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Research Article
Bio-nitrogen Fertilization and Leaf Defoliation Increased Yield and Quality of Sugar Beet

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Abstract
Background and Objective: Bio-nitrogen fertilization and leaf defoliation are the important management practices which influence the yield and quality of sugar beet. To know the effect of bio-nitrogen fertilization and leaf defoliation on the growth yield traits, yield and quality of sugar beet (cv. farida), a experiment was conducted at the experimental farm of Sakha Agric. Res. Station, Kafr El-Sheikh, Egypt, during 2014/15 and 2015/16 growing seasons. **Materials and Methods:** A split plot design with three replicates was used, where main plots were assigned for four bio-nitrogen fertilizer levels (100 and 75 kg N fed^{-1}+Rhizobacterine, 50 kg N fed^{-1}+Rhizobacterine and Rhizobacterine only), while sub-plots were allocated to three leaf defoliation levels (zero, 25 and 50%). **Results:** The result of study revealed that 100 and 75 kg N fed^{-1}+Rhizobacterine produced the highest values of root length, root diameter, root yields, top yields and sugar yields/fed and enhanced the quality of sugar beet. In addition, the root and sugar yields increased with decreasing defoliation levels. However, no significant effect from defoliation treatments on sugar beet quality was observed under in this study. **Conclusion:** Inoculation of Rhizobacterine with 75 kg N fed^{-1} and 25% defoliation are advised to use for increasing sugar beet yield.

Key words: Beta vulgaris, bio-fertilizer, quality parameters, sugar yield

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) under the family of Chenopodiaceae, is one of the most important sugar crops in the world. It is mostly a crop of temperate areas where it is grown as a spring or early summer crop. It ranks the second in next to sugarcane as a source of sucrose in the world[1]. Productivity of sugar beet grown under semi-arid, Mediterranean conditions is mainly restricted by water unavailability[2]. It is the second main source of sugar after sugar cane not only in the world but also in Egypt. Sugar beet, a semi-halophytic member of Chenopodiaceae, is considered as tolerant to both drought and salinity[3].

The Egyptian government encourages sugar beet growers to increase the cultivated area. Government begins to establish new beet factories in the newly reclaimed soils of El-Nubaria and El-Bustan to increase the production of sugar and minimize the gap between production and consumption. Sugar beet can be grown in a wide range of climatic conditions and is noted for its tolerance to salinity but drought stress is one of the major factors causing huge loss of the sugar beet crop. However, sugar beet could be efficiently grown under a wide range of irrigation level, where it is readily adapted to limited irrigation because plants utilize deep stored soil water and recover quickly following water stress[4]. For the above mentioned advantages in addition to its limited water requirements (3500 m^3/fed/7 months) compared to sugar cane (12140 m^3/fed/year)[5]. On the other hand, the water budget of Egypt is 55.5 billion m^3/year from the Nile in addition to small quantities of ground water and irregular precipitations and hence, the limited resources of water make the use of poor quality water like drainage water for irrigation which is essential to meet the agricultural demand, a considerable amount of drainage water estimated at 15.5 billion m^3/year[6]. So, saline water has been proposed as an alternative irrigation source for sugar beet[7,8].

Presently, a great concern is being establish to search for untraditional natural and safe stimulating growth substances, which have marked effect on the plant growth traits, that is reflect to improve the productivity of crops under Egyptian conditions[9]. Bio-fertilizers technologies enhanced the naturally existing nutrient transformation activities in the soil profiles and the function of bio-fertilizers depends on the environmental conditions prevailing in the site of application. Inoculated seeds of various C_3 and C_4 plants with associative nitrogen-fixing bacteria led to improve plant growth and yield[10].

Sugar beet is considered to be tolerant to defoliation since foliage losses up to 75% can be compensated and yield is not significantly affected. The selection of a suitable cultivar can also restrict root quality degradation[11]. It is assumed that the mechanism responsible for this compensation is that the newly expanded leaves after defoliation photosynthesize more and respire less than the older, intact leaves[12]. According to the findings of Jones *et al.*[13], it is reported that sugar beet with 50, 75 and 100% defoliation at 4 or 8- leaf stages reduced the yield of root up to 5, 10 and 27%, respectively. In general, the increase in the defoliation concentration adversely affects the root growth and leading a reduction in white sugar yield compared to control treatment[14]. Now, there is no accurate knowledge regard to influence of a bio fertilizer and leaf defoliation combining nitrogen rates on the yield quantity features of sugar beet under Egyptian conditions. Hence, the study was, therefore, undertaken to examine the effect of replacing mineral fertilizers partially using a bio fertilizer and leaf defoliation on the growth, yields and quality of sugar beet.

