

1.1. Ridges Width.

Growth characters were significantly affected by ridges width in the two growing seasons as shown in Table (2). The highest values of chlorophyll leaf content and crop growth rate (54.21 and 55.35 as well as 1.76 and 1.78 g/day) were obtained by planting sugar beet on 110 cm ridge width (Rw1), while the lowest values (49.88 and 50.74 as well as 1.60 and 1.64 g/day) were recorded by sugar beet on 80 cm ridge width (Rw4) for these characters in both seasons, respectively. Increasing plant densities decreased fresh weight (Nassar, 2001). The highest leaf area index (6.41 and 6.54) was achieved when planting sugar beet on 80 cm ridge width. Meanwhile no significant difference between the planting sugar beet on ridges 90cm or 80cm in width. While the lowest leaf area index (5.59 and 5.55) resulted from planting sugar beet on 110 cm ridge width in both seasons, respectively. The number of shoots and stems per m^2 in the triple-row planting was found to be higher than in the double-row planting and the difference between them was significant at a 5% level (Dehkordi, 2016).

Yield traits were significantly affected by ridges width in both seasons. Data in Table (2) obtained that, the highest values of root yield, top yield, biological yield and sugar yield (ton/fed) (30.390 and 31.127, 12.165 and 12.001, 41.989 and 43.153 and 5.120 and 5.092 ton) were revealed by planting sugar beet on 90cm narrow ridges, whereas grown sugar beet on ridges 110cm (Rw1) recorded the lowest values for these characters in both seasons, respectively. Takada *et al.* (1993) found that 50 cm row width increased sugar beet root yield by 1% as compared to 60 cm row width.

1.2. N fertilizer Levels:

N fertilizer levels had significant effects on the growth of sugar beet in the two studied seasons. Added 90 kg N/fed (N2) resulted in the highest chlorophyll content and CGR, while added 75kg N/fed resulted in the highest LAI in both seasons. Similar results were found by Seadh *et al.* (2007) and Seadh (2008).

N fertilizer levels had a significance on the yield of sugar beet in 2019/2020 and 2020/2021 seasons. N1 levels gave the highest values (29.253 and 29.945, 40.556 and 40.901 and 4.707 and 4.901 ton), whereas N4 levels recorded the lowest values for root yield, and biological yield (ton/fed) in both seasons, respectively. While N4 fertilizer level recorded the highest top yield/fed in both seasons, which was (12.743 and 12.392 tons). Excessive applications of N fertilizers result in delayed maturity and competition between sink (tubers) and supply (leaves) and may lower yields (Najm *et al.,* 2013).

1.3. Foliar spray of boron (B).

Growth characters were significantly affected by foliar spray of boron in the two growing seasons as shown in Table (2). Foliar spraying twice with boron (B2) gave the highest values (54.32 and 54.31, 1.74 and

1.79g as well as 6.36 and 6.34) for chlorophyll content, CGR and LAI in the first and second seasons, respectively. These results may be due to the optimum fertilization with minor elements such as boron is important for sugar beet plants grown. Similar results were obtained by El-Hawary (1994) and El-Hawary (1999).

Yield characters were significantly affected by foliar spray of boron in the two studied seasons as presented in Table (2). Foliar spraying twice with boron (B2) gave the

highest values (28.954 and 29.431, 12.068 and 11.761, 40.999 and 41.191 as well as 4.878 and 4.839 ton) for root yield, top yield, biological yield and sugar yield (ton/fed), while without boron (B0) recorded the lowest values of these characters in both seasons, respectively. Boron is by far the most important micro-elements needed in sugar beet because, without boron supply, the yield and quality of roots are very depressed. Similar results were found by Abbas *et al.* (2014) and Mekdad (2015).

Table 2: Effect of ridges width, N fertilizer levels and foliar spraying of boron on sugar beet during 2019/2020 and 2020/2021 seasons.

Factors	Character													
	Chlorophyll content		Crop growth rate (g/day)		Leaf aria index (LAI)		Root yield (ton/fed)		Top yield (ton/fed)		Biological yield(ton/fed)		Sugar yield (ton/fed)	
	2019/20	2020.21	2019/20	2020.21	2019/20	2020.21	2019/20	2020.21	2019/20	2020.21	2019/20	2020.21	2019/20	2020.21
Rw1	54.21a	55.35a	1.76	1.78	5.59	5.55	25.678	26.271	11.385	10.814	37.063	38.085	4.016	4.274
Rw2	54.00a	55.21a	1.70	1.74	6.31	6.24	29.361	29.994	11.667	11.479	41.028	41.474	4.665	4.755
Rw3	53.03b	53.95b	1.68	1.71	6.46	6.44	30.390	31.127	12.165	12.001	41.989	43.153	5.120	5.092
Rw4	49.88c	50.74c	1.60	1.63	6.41	6.54	27.523	28.121	11.875	11.694	39.602	39.815	4.486	0.067
LSD 5%	0.261	0.234	0.021	0.030	0.095	0.103	0.158	0.212	0.175	0.221	0.586	0.672	0.067	0.082
N1	54.14a	55.10a	1.65	1.71	6.15	6.10	29.253	29.945	10.801	10.457	40.556	40.901	4.707	4.901
N2	54.13a	55.26a	1.69	1.76	6.09	6.07	28.581	28.734	11.428	11.204	40.008	40.438	4.727	4.699
N3	51.73b	52.75b	1.61	1.68	6.28	6.25	27.202	27.958	12.121	11.935	39.823	40.468	4.396	4.516
N4	51.11c	52.14c	1.63	1.70	6.24	6.35	26.413	27.875	12.743	12.392	39.861	40.717	4.222	4.449
LSD 5%	0.213	0.182	0.022	0.029	0.055	0.048	0.124	0.184	0.145	0.127	0.554	0.489	0.043	0.028
B0	52.17	53.19	1.56	1.62	6.04	6.06	27.637	28.783	11.463	11.249	39.100	40.033	4.570	4.449
B1	52.84	53.94	1.64	1.73	6.17	6.23	28.092	29.190	11.788	11.482	40.088	40.671	4.575	4.653
B2	53.32	54.31	1.74	1.79	6.36	6.34	28.954	29.431	12.068	11.761	40.999	41.191	4.878	4.839
LSD 5%	0.265	0.304	0.020	0.024	0.049	0.039	0.109	0.112	0.143	0.134	0.421	0.472	0.044	0.056

