Yield and Quality of Sugar Beet (*Beta vulgaris.* L) as Affected by Bio and Mineral Nitrogen Fertilization

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ABSTRACT

Nitrogen fertilizer is essential element for sugar beet yield and quality, biofertilization is a new source of nitrogen fertilizer which may prevent and decrease its environmental pollution. Two field trails were carried out at experimental farm of Sakha Agricultural Research Station Kafer El-Shakh Governorate to study the effect of biofirtilizer (Azototobacter chroococcum, Cerealine), nitrogen fertilizer as well as the effect of herbicides and insecticides which coated orange mixed with seeds on yield and quality of sugar beet plant during 1999/2000 and 2000/2001 seasons. Results indicated that root and top yields significantly decreased with decreasing N application from 90 to 60 and 30 kg /fad. with applied one or two recommended dose of biofertilizer (Cerealine). Whereas, the highest root yields were 34.84 and 35.40 ton/ fad. when N decreased to 30 kg with one recommended dose from cerealine in both seasons respectively. Top yield also take the same trend. Sugar yield and top/ root ratio gave the highest values with 90 Kg N/fad. and decreased with decreasing N mineral. While, the lowest economic sugar control was recorded 16.77 and 17.11 % when 30 Kg N+ two recommended dose from cerealine was added in the opposite direction the highest percentage (17.86 and 17.81%) produced when applied 60 Kg N + one biofertilizer recommended dose. Superiority values of purity % 79.52 and 79.83 resulted from control treatment (90 Kg N /fad) compared to the lowest values (78.12 and 78.17%) which complained to the lowest dose from N mineral or biofertilizer. Economic sugar yield (E.S) recorded the highest yields 6.02 and 6.10 tan/fad with 90 Kg N/fad only in both seasons. Alkalinity coefficient (AC) not decreased less than critical level (1.8) in all treatments in this work and this indication that all N doses whether N mineral or mineral together biofertilizer was not accessive doses for sugar beet plant but was optimum doses.

Generally, we can concluded that all characters under study not recorded significantly differences due to washing or not washing the seeds and the herbicides or insecticides not affected on viability of seed germination and growth through the season and we can used biofertilizers with sugar beet seeds without washing it.

INTRODUCTION

Sugar beet crops ranks the second sugar crop in the world and in Egypt also. Nitrogen fertilization is the limiting factor for yield and quality of sugar beet. Biological fertilization plays an important role for sugar beet production.

The effect of biofertilization had investigated by Saric *et al.*, (1991) he found that inoculated sugar beet with 20 Azototbacter strains significantly affected dry matter of root and shoots. El-Badry and Bassel (1993) indicated that the best economical rate of inorganic N-fertilizer used was 45 kg/fad + bacterical inoculation gave the highest sugar yield and (TSS) were about equal to those obtained with higher rates of 60 and 75 kg N/ fad without inoculation. This represents saving about 40% in N fertilizers. There was also an increase in average of root yield from 2.8 to 6.0 ton/fad with marked increase in sugar yield. More, Favilli *et al.*,(1993) concluded that inoculation of sugar beet with

biofertilizer increased root yield compared with the uninoculation. Afify *et al.*, (1994) showed that inoculation of sugar beet seeds with Azotobacterine significantly increased LAI, root length and diameter, root and sugar yields /fad as well as sucrose %, TSS and purity percentage. Abo El-Fotoh *et al.*, (2000) pointed out that the addition of biofertilizer with N mineral at 50% recommended dose produced significantly higher root yield compared with the other treatments also, showed that sugar beet quality affected such as sodium ions, kions, α-amino nitrogen, extractable sugar and total sugar percentage and concluded that biofertilizer alone not be met N requirement for sugar beet crop. Also, Maareg *et al.*,(2000) demonstrated that application of Azototbacter chroococcum as a (Cerealine) caused to increase in root and foliage weight and also, increased quality characters i.e., TSS, sucrose% and purity% as well as sugar yield.