MATERIALS AND METHODS

Experimental site and duration: Two field experiments were carried out at the experimental Farm of Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt during 2014/15 and 2015/16 seasons to study the effect of bio-fertilization and leaf defoliation on yield and quality of sugar beet.

Seed collection: The sugar beet variety farida (multi-germ) was collected from Sugar Crops Research Institute (SCRI), Agricultural Research Center (ARC).

Design and treatments: The experiments were laid in a split plot design with three replicates. Two factorial experiment consisting factor A: four levels of bio-fertilizers viz., (i) 100 kg N fed^{-1} (the recommended dose used as control), (ii) 75 kg N fed^{-1}+Rhizobacterine, (iii) 50 kg N fed^{-1}+ Rhizobacterine and (iv) Rhizobacterine, factor B: three levels of leaf defoliation treatments viz., (i) Zero defoliation (%) level (control), (ii) 25% defoliation level and (iii) 50% defoliation level. Bio-fertilizers were arranged as main plots and leaf defoliation treatments were placed in sub-plots.

Soil analysis: Soil samples were randomly taken from the experimental sites at a depth of 30 cm from soil surface and were prepared for both physical and chemical analysis[15]. Results of the physical and chemical properties in 2014/15 and 2015/16 seasons are presented in Table 1. The preceding crop was rice in both seasons.

Table 1: Soil physical and chemical analysis of the experimental sites in 2014/15 and 2015/16 seasons

	Season			Season	
Variables	2014-15	2015-16	Variables	2014-15	2015-16
Soluble cations (mq L^{-1})			**Soluble anions (mq L^{-1})**		
Ca^{2+}	6.65	7.21	HCO_3^-	6.20	6.40
Mg^{2+}	11.07	12.47	Cl^-	5.40	5.90
Na^+	15.54	14.09	SO_4=	0.17	0.23
K^+	0.54	0.36	CO_3=	0.00	0.00
B	0.35	0.32			
Cu	0.60	0.50			
Fe	0.75	0.65			
Mn	2.00	1.85			
Mo	0.23	0.20	**Physical analysis**		
Zn	0.38	0.40	Sand (%)	20.69	20.85
			Silt (%)	25.71	25.74
			Clay (%)	53.60	53.41
			Texture class	Clay	Clay
Chemical analysis					
Soil reaction pH (1:25)				8.30	8.40
EC (m.mhos cm^{-1})				3.38	3.41
Organic matter (%)				1.70	1.65
Available N (ppm)				15.25	16.14
Available P (ppm)				6.20	6.00
Available K (ppm)				281.1	288.3

Growing of the crop and imposition of treatments: The experimental field was prepared through ploughing and calcium super phosphate was added during tilling operation at the rate of 100 kg fed^{-1}. The plot size was 10.5 m^2, each plot included 5 ridges 60 cm apart and 3.5 cm long and sown in hills 25 cm apart one side of the ridge at a rate of 3-4 seeds per hills. Sugar beet seed variety farida (multi-germ) was sown at October 25th, 2014 in the first season and at October 10th, 2015 in the second season. Plants were thinned to one plant per hill at 4 true leaves stage. All other practices were followed as usually done for growing sugar beet crop in the area. The crop was harvested on May 20th, 2015 and May 5th, 2016 seasons.

Rhizobacterine is a commercial bio-fertilizer contain active bio-nitrogen fixation bacteria (*Azotobacter chroococcum* and *Azosprillum* spp)[16]. Seeds were inoculated with Rhizobacterine at the rate of 0.8 kg fed^{-1}. The moistered sugar beet seed was inoculated with Rhizobacterine just before planting. Arabic gum (5% Arabic gum) was used as an adhesive agent. Soil was directly irrigated after sowing to provide suitable moisture for the inoculation. Rhizobacterine was produced by the General Organization for Agriculture Equalization Fund, Ministry of Agriculture and Land Reclamation, Egyt. Nitrogen fertilizer in the form of urea (46.5% N) was applied in two equal doses and the first dose was applied after thinning while the second dose was applied after 25 days later in the two seasons. Root samples were taken at random of 15 kg to determine complete quality measurements in Delta Sugar Company Limited laboratories at El-Hamoul, Kafr El-Sheikh.