1.4. Interaction (RwxN):

Data in Table (3) discovered that all studied characters were significantly affected by the interaction between ridges width and N fertilizer levels, except chlorophyll content in the second season and biological yield in both seasons. Narrow ridges 80cm in width with (N4) N fertilizer level recorded the highest LAI and top yield/fed in both seasons. While no significant differences were found between narrow ridges 80 and 90cm under the same N fertilizer level (N4). Similar results were fending by (Ramazan, 2002 and Seadh, 2012). On the other hand, narrow ridges, 90cm with (N1) N fertilizer level recorded the highest values (32.065 and 32.750, 43.644 and 43.906 as well as 5.582 and 5.460 ton) of root yield, biological yield and sugar yield (ton/fed) in the two growing seasons, respectively. These seemed to have resulted from optimal density increased in production, while at the optimum dose the application of too little nitrogen will result in reduced root tonnage, however, the application of too much nitrogen will result in reduced sugar concentrations (Abdou and Selim, 2008 and Hergert, 2010).

1.5. Interaction (RwxB):

Data in Table (3) showed that wider ridges and foliar spraying twice with boron (B2) recorded the highest chlorophyll content and CGR, whereas narrowing ridges with the same rate of spray boron (B2) resulted in the highest root yield and sugar yield per fed in both seasons.

Table 3: Effect of interactions between ridges width with N fertilizer, ridges width with foliar spray of boron and N fertilizer levels with foliar spray of boron on sugar beet during 2019/2020 and 2020/2021 seasons.