MATERIALS AND METHODS

Tow field trails were conducted at Sakha Agricultural research Station at Kafr El-Sheikh Governorate. Every trail included 9 treatments arranged in Randomized Complete Block Design with three replicates. Four treatments planted with seeds without washing as usual used by farmers in sugar beet fields and another four treatments the seeds were washed before inoculation with Azototobacter chroococcum the commercial name Cerealine to saving the seeds from any bad effect of herbicides and insecticides in addition the mine treatment was control (90 kg N/ fad) as follow:

A-seeds without washing by water:

1- 90 kg N/ fad as a mineral fertilization alone
2- 30 kg N/ fad + one recommended dose of Cerealine
3- 30 kg N/ fad + two recommended dose of Cerealine
4- 60 kg N/ fad + one recommended dose of Cerealine
5- 60 kg N/ fad + two recommended dose of Cerealine
6- 8 treatments contained the same mentioned treatments but seeds was washed with water

Sugar beet cultivar viz Raspoly was used in both seasons and sowing in ridges 50 cm apart and 20 cm mostly between hills, plot area was 14 m^2. The recommended doses of P and K (15 and 48 kg P_2O_5 and K_2O /fad, respectively) fertilizers were applied as used in sugar beet fields through soil preparation and before sowing. Sowing date was during 1st and 2nd week of October in both seasons. Other cultural practices were carried out as usual. At harvest date after 210 days from sowing, two guarded rows were harvested to determined yield and quality attributes. A sample of ten roots were taken at random for chemical analysis and the following data were recorded:

1- Total Soluble Solids in term (T.S.S) was determined by using hand refractometer.
2- Sucrose percentage was determined by using saccharometer according to Le Docte (1927).

3- Purity percentage (P) was calculated according to the following equation:

$$\text{Apparent purity (P) \%} = \frac{\text{Sucrose \%}}{\text{T.S.S \%}} \text{X} 100$$

4- Economic sugar content % (E.S.C) was calculated according to Reinefeld *et al.*, (1974).

E.S.C = Pol – [0.43 (K + Na) + 0.094 N α + 0.29]

5- Economic sugar yield (E.S) = E.S.C% x root yield (ton/fad) According to Reinfeld *et al.*, (1974).

6- Alkaline coefficient (A.C.) = $\frac{\text{K} + \text{Na}}{\alpha \text{ - amino N}}$

According to Wieninger and Kubadinow (1971)

(K+ and Na and α amino N (expressed as milliequivalents / 100 g of sugar)

Treatments means were compared at 5% level of probability according to Snedecor and Cochran (1967). The mechanical and chemical analysis of experimental soil is shown in Table (1).

Table 1. The mechanical and chemical analysis of experimental soil during 1999/2000 and 2000/2001 growing seasons.

Season	Sand %	Silt %	Clay %	texture	Organic matter %	pH	Total N(ppm)	Cations meq /l				Anion meq/l			
								Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	HCO_3^{-+}	CO_3^-	SO_4^-
99/00	12.3	26.9	60.8	Clay	1.81	8.2	85.0	16.2	0.30	5.2	2.9	9.2	2.8	0.0	13.6
00/01	12.2	26.7	61.1	Clay	1.89	8.0	86.0	16.3	0.35	5.1	2.6	9.4	2.9	0.0	13.3

RESULTS AND DISCUSSION

1- Root and top yields (ton/fad):