The following characters were measured:

- Growth, yield and yield components

Root growth: Root length (cm) and root diameter (cm).

Yield and yield components: Root yield (t/fed), top yield (t/fed) and sugar yield (t/fed).

Quality parameters

Alkalinity coefficient: Alkalinity coefficient was calculated as described by Harvey and Dutton[17] as follow:

$$AC = \frac{K+Na}{\text{Amino N}}$$

Gross sugar contents (Sucrose (%)): Sucrose content in juice of beet treatments was determined Delta Sugar Company Limited laboratories at El-Hamoul, Kafr El-Sheikh Governorate according to the method of Le Docte[18] as described by McGinnus[19]:

$$\text{Purity (\%): Qz} = \frac{ZB^*}{Pol} \times 100$$

Statistical analysis: All the collected data were analyzed statistically using 'analysis of variance' technique (two-way) by using MSTAT-C operated program[20]. The mean values were compared according to Duncan's multiple range test[21].

RESULTS

According to the results of variance analysis, the growth, yield components and yield as well as sugar quality as influenced by fertilizer leavls and leaf defoliation rates are shown below:

Growth characteristics

Root length and diameter (cm): The root length and diameter was affected by mineral and bio-nitrogen fertilizer and defoliation rate as well as their interactions during 2014-15 and 2015-16 seasons (Table 2). Data showed application of 100 kg N fed^{-1} produced the highest values of root length and root diameter which was statistically identical with 75 kg N fed^{-1} with bio-fertilizer (Rhizobacterine) in both seasons, while Rhizobacterine treatment had the lowest values for root diameter in both seasons. Concerning the effect of defoliation rates on the root length and root diameter, the results showed that the root length and the root diameter decreased significantly with the increasing defoliation rates up to 50% (Table 2). The interaction between defoliation rates and fertilizer had no significant effect on the root lengths in both seasons, but root diameter was significant only in the year of 2014-15 (Table 2).

Yield characteristics

Root yield (t/fed): Root yield per feddan was influenced by mineral and bio-nitrogen fertilizer and defoliation rates as well as their interactions during growing seasons 2014-15 and 2015-16 (Table 3). Results indicated that applying of 100 kg N fed^{-1} gave the highest values of root yield and it was statistically similar to the treatment of 75 kg N fed^{-1}+ Rhizobacterine (biofertilizer) in 2014-2015 and 2015-2016 seasons. Dealing to the effect of defoliation rates, data presented in the same table showed high significant effect on the root yield in 2014-2015 and 2015-2016 growing seasons with the 25% defoliation, where the lowest mean values of the root yield produced by increasing rate of defoliation up to 50% in both seasons. The obtained data revealed that the interaction between defoliation rates and fertilizer had no significant effect on the root yield in both seasons (Table 3).

Top yield (t/fed): The effects of mineral and bio nitrogen fertilizer and defoliation rates as well as their interactions on top yield per feddan in 2014-15 and 2015-16 growing seasons are presented in the Table 3. Nitrogen fertilizer significantly influenced the top yield per feddan in both seasons. Application of nitrogen fertilizer at 75 kg N fed^{-1} with inoculating seeds with biofertilizer (Rhizobacterine) produced statistically similar results of top yield as like 100 kg N fed^{-1} in both seasons. Data in the Table 3 pointed that the top yield per feddan was increased significantly with decreasing defoliation rate in both seasons. The highest mean values recorded from undefoliated plants in the two seasons. On the other hand, 50% defoliation rate gave the lowest mean values of top yield per feddan. The obtained data in the Table 3 did not show any significant interactions in the first season, while significant interaction was recorded in the second season (Table 3).