Treatments		Chlorophyll content		Crop growth rate (g/day)		Leaf aria index (LAI)		Root yield (ton/fed)		Top yield (ton/fed)		Biological yield (ton/fed		Sugar yield (ton/fed)	
		2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20	2020/21
RwxN	N1	55.10	56.24	1.80	1.79	5.60	5.56	26.550	27.718	9.818	9.369	36.368	37.088	4.174	4.387
Rw1 (110cm)	N2	57.34	58.46	1.81	1.82	5.56	5.49	26.318	27.693	11.155	10.433	37.473	38.127	4.240	4.351
	N3	53.08	54.24	1.67	1.74	5.59	5.64	25.402	26.876	11.805	11.289	37.207	38.166	3.903	4.222
	N4	51.30	52.44	1.70	1.76	5.62	5.53	24.442	26.796	12.763	12.164	37.205	38.960	3.748	4.134
Rw2 (100cm)	N1	56.04	57.08	1.63	1.70	6.21	6.07	30.773	31.320	10.873	10.568	41.646	41.888	5.044	5.057
	N2	54.68	56.06	1.69	1.69	6.27	6.23	30.029	30.164	11.399	11.185	41.429	41.350	4.921	4.799
	N3	52.57	53.61	1.71	1.73	6.52	6.42	29.045	29.443	11.741	12.006	40.787	41.450	4.506	4.638
	N4	52.72	54.09	1.77	1.86	6.23	6.26	27.596	29.050	12.654	12.155	40.250	41.206	4.189	4.524
Rw3 (90cm)	N1	53.94	54.61	1.72	1.77	6.46	6.30	32.065	32.750	11.579	11.155	43.644	43.906	5.582	5.460
	N2	54.44	55.45	1.71	1.76	6.40	6.39	30.486	30.826	11.708	11.510	42.495	42.335	5.224	5.090
	N3	52.21	53.22	1.68	1.66	6.42	6.28	29.357	30.590	12.736	12.689	42.092	43.079	4.883	4.901
	N4	51.51	52.50	1.61	1.65	6.58	6.59	29.354	30.340	12.634	12.649	41.989	43.290	4.792	4.916
Rw4 (80cm)	N1	51.49	52.47	1.61	1.56	6.25	6.29	29.633	29.991	10.932	10.733	40.566	40.724	4.973	4.800
	N2	50.06	51.02	1.68	1.78	6.33	6.28	27.191	28.255	11.448	11.687	38.638	39.942	4.522	4.554
	N3	49.07	49.93	1.56	1.61	6.53	6.77	27.008	27.424	12.199	11.754	39.207	39.179	4.290	4.301
	N4	48.89	49.54	1.55	1.54	6.52	7.01	27.081	26.813	12.919	12.600	40.001	39.413	4.158	4.223
LSD at 5%		0.378	Ns	0.031	.035	0.097	0.089	0.220	0.149	0.357	0.226	Ns	Ns	0.077	0.086
RwxB	B0	53.45	54.58	1.66	1.69	5.41	5.55	25.024	27.062	11.110	10.599	36.134	37.661	3.697	4.112
Rw1 (110cm)	B1	54.50	55.63	1.72	1.80	5.64	5.66	25.734	27.296	11.417	10.839	37.150	38.135	4.001	4.298
	B2	54.67	55.83	1.87	1.85	5.73	5.70	26.276	27.456	11.628	11.003	37.904	38.459	4.351	4.412
Rw2 (100cm)	B0	53.53	54.81	1.64	1.64	6.17	6.01	28.706	29.605	11.426	11.250	40.131	40.855	4.311	4.520
	B1	54.07	55.37	1.68	1.75	6.28	6.29	29.393	30.103	11.706	11.356	41.099	41.460	4.645	4.723
	B2	54.41	55.45	1.79	1.84	6.48	6.44	29.985	30.275	11.868	11.830	41.853	42.090	5.039	5.022
Rw3 (90cm)	B0	52.28	53.03	1.60	1.64	6.29	6.25	29.839	30.829	11.745	11.680	41.584	42.508	4.827	4.872
	B1	53.21	54.21	1.69	1.73	6.39	6.39	30.516	31.170	12.187	12.061	42.703	43.230	5.174	5.117
	B2	53.59	54.59	1.76	1.76	6.70	6.55	30.816	31.457	12.561	12.261	43.376	43.718	5.360	5.286
Rw4 (80cm)	B0	49.43	50.34	1.59	1.52	6.31	6.45	26.979	27.638	11.569	11.467	38.549	39.105	4.214	4.294
	B1	49.57	50.55	1.62	1.64	6.36	6.59	27.557	28.190	11.842	11.669	39.399	39.858	4.478	4.476
	B2	50.63	51.35	1.68	1.71	6.55	6.72	28.649	28.536	12.212	11.944	40.861	40.479	4.765	4.638
LSD at 5%		Ns	Ns	0.038	0.047	0.096	0.091	0.212	0.217	0.279	Ns	Ns	0.537	0.087	0.091
NxB	B0	53.29	54.08	1.61	1.64	5.99	5.90	29.151	30.024	10.421	10.191	39.573	40.215	4.447	4.696
	B1	54.37	55.41	1.70	1.72	6.14	6.16	29.817	30.393	10.856	10.408	40.673	40.801	4.981	4.895
N1	B2	54.75	55.81	1.77	1.76	6.33	6.24	30.298	30.918	11.123	10.770	41.421	41.688	5.304	5.187
N2	B0	54.12	55.40	1.62	1.65	5.91	5.86	28.078	28.981	10.957	10.924	39.035	39.905	4.390	4.497
	B1	54.11	55.16	1.73	1.80	6.06	6.09	28.649	29.404	11.378	11.238	40.027	40.642	4.772	4.741
	B2	54.15	55.20	1.82	1.84	6.31	6.28	29.015	29.319	11.947	11.448	40.962	40.767	5.019	4.858
N3	B0	50.78	51.73	1.58	1.61	6.16	6.07	26.989	28.082	11.873	11.655	38.861	39.737	4.155	4.304
	B1	51.90	52.94	1.63	1.69	6.25	6.29	27.818	28.636	12.157	11.897	39.975	40.533	4.380	4.540
	B2	52.53	53.58	1.76	1.76	6.45	6.40	28.302	28.883	12.331	12.251	40.633	41.133	4.652	4.702
N4	B0	50.50	51.54	1.56	1.61	6.12	6.18	26.329	28.055	12.599	12.326	38.929	40.271	3.959	4.300
	B1	50.97	52.26	1.65	1.72	6.22	6.38	26.916	28.326	12.760	12.381	39.676	40.707	4.166	4.437
	B2	51.85	52.63	1.75	1.78	6.37	6.48	28.111	28.603	12.867	12.569	40.978	41.172	4.541	4.611
LSD at 5%		0.515	0.591	0.037	0.046	0.095	0.076	0.211	0.216	0.278	Ns	Ns	0.535	0.085	0.090

1.7. Interaction (RwxNxB):

All studied characters were significantly affected by an interaction between ridges width, N fertilizer levels and foliar spray of boron in both seasons, except biological yield as shown in Table (4). The highest chlorophyll content and CGR (57.47 and 58.60 as well as 1.94 and 1.91g/plant/day) when grown sugar beet on ridges 110cm apart with added (N2) N fertilizer level and (B2) boron rate in both seasons, respectively. When increasing the font width of the ridge increased the lightness of the sugar beet leaves, and leads to an increase in photosynthesis (El-Bakary, 2006). While narrow ridges achieved the highest LAI and top yield with an increase N fertilizer and when B2 boron rate in both seasons. Similar results were obtained by Zahoor (2007) and (Cai Baiyan and Ge Jingping, 2004)). Whereas the highest root yield and sugar yield (ton/fed) (32.734 and on ridges 90cm apart with N1 N fertilizer and B2 boron rate in the first and second seasons, respectively. These results were agreed upon by Kashem et al. (2015) and Sinta and Garo (2021).