Data presented in Table (2) showed that significant differences were observed between values of root and top yields due to the source of nitrogen fertilization. Mineral nitrogen (90 kg N/fad) gave the highest root yield 34.84 and 35.42 ton/fad in both seasons, and decreased with decreasing N levels to 60 kg N/ fad and two recommended biofertilizer dose together followed by 30 kg N/ fad with one recommended biofertilizer dose 22.30 and 27.20 ton/fad with and without washing seeds in both seasons, respectively. Similar results were obtained by El-Badry and Bassel (1993); Favilli *et al.*, (1993); Sultan *et al.*, (1999) and Abo El-Fotoh *et al.*, (2000). Top yield significantly affected by mineral N fertilization and produced the highest top yields 15.54 and 9.2 ton/fad in both seasons compared to the lowest yields 9.74 and 6.7 ton/fad resulted from 30 kg N/ fad plus one biofertilizer dose. These findings are in good agreement with those obtained by Favilli *et al.*, (1993); Afify *et al.*, (1994); Sulton

et al., (1999). We can notice that neither washed nor unwashed seeds attained significant differences on root and top yields.

Table 2. Effect of bio and mineral nitrogen fertilization on root and top yields of sugar beet plant during 1999/2000 and 2000/2001 growing seasons.

Treatments		Root yield (ton/fad)		Top yield (ton/fad)	
		1999/2000	2000/2001	1999/2000	2000/2001
Control	90 kg N/ fad	34.84	35.42	15.54	9.20
Seeds not washed by water before inoculation	30kg N/ fad +one bio-dose	22.30	28.40	9.74	6.70
	30kg N/ fad +two bio-dose	29.50	29.80	11.01	7.90
	60kg N/ fad +one bio-dose	31.70	31.20	12.12	7.70
	60kg N/ fad +two bio-dose	32.42	33.40	14.73	8.50
Seeds washed by water before inoculation	30kg N/ fad +one bio-dose	27.94	27.20	10.02	6.70
	30kg N/ fad +two bio-dose	30.24	29.20	12.30	7.27
	60kg N/ fad +one bio-dose	30.96	32.40	13.28	8.20
	60kg N/ fad +two bio-dose	32.84	33.20	13.91	8.90
L.S.D. at 0.05 level of significance		3.59	5.13	1.80	1.58

2- Top/root ratio and economic sugar content (E.S.C.)%.

Table 3. Effect of bio and mineral nitrogen fertilization on top/root ratio and economic sugar content (E.S.C) during 1999/2000 and 2000/2001 growing seasons.

Treatments		Top/root ratio		E.S.C %	
		1999/2000	2000/2001	1999/2000	2000/2001
Control	90 kg N/ fad	44.60	25.97	17.30	17.22
Seeds not washed by water before inoculation	30kg N/ fad +one bio-dose	35.69	24.83	17.01	17.37
	30kg N/ fad +two bio-dose	38.50	26.78	16.58	17.13
	60kg N/ fad +one bio-dose	38.02	25.62	17.86	17.76
	60kg N/ fad +two bio-dose	45.91	25.88	17.23	17.35
Seeds washed by water before inoculation	30kg N/ fad +one bio-dose	36.01	24.95	17.22	17.36
	30kg N/ fad +two bio-dose	41.78	25.33	16.77	17.11
	60kg N/ fad +one bio-dose	43.22	25.23	17.49	17.81
	60kg N/ fad +two bio-dose	42.64	26.75	17.15	17.61
L.S.D. at 0.05 level of significance		7.08	1.62	0.35	0.22

Data in Table (3) indicated that bio and mineral N fertilization exhibited significant effect on top/root ratio and E.S.C% . The highest top/root% values was compained with high mineral nitrogen levels and decreased with decreasing N mineral plus any biofertilizer dose. The high top/root ratio indicator to complete maturity of sugar beet to harvest. On the other hand, E.S.C. recorded the highest percentage (17.86 and 17.81) when sugar beet plants were fertilized by 60 kg N and one or two biofertilizer dose with or without washing seeds in both seasons, respectively. While, the lowest one was 16.58 and 17.11 resulted from 30 kg N + 2 biofertilizer dose. The results of El-Badry *et al.*,(1993); Favilli *et al.*,(1993); Ali (1996); Sultan *et al.*,(1999) and Abo El-Fotoh (2000) confirmed this finding.