Sugar yield (t/fed): Sugar yield (t/fed) was affected by mineral and bio nitrogen fertilizer and defoliation rates as well as their interactions in 2014-15 and 2015-16 seasons (Table 3). Variation in nitrogen fertilizer levels resulted in significant

Table 2: Effect of bio-fertilization, defoliation rate and their interaction on the root length, root diameter of sugar beet plants in 2014-15 and 2015-16 seasons

	Root length (cm)		Root diameter (cm)	
Treatments	2014-15	2015-16	2014-15	2015-16
Nitrogen fertilizer rate (kg N fed^{-1})				
100 kg N fed^{-1}	32.0^{a}	24.0^{a}	15.2^{a}	12.4^{a}
75 kg N fed^{-1}+rhizobacterine	31.8^{a}	23.9^{a}	15.0^{a}	12.3^{a}
50 kg N fed^{-1}+rhizobacterine	28.4^{b}	22.7^{a}	14.0^{b}	11.8^{b}
Rhizobacterine	24.7^{c}	20.3^{b}	11.8^{c}	9.8^{c}
F-test	**	*	**	**
Defoliation rate (%)				
0	30.3^{a}	23.5^{a}	14.5^{a}	11.7
25	29.5^{a}	22.7^{ab}	14.0^{b}	11.7
50	27.8^{b}	22.0^{b}	13.5^{c}	11.3
F-test	**	*	**	ns
Interaction				
A*B	ns	ns	*	ns

*, ** and NS indicate p<0.05, p<0.01 and not significant, respectively. Means of each treatment followed by the same letter are not significantly different at 5% level, according to DMRT

Table 3: Effect of nitrogen fertilizer levels and defoliation rate on root yield, top yield, sugar yield and their interaction of sugar beet plants in 2014-15 and 2015-16 seasons

	Root yield (t f^{-1})		Top yield (t f^{-1})		Sugar yield (t f^{-1})	
Treatments	2014-015	2015-16	2014-015	2015-16	2014-15	2015-16
Nitrogen fertilizer rate (kg N fed^{-1})						
100 kg N fed^{-1}	24.4^a	23.2^a	7.1^a	6.4^a	3.80^a	4.7^a
75 kg N fed^{-1}+rhizobacterine	24.3^a	23.1^a	6.9^a	6.3^a	3.80^a	4.6^a
50 kg N fed^{-1}+rhizobacterine	22.9^b	22.5^b	5.5^b	5.0^b	3.40^b	3.7^b
Rhizobacterine	17.1^c	13.8^c	3.3^c	2.4^c	2.40^c	2.3^c
F-test	**	**	**	**	**	**
Defoliation rate (%)						
0 (zero)	22.7^a	21.6^a	7.6^a	6.6^a	3.70^a	4.0^a
25	22.2^b	21.5^a	5.5^b	4.8^b	3.30^b	3.9^a
50	21.7^c	18.9^b	4.1^c	3.7^c	3.14^b	3.6^b
F-test	**	**	**	**	*	**
Interaction						
A*B	NS	NS	Ns	**	Ns	Ns

*, ** and NS indicate $p<0.05$, $p<0.01$ and not significant, respectively. Means of each treatment followed by the same letter are not significantly different at 5% level, according to Duncan's multiple range tests

Table 4: Effect of nitrogen fertilizer levels and defoliation rate on alkalinity coefficient (AC), sucrose (%), purity (%) and their interaction of sugar beet plants in 2014-15 and 2015-16 seasons

	Alkalinity coefficient (%)		Sucrose (%)		Purity (%)	
Treatments	2014-15	2015/2016	2014/2015	2015/2016	2014/2015	2015/2016
Nitrogen fertilizer rate (kg N fed^{-1})						
100 kg N fed^{-1}	6.4^a	4.5^a	16.4^a	18.5^a	90.6^c	93.2^c
75 kg N fed^{-1}+rhizobacterine	5.6^b	3.7^b	16.3^a	17.9^b	91.9^b	93.4^c
50 kg N fed^{-1}+rhizobacterine	3.8^c	3.5^b	16.3^a	17.6^{bc}	92.6^{ab}	93.8^b
Rhizobacterine	3.6^c	3.0^c	15.0^b	17.6^c	93.4^a	94.1^a
F-test	**	**	**	**	**	**
Defoliation rate (%)						
0	5.0^a	3.7^a	16.1^a	17.9^a	92.6^a	93.7^a
25	4.9^a	3.6^a	16.0^a	17.9^a	92.2^b	93.6^a
50	4.7^a	3.6^a	15.9^a	17.8^a	91.6^c	93.5^a
F-test	NS	NS	NS	NS	**	NS
Interaction						
A*B	NS	NS	NS	**	NS	NS