Table 4: Effect of interaction between ridges width, N fertilizer levels and foliar spray of boron on sugar beet during 2019/2020 and 2020/2021 seasons.

Interaction RwxNxB			Chlorophyll content		Crop growth rate (g/day)		Leaf aria index (LAI)		Root yield (ton/fed)		Top yield (ton/fed)		Biological yield (ton/fed		Sugar yield (ton/fed)	
			2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20	2020/21
Rw1	N1	B0	53.37	54.50	1.72	1.73	5.43	5.33	25.958	27.500	9.430	9.050	35.388	36.550	3.894	4.266
		B1	56.07	57.20	1.81	1.81	5.63	5.83	26.708	27.813	9.924	9.225	36.632	37.038	3.973	4.370
		B2	55.87	57.01	1.89	1.84	5.74	5.81	26.984	27.842	10.099	9.833	37.083	37.675	4.655	4.524
	N2	B0	57.37	58.50	1.70	1.65	5.30	5.34	25.863	27.463	10.783	10.217	36.646	37.680	3.785	4.119
		B1	57.17	58.30	1.77	1.89	5.67	5.54	26.268	27.725	11.067	10.633	37.335	38.358	4.409	4.437
		B2	57.47	58.60	1.94	1.91	5.71	5.58	26.822	27.892	11.616	10.450	38.438	38.342	4.526	4.498
	N3	B0	52.07	53.20	1.60	1.68	5.55	5.60	24.720	26.783	11.537	11.058	36.257	37.841	3.662	4.085
		B1	53.39	54.50	1.66	1.75	5.59	5.65	25.535	26.883	11.894	11.325	37.429	38.208	3.959	4.234
		B2	53.78	55.01	1.76	1.79	5.62	5.66	25.950	26.963	11.984	11.485	37.934	38.448	4.087	4.348
	N4	B0	50.87	52.00	1.62	1.70	5.35	5.21	23.554	26.500	12.691	12.073	36.245	38.573	3.445	3.977
		B1	51.37	52.51	1.63	1.74	5.66	5.61	24.423	26.763	12.784	12.173	37.207	38.936	3.664	4.149
		B2	51.67	52.81	1.87	1.85	5.85	5.76	25.349	27.125	12.815	12.246	38.164	39.371	4.135	4.277
Rw2	N1	B0	55.47	56.51	1.62	1.67	5.96	5.79	30.208	30.660	10.681	10.360	40.889	41.020	4.531	4.680
		B1	55.87	56.92	1.61	1.71	6.22	6.16	30.601	31.240	10.879	10.640	41.480	41.880	5.165	4.960
		B2	56.77	57.80	1.66	1.75	6.44	6.22	31.509	32.060	11.060	10.704	42.569	42.764	5.435	5.530
	N2	B0	54.88	56.91	1.65	1.64	6.12	6.04	29.368	29.840	10.818	10.800	40.186	40.640	4.625	4.625
		B1	54.57	55.63	1.63	1.66	6.10	6.14	30.079	30.560	11.537	11.080	41.616	41.640	4.852	4.840
		B2	54.59	55.65	1.80	1.79	6.59	6.52	30.641	30.093	11.844	11.677	42.485	41.770	5.286	4.952
	N3	B0	51.77	52.80	1.60	1.63	6.36	6.08	28.389	29.370	11.657	11.800	40.046	41.170	4.258	4.483
		B1	52.87	53.91	1.68	1.73	6.51	6.53	29.290	29.333	11.764	11.620	41.054	40.953	4.394	4.624
		B2	53.08	54.11	1.84	1.86	6.69	6.64	29.457	29.627	11.803	12.600	41.260	42.227	4.866	4.808
	N4	B0	52.01	53.03	1.67	1.70	6.22	6.11	26.857	28.550	12.549	12.040	39.406	40.590	3.828	4.291
		B1	52.98	55.01	1.78	1.87	6.28	6.31	27.601	29.280	12.646	12.087	40.247	41.367	4.170	4.466
		B2	53.18	54.22	1.87	1.89	6.19	6.36	28.331	29.320	12.767	12.340	41.098	41.660	4.569	4.816
Rw3	N1	B0	53.41	53.42	1.63	1.73	6.33	6.27	31.247	32.326	11.107	11.045	42.354	43.371	5.156	5.172
		B1	54.11	55.10	1.74	1.78	6.47	6.37	32.213	32.822	11.705	11.133	43.918	43.955	5.654	5.498
		B2	54.31	55.32	1.78	1.81	6.89	6.57	32.734	33.103	11.926	11.289	44.660	44.392	5.935	5.709
	N2	B0	54.60	55.61	1.61	1.62	6.26	6.25	30.318	30.900	11.424	11.264	41.742	42.164	4.832	4.851
		B1	54.31	55.30	1.73	1.82	6.44	6.40	31.074	30.989	11.555	11.512	42.629	42.501	5.342	5.153
		B2	54.41	55.43	1.80	1.84	6.81	6.52	30.967	30.589	12.147	11.752	43.114	42.341	5.497	5.266
	N3	B0	50.31	51.30	1.61	1.61	6.03	5.98	28.740	29.703	12.203	12.045	40.943	41.748	4.635	4.678
		B1	53.01	54.05	1.68	1.66	6.09	6.23	29.337	30.393	12.786	12.911	42.123	43.304	4.896	4.901
		B2	53.31	54.31	1.74	1.71	6.48	6.34	29.990	31.074	13.221	13.111	43.211	44.185	5.118	5.123
	N4	B0	50.81	51.80	1.50	1.59	6.52	6.51	29.051	30. 385	12.249	12.367	41.300	42.752	4.684	4.786
		B1	51.41	52.40	1.61	1.67	6.58	6.56	29.441	30.474	12.703	12.689	42.144	43.163	4.802	4.915
		B2	52.31	53.30	1.71	1.69	6.63	6.71	29.572	31.061	12.950	12.893	42.522	43.954	4.891	5.047
Rw4	N1	B0	50.92	51.90	1.48	1.43	6.25	6.22	29.192	29.610	10.469	10.309	39.661	39.919	4.598	4.664
		B1	51.42	52.41	1.62	1.61	6.23	6.28	29.744	29.697	10.919	10.636	40.663	40.333	5.130	4.752
		B2	52.13	53.11	1.73	1.65	6.26	6.36	29.964	30.667	11.409	11.254	41.373	41.921	5.190	4.984
	N2	B0	49.53	50.54	1.53	1.67	5.96	6.09	26.764	27.721	10.805	11.418	37.569	39.139	4.317	4.393
		B1	50.42	51.40	1.77	1.82	6.01	6.26	27.175	28.340	11.356	11.730	38.531	40.070	4.484	4.534
		B2	50.23	51.21	1.75	1.84	6.12	6.48	27.630	28.703	12.183	11.915	39.813	40.618	4.766	4.736
	N3	B0	48.95	49.60	1.49	1.52	6.70	6.60	26.105	26.473	12.095	11.719	38.200	38.192	4.064	3.979
		B1	48.33	49.30	1.51	1.61	6.80	6.76	27.110	27.934	12.185	11.735	39.295	39.669	4.270	4.400
		B2	49.93	50.89	1.64	1.71	6.99	6.94	27.809	27.867	12.318	11.808	40.127	39.675	4.537	4.528
	N4	B0	48.12	49.10	1.44	1.41	6.34	6.89	25.855	26.747	12.910	12.425	38.765	39.172	3.878	4.146
		B1	48.32	49.31	1.60	1.59	6.40	7.04	26.197	26.788	12.909	12.575	39.106	39.363	4.028	4.219
		B2	50.22	50.20	1.62	1.62	6.81	7.08	29.192	26.905	12.939	12.800	42.131	39.705	4.567	4.305
LSD at 5%			0.919	0.955	0.068	0.059	0.171	0.151	0.378	0.387	0.498	0.466	ns	Ns	0.153	0.191

2- Quality Characters:

2.1. Ridges Width (Rw):

All quality traits were significantly affected by ridges width in both seasons, except juice purity in the second season. Data in Table (5) showed that the highest values (22.30 and 22.01, 18.14 and 17.62 and 16.82 and 16.36) resulted when grown sugar beet on ridges 90cm apart in both seasons, respectively. While grown sugar on ridges 110cm recorded the highest purity%. These results may be due to increased sugar productivity by planting sugar beet on narrow ridges (Rw3). These findings are in agreement with El-Bakary (2006).

2.2. N fertilizer Levels (N):

All quality characters were significantly affected by N fertilizer levels in both seasons, except TSS in the second season. Data in Table (5) obtained that the highest values (17.84 and 17.26, 16.58 and 16.15 and 81.93 and 80.54) were recorded when fertilized sugar beet by 75kg N/fed (N1) for sucrose%, sugar extractable% and juice purity% in both seasons, respectively. These results may be due to increased sugar productivity by planting sugar beet on narrow ridges (Rw3). These findings are in agreement with El-Sarag and Moselhy (2013) and Johnson (2014).

2.3. Foliar Spray of Boron (B):

Regarding foliar spray of boron data in Table (5) showed that TSS, sucrose%, sugar extractable% and juice purity% were affected by foliar spray of boron in both seasons. Twice foliar spraying of boron (B2) recorded the highest values for all studied characters in the two growing seasons. Boron is the most important additive that is necessary for the production and quality of sugar beets. These results are in parallel with those findings by Hellal *et al.* (2009) and Mekdad (2015).