*, ** and NS indicate $p<0.05$, $p<0.01$ and not significant, respectively. Means of each treatment followed by the same letter are not significantly different at 5% level, according to Duncan's multiple range tests

effect on sugar yield in 2014-15 and 2015-16 seasons. Sugar yield was maximized (3.8 and 4.6 t fed^{-1}) with 75 kg N fed^{-1} and inoculating seeds with biofertilizer (Rhizobacterine) in both seasons, respectively. The values were statistically identical with the 100 kg N fed^{-1}. Sugar yield gradually decreased with increasing defoliation rate from 0-50% in both the years (Table 3). The highest sugar yield was observed under control condition, while, the lowest sugar yield was recorded from 50% defoliation rate in both seasons. Reduction of sugar yield due to defoliation of 25% was statistically similar with the control treatment only in the second season of crop grown.

Quality parameters: Quality parameters were affected by nitrogen fertilizer and defoliation rates and their interaction during the two growing seasons (Table 4).

Alkalinity coefficient (AC): The effects of mineral and bio-fertilization and defoliation rates as well as their interactions on the AC in 2014-2015 and 2015-2016 growing seasons are presented in the Table 4. Concerning nitrogen fertilizer, results showed significant effect on AC in both seasons, where the lowest mean values produced from increasing up to 75 kg N fed^{-1} with inoculating seeds via biofertilizer (Rhizobacterine) and the highest mean values obtained by using nitrogen fertilizer (100 kg N fed^{-1}) without adding Rhizobacterine in both seasons. According the effect of defoliation rates, data presented in Table 4 showed in significant effect on the AC in 2014-2015 and 2015-2016 growing seasons, where the lowest mean values of AC was produced by increasing rate of defoliation up to 50% in both seasons. The obtained data in Table 4 revealed that the interactions between these factors did not show any significant effect on the AC in 2014-2015 and 2015-2016 seasons.

Sucrose (%): The sucrose (%) was remarkably influenced by mineral and bio nitrogen fertilizer and defoliation rates as well as their interactions in 2014-2015 and 2015-2016 seasons (Table 4). The highest mean values produced from using 100 kg N fed^{-1}, which was at par with 75 kg N fed^{-1}+Rhizobacterine, 50 kg N fed^{-1}+Rhizobacterine in the first season. Significantly the highest mean values produced was 100 kg N fed^{-1} in the second season. Concerning defoliation rates, data presented in Table 4 showed no significant effect on sucrose percentage in both seasons. Highly significant interaction was obtained only in the second season.

Purity (%): The purity (%) was influenced significantly by mineral and bio-fertilization and defoliation rates as well as their interactions in 2014-2015 and 2015-2016 seasons. The highest mean values produced from using biof ertilizer (Rhizobacterine) only in both seasons (93.4 and 94.1, respectively). Concerning defoliation rates, the significant effect on purity percentage was observed in the first season only. Increasing defoliation rates decreasing purity percentage. No significant interaction effect was recorded on purity percentage in both seasons.

DISCUUSION

Bio-nitrogen fertilizer and defoliation significantly increased the root length and diameter of sugar beet plants. Application of Rhizobacterine reduced 25 kg N fed^{-1} for getting identical root length and diameter to control in this study (Table 2). These results are in harmony with those obtained by Abou-El-Fotoh *et al.*[22] and Ouda[23] who reported that bio-fertilization reduced the N requirements in sugar beet plants for obtaining similar root length and diameter. Leaf defoliation reduced the root length and root diameter but 25% defoliation has no significant with the control (Defoliation (%)) regarding root length in both years but varied with the root diameter in 2014-15, although non-significant effect was observed in 2nd of 2015-16. Similar results were obtained by Abd El-Hak[24].

Rhizobacterine (biofertilizer) declined the nitrogen requirement in sugar beet root yield (Table 3). It could be concluded that N-biofertilization of sugar beet plants could be attributed to more adsorption of nutrients which reflect more growth activity through nitrogenous compounds assimilation, forming more growth substances, more cell division and enlargement, more forming of tissues and organs and plant growth. Similar results were obtained by Abou-El-Fotoh *et al.*[22] and Badr[25]. Defoliation had significant effect on the root yield only in 2014-15 but statistically similar result was observed at 25% defoliation with control condition in 2015-16 (Table 3). French *et al.*[12] and Abd El-Hak[24] reported that defoliation had significant effect on the root yield.