Table 5: Effect of ridges width, N fertilizer levels and foliar spraying of boron on sugar beet quality during 2019/2020 and 2020/2021 seasons

Factors	Character							
	TSS%		Sucrose%		Sugar extractable%		Juice purity%	
	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21
Rw1	20.54d	20.81d	16.81d	16.65d	15.62	15.66	82.00a	80.43
Rw2	20.90c	21.23c	17.03c	17.06c	15.86	15.84	81.73a	80.08
Rw3	22.30a	22.01a	18.14a	17.62a	16.82	16.36	80.58b	80.11
Rw4	22.02b	21.64b	17.56b	17.28b	16.25	15.90	79.72b	79.83
LSD 5%	0.145	0.198	0.257	0.135	0.141	0.141	1.076	Ns
N1	21.73a	21.40	17.84a	17.26a	16.58a	16.15a	81.93a	80.54a
N2	21.77a	21.52	17.76a	17.23a	16.51a	16.08a	81.29b	80.31a
N3	21.22b	21.42	17.07b	17.09b	15.83b	15.84b	80.50c	79.86b
N4	21.03c	21.35	16.98b	17.05b	15.63c	15.70c	80.33c	79.75b
LSD 5%	0.138	Ns	0.146	0.082	0.152	0.084	0.451	0.509
B0	20.85c	21.09c	16.79c	16.77c	15.39a	15.47a	80.18c	79.51c
B1	21.45b	21.40b	17.38b	17.16b	16.18b	15.93b	81.01b	80.14b
B2	22.02a	21.81a	18.01a	17.58a	16.85c	16.43c	81.84a	80.72a
LSD 5%	0.146	0.128	0.146	0.067	0.165	0.069	0.545	0.928
RwxN	0.245	Ns	0.258	0.145	0.269	0.147	0.799	0.981
RwxB	0.284	0.248	0.283	0.131	Ns	0.131	1.061	ns
NxB	0.283	0.247	0.281	0.130	0.318	0.130	1.060	ns
RxNxB	0.507	0.443	0.506	0.234	0.549	0.235	1.893	ns

2.4. Interaction (RwxN).

Quality traits were significantly affected by the interaction between ridge width and N fertilizer levels in both seasons e as presented in Table (6).

The highest values (18.85 and 17.83%, 17.37 and 16 67%) were obtained when grown sugar beet on ridges 90cm in width and fertilized 75kg N/fed (N1) for sucrose% and sugar extractable%, while the lowest values resulted when grown sugar beet on ridges 110cm width and fertilized 120kg N/fed (N4) for these characters in both seasons, respectively. Increasing the width of the ridge with high N fertilization led to an increase in root weight and a decrease in technological qualities, as well as high N fertilization, pushed the plant to vegetative growth without fruiting. The obtained results were concordant with those obtained by El-Bakary (2006) and Seadh (2008).

2.5. Interaction (RwxB):

All quality traits were significantly affected by the interaction between ridge width and foliar spray of boron in the two growing seasons, while juice purity% was affected by this interaction in the first season only as shown in Table (6). The highest values (22.75 and 22.39, 18.54 and 18.01 as well as 17.36 and 16.83%) were obtained when growing sugar beet on ridges 90cm in width and the higher rate of foliar spray boron (B2) for TSS%, sucrose% and sugar extractable%, while the lowest values have resulted when grown sugar beet on ridges 110cm width and zero boron (B0) for these characters in both seasons, respectively. The mean yield of sugarcane and sugar content in triple-row planting was higher than in double-row planting (Dehkordi, 2016). While the highest value of juice purity (83.09%) has resulted when grown sugar beet on a ridge 90cm apart with the same rate of

boron foliar spray (B0). Increasing ridge width from 80 to 100 cm significantly increased root fresh weight (g/plant), root length, diameter and root weight in the two seasons and purity percentage (Abdou and Selim, 2008). Sucrose and juice purity percentages were increased by adding a higher concentration of boron which might be attributed to a decrease Na and K uptake in root juice (Kristek *et al.*, 2009).

2.6. Interaction (NxB):

Quality characters were significantly affected by the interaction between N fertilizer levels and foliar spray of boron in the two growing seasons, except juice purity% was affected by this interaction in the first season only as shown in Table (6). The highest values (22.44 and 21.91, 18.52 and 17.79 as well as 17.25 and 16.76%) were recorded by fertilized sugar beet 75kg N/fed (N1) and the higher rate of foliar spray boron (B2) for TSS%, sucrose%, sugar extractable%, while the lowest values have resulted when fertilized sugar beet 120kg N/fed and zero boron (B0) for these characters in the first and second seasons, respectively. Juice purity was taken the same trend. Increasing nitrogen fertilization leads to significantly decreased sugar beet quality when, especially without boron**.** Mahapatra *et al.* (2020) found that in maximizing beet and sugar yields, the knowledge of the management of the fertilizers or nutrition is very essential.

Table 6: Effect of interactions between ridges width with N fertilizer, ridges width with foliar spray of boron and N fertilizer levels with foliar spray of boron on sugar beet quality during 2019/2020 and 2020/2021 seasons.

Treatments		TSS%		Sucrose%		Sugar extractable%		Juice purity%	
		2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20	202/21
RwxN Rw1 (110cm)	N1	20.25	20.70	17.00	16.71	15.76	15.79	84.03	80.76
	N2	20.97	20.87	17.40	16.84	16.07	15.72	82.95	80.55
	N3	20.48	21.00	16.44	16.79	15.35	15.71	80.31	80.14
	N4	20.47	20.68	16.48	16.59	15.31	15.43	80.69	80.22
Rw2 (100cm)	N1	21.33	21.23	17.46	17.21	16.40	16.13	82.49	80.60
	N2	21.50	21.29	17.50	17.06	16.39	15.90	81.38	80.18
	N3	20.52	21.28	16.75	17.01	15.52	15.75	81.69	79.92
	N4	20.23	21.11	16.46	16.90	15.12	15.57	81.36	79.62
Rw3 (90cm)	N1	22.84	22.19	18.85	17.83	17.37	16.67	81.08	80.59
	N2	22.11	22.17	18.18	17.77	16.96	16.57	80.89	80.12
	N3	22.22	21.78	17.83	17.44	16.63	16.13	80.23	80.07
	N4	22.02	21.89	17.71	17.43	16.32	16.04	80.14	79.65
Rw4 (80cm)	N1	22.54	21.54	18.05	17.28	16.79	16.00	80.12	80.18
	N2	22.50	21.74	17.98	17.47	16.62	16.11	79.92	80.35
	N3	21.64	21.58	17.26	17.11	15.81	15.76	79.75	79.29
	N4	21.41	21.71	16.94	17.26	15.78	15.74	79.10	79.50
LSD at 5%		0.245	Ns	0.258	0.145	0.269	0.147	0.799	0.981
RwxB Rw1 (110cm)	B0	19.98	20.47	16.17	16.39	14.77	15.20	80.83	80.27
	B1	20.56	20.88	16.84	16.79	15.80	15.72	82.08	80.34
	B2	21.07	21.10	17.49	17.02	16.30	16.07	83.09	80.70
Rw2 (100cm)	B0	20.13	20.76	16.24	16.53	15.02	15.26	80.54	79.36
	B1	20.77	21.14	16.96	16.89	15.76	15.69	81.72	79.93
	B2	21.80	21.80	17.93	17.72	16.80	16.57	82.94	8098
Rw3 (90cm)	B0	21.76	21.66	17.77	17.15	16.18	15.82	80.12	79.20
	B1	22.40	21.97	18.12	17.69	16.92	16.41	80.51	80.52
	B2	22.75	22.39	18.54	18.01	17.36	16.83	81.12	80.62
Rw4 (80cm)	B0	21.52	21.47	17.05	17.01	15.58	15.59	79.22	79.17
	B1	22.09	21.63	17.61	17.27	16.23	15.88	79.74	79.79
	B2	22.46	21.83	18.02	17.58	16.94	16.25	80.21	80.50
LSD at 5%		0.284	0.248	0.283	0.131	Ns	0.131	1.061	ns
NxB N1	B0	20.88	21.04	17.14	16.81	15.57	15.63	80.05	79.90
	B1	21.89	21.31	17.91	17.17	16.92	16.07	82.43	80.63
	B2	22.44	21.91	18.52	17.79	17.25	16.76	83.31	81.11
N2	B0	21.11	21.10	16.85	16.85	15.62	15.54	80.90	79.93
	B1	21.92	21.57	17.82	17.33	16.63	16.12	80.92	80.20
	B2	22.30	21.87	18.39	17.67	17.28	16.57	82.04	80.79
N3	B0	20.81	21.02	16.68	16.66	15.34	15.38	80.14	79.41
	B1	21.07	21.46	16.93	17.13	15.75	15.86	80.40	79.82
	B2	21.76	21.75	17.60	17.47	16.41	16.28	80.96	80.36
N4	B0	20.59	21.19	16.43	16.75	15.03	15.32	79.63	78.78
	B1	20.94	21.28	16.79	17.01	15.42	15.66	80.30	79.92
	B2	21.59	21.59	17.48	17.38	16.46	16.12	81.05	80.55
LSD at 5%		0.283	0.247	0.281	0.130	0.318	0.130	1.060	ns

2.7. Interaction (RxNxB):

Data in Table (7) obtained that quality characters were significantly affected by the interaction between ridges width, N fertilizer levels and foliar spray of boron in the two growing seasons, while juice purity% was affected by this interaction in the first season. The highest values (23.50 and 22.87, 19.19 and 18.41 as well as 18.13 and 17.28%) were shown when planting sugar beet on narrow ridges (90cm) with added 75kg N/fed (N1) and twice foliar spraying of boron (B2) for TSS%, sucrose%, sugar extractable%, whereas the lowest values have resulted when planting sugar beet on ridges 110cm width with added 120kg N/fed and without boron (B0) for these characters in the first and second seasons, respectively. Whereas, the highest value of purity% (87.45%) was when planting sugar beet on a ridge 110cm apart with the same N fertilizer level and foliar spray of boron. Integration of N3 {290 kg/ha) + Zn2 (7 kg/ha) + B2 (2.4 kg/ha) improved the growth, SPAD value, sugar yields and their qualities, and N-use efficiency based on root yield (RY-NUE) of beet in a nutrients-deficient soil under semi-arid conditions (Mekdad and Shaaban, 2020). Sinta and Garo (2021) reported that the highest root yield of beetroot was achieved from the combination of 66 666, 80 000, and 10 0000 plant ha^{-1} with 92 kg N ha^{-1}, whereas the lowest root yield of beet was obtained from the combination of 0 kg N ha^{-1} with a planting density of 133 333 plants ha^{-1}.