Statistically, similar top yield was observed between the treatments of 100 kg N fed^{-1} (control) and 75 kg N fed^{-1}+ Rhizobacterine indicating that Rhizobacterine bio-fertilization reduced the necessity of 25 kg fed^{-1} to obtain alike top yield of sugar beet (Table 3). Thus, reflecting the important role of bio-fertilization which overcome addition of 25 kg N fed^{-1} in building up the photosynthetic and growth of beet plants. A positive association between nitrogenous fertilizer and top yield per feddan were reported by Abou-El-Fotoh *et al.*[22] and Medani *et al.*[26]. Defoliation gradually decreased top yield of sugar beet and the reduction was remarkable among the treatments in the both years (Table 3). Our result is corroborated with the findings of French *et al.*[12] and Abd El-Hak[25] in sugar beet. This may be due to the role of microorganisms activity for phytohormones formation and translocation to the plant especially IAA, CKs and Gas. These results are in agreement with those obtained by Abo-Elgoud[10] and Abd El-Mawla[27]. Sugar yield was influenced by defoliation rates in both seasons (Table 3). The result cleared high significant effect on the sugar yield in both seasons. Increasing defoliation sigificantly decreased the sugar yield in the 1st year cropping but the reduction was remarkable only between the 0 and 25% defoliation in the 2nd year (2015-16). In this respect Abd El-Hak[25] showed a significant increment in sugar yields by increasing the rate of defoliation from 0-50%. According to Stallknecht and Gilbertson[28], 100% defoliation leads substantially reduction in the amount of sugar yield. Furthermore, white sugar yield was decreased with increasing of defoliation compared with the control[29].

Higher N fertilizers produced greater AC of sugar beet in this study in both the years. The variation of AC was ignorable between the treatment of 50 kg N fed^{-1}+Rhizobacterine and only Rhizobacterine in 2014-15 and between the treatment of 75 kg N fed^{-1}+Rhizobacterine and 50 kg N fed^{-1}+ Rhizobacterine in 2015-16 which indicated that bio-fertilization Rhizobacterine reduced nitrogen requirements in sugar beet plant. This result may be due to the active role of bacteria and increasing the endogenous hormones which play important roles in big active root system and hence increasing the nutrients uptake, photosynthesis rate and translocation as well as accumulation of assimilates within different plant organs. These results are in agreement with Nemeat-Allah[30], El-Sayed *et al.*[31] and Soudi *et al.*[32]. No significant variations among the defoliation were recorded regarding the AC in both years (Table 4). These results may be due to the main effect of defoliation which limits the production of exportable sugars (mainly SUC) which are required as a fuel for meristematic activity and for the growth of sink organs such as roots, new leaves, flowers, fruits and seeds. These results are in disagreement with Abd El-Hak[25]. In case of sucrose percentage, biofertilization of Rhizobacterine with 75 kg N fed^{-1} produced the same the sucrose percentage as like 100 kg N fed^{-1} in 2014-15. These results are in agreement with Soudi *et al.*[32]. Defoliation has no significant effect on sucrose percentage. But controversy result was observed by Abd El-Hak[25] who concluded that defoliation has a significant increase in sugar sucrose percentage. Bio-fertilization increased the purity percentage of sugar beet in both years and as well as reduced the nitrogen fertilization in the crop (Table 4). This increase in quality traits due to bio-fertilizer application especially Rhizobacterine could be due to its role in improving growth and dry matter accumulation by improving the uptake and availability of major nutrients, consequently enhancement of sucrose content in roots[33]. Defoliation reduced the purity percentage and reduction was not remarkable between 0 and 25% defoliation in the second year. These results with are in disagreement Abd El-Hak[24].

CONCLUSION

From the obtained result, it can be concluded that defoliation at 25% of total plant leaves at 160 DAS with inoculation Rhizobacterine+75 kg N fed^{-1} are recommended for increasing sugar beet yield (cv. faraida) at Kafr El-Sheikh region, Egypt.

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