Table 7: Effect of interactions between ridges width with N fertilizer, ridges width with foliar spray of boron and N fertilizer levels with foliar spray of boron on sugar beet quality during 2019/2020 and 2020/2021 seasons.

Interaction RwxNxB			TSS%		Sucrose%		Sugar extractable%		Purity%
			2019/20	202/21	2019/20	202/21	2019/20	202/21	2019/20
Rw1 (110cm)	N1	B0	20.00	20.50	16.01	16.51	15.02	15.50	80.05
		B1	20.01	20.53	16.92	16.55	16.01	15.63	84.60
		B2	20.66	21.03	18.07	17.07	16.27	16.25	87.45
	N2	B0	20.17	20.33	16.72	16.39	14.65	15.03	82.90
		B1	21.25	21.11	17.69	17.09	16.69	16.01	83.25
		B2	21.50	21.18	17.78	17.03	16.88	16.13	82.69
	N3	B0	20.08	20.66	15.98	16.42	14.81	15.25	79.61
		B1	20.66	21.03	16.59	16.84	15.50	15.75	80.29
		B2	20.69	21.31	16.74	17.12	15.75	16.14	81.04
	N4	B0	19.67	20.37	15.88	16.26	14.61	14.99	80.74
		B1	20.33	20.84	16.17	16.67	15.00	15.49	80.17
		B2	21.42	20.87	17.38	16.84	16.31	15.77	81.17
Rw2 (100cm)	N1	B0	20.02	20.67	16.14	16.41	15.02	15.26	80.07
		B1	21.50	21.03	17.96	16.96	16.88	15.88	83.54
		B2	22.50	22.00	18.27	18.27	17.29	17.25	83.86
	N2	B0	21.00	21.01	16.87	16.72	15.77	15.51	80.33
		B1	21.50	21.35	17.29	17.00	16.14	15.84	80.42
		B2	22.01	21.51	18.35	17.47	17.26	16.37	83.40
	N3	B0	20.00	20.83	16.31	16.57	15.03	15.25	81.55
		B1	20.05	21.33	16.25	17.02	15.04	15.77	81.25
		B2	21.51	21.69	17.69	17.42	16.50	16.23	82.28
	N4	B0	19.50	20.52	15.64	16.42	14.25	15.03	80.21
		B1	20.01	20.83	16.33	16.58	14.98	15.25	81.66
		B2	21.17	21.99	17.40	17.70	16.13	16.43	82.20
Rw3 (90cm)	N1	B0	22.00	21.53	18.71	17.21	16.51	16.00	80.50
		B1	23.01	22.19	18.64	17.91	17.48	16.75	81.06
		B2	23.50	22.87	19.19	18.41	18.13	17.28	81.67
	N2	B0	21.25	21.50	17.23	17.04	15.94	15.78	80.49
		B1	22.42	22.17	18.43	17.87	17.19	16.63	80.68
		B2	22.67	22.83	18.89	18.37	17.75	17.26	81.49
	N3	B0	21.83	21.60	17.51	17.13	16.15	15.76	80.17
		B1	22.08	21.73	17.69	17.46	16.69	16.14	80.09
		B2	22.75	22.01	18.29	17.73	17.06	16.50	80.42
	N4	B0	21.97	22.03	17.61	17.20	16.12	15.75	79.32
		B1	22.08	21.80	17.71	17.53	16.32	16.13	80.20
		B2	22.09	21.85	17.80	17.55	16.50	16.26	80.91
Rw4 (80cm)	N1	B0	21.50	21.47	17.11	17.11	15.75	15.75	79.58
		B1	23.02	21.49	18.52	17.27	17.30	16.01	80.52
		B2	23.09	21.67	18.54	17.46	17.32	16.25	80.25
	N2	B0	22.01	21.56	17.57	17.29	16.14	15.84	79.86
		B1	22.50	21.66	17.85	17.35	16.50	16.00	79.33
		B2	23.00	22.02	18.53	17.78	17.24	16.52	80.57
	N3	B0	21.33	21.00	16.90	16.53	15.38	15.25	79.21
		B1	21.50	21.74	17.19	17.19	15.75	15.74	79.95
		B2	22.08	22.00	17.68	17.62	16.30	16.25	80.08
	N4	B0	21.22	21.83	16.60	17.10	15.06	15.50	78.23
		B1	21.33	21.64	16.89	17.26	15.38	15.75	79.15
		B2	21.67	21.65	17.32	17.44	16.90	16.02	79.93
LSD at 5%			0.507	0.443	0.506	0.234	0.549	0.235	1.893

CONCLUSION

Based on this investigation and under the same conditions, we can recommend under narrow ridges 90cm, with 75 kg N/fed and foliar spraying twice with boron, which can increase root yield, sugar yield and quality.

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