3- Purity percentage and economic sugar yield (ton/fad).

Table 4. Effect of bio and mineral nitrogen fertilization on purity percentage and economic sugar yield during 1999/2000 and 2000/2001 growing seasons.

Treatments		Purity percentage %		Economic sugar yield	
		1999/2000	2000/2001	1999/2000	2000/2001
Control	90 kg N/ fad	79.52	79.83	6.02	6.10
Seeds not washed by water before inoculation	30kg N/ fad +one bio-dose	78.12	78.17	4.64	4.93
	30kg N/ fad +two bio-dose	78.57	78.78	4.89	5.10
	60kg N/ fad +one bio-dose	78.93	79.29	5.66	5.54
	60kg N/ fad +two bio-dose	78.03	78.39	5.86	5.79
Seeds washed by water before inoculation	30kg N/ fad +one bio-dose	78.93	78.66	4.81	4.72
	30kg N/ fad +two bio-dose	78.48	78.63	5.07	5.00
	60kg N/ fad +one bio-dose	78.80	79.11	5.41	5.77
	60kg N/ fad +two bio-dose	78.71	79.02	5.63	5.85
L.S.D. at 0.05 level of significance		0.39	1.04	0.35	0.52

Effect of bio and mineral nitrogen fertilization on purity percentage and sugar yield is presented in Table (4). It is closely shown that purity % affected significantly by mineral nitrogen source (90 kg N/fad) and gave the highest values in both seasons (79.52 and 79.83%) followed by any treatment take the largest amount from mineral nitrogen and the lowest values was obtained when biofertilizer was increased to two recommended dose. The distinguished influence of bio and mineral nitrogen fertilization on purity % was reported by Sulton *et al.*,(1999); Abo El-Fotoh (2000) and Maareg *et al.*,(2000). Economic sugar yield per fad significantly increased with increasing mineral nitrogen to 90 kg N/ fad (6.02 and 6.10 ton/fad)in both seasons. Applied biofertilizer by any dose with low mineral level 30 or 60 kg/fad fall to give the same effect of mineral nitrogen alone and can't supply the requirement of the plant from nitrogen element and produced the lowest economic sugar yield (4.64 and 4.93 ton/fad). These results are in accordance with those obtained by El-Badry *et al.*,(1993); Favilli *et al.*, (1993); Afify *et al.*, (1994) and Abo El-Fotoh *et al.*,(2000).

4-Alkaline coefficient (A.C):

No significant differences were observed due to the effect of bio and mineral nitrogen nutrition on A.C. in Table (5) in both seasons. Washed or not washed seeds and inoculated by Cerealine by any dose or N mineral were not appeared any significant differences due to these treatments. A.C. in all means of treatments was more than Critical level of A.C. (1.8) and this indicator that all nitrogen fertilizers dose whether mineral alone or mineral together biofertilizer were not accessive doses but at optimum dose which caused to gave optimum photosynthesis rate represented in high yield and quality of sugar beet. These results are agreement with Wieninger and Kubadinow (1971) they considered that the A.C should not fall below 1.8 to reducing molasses sugar during extraction.

Table 5. Effect of bio and mineral nitrogen fertilization on Alkaline coefficient (A.C) during 1999/2000 and 2000/2001 growing seasons.

Treatments		Alkaline coefficient (A.C.)	
		1999/2000	2000/2001
Control	90 kg N/ fad	3.72	10.97
Seeds not washed by water before inoculation	30kg N/ fad +one bio-dose	3.47	10.47
	30kg N/ fad +two bio-dose	3.66	10.17
	60kg N/ fad +one bio-dose	3.75	1097
	60kg N/ fad +two bio-dose	3.53	10.36
Seeds washed by water before inoculation	30kg N/ fad +one bio-dose	3.42	10.20
	30kg N/ fad +two bio-dose	3.69	10.72
	60kg N/ fad +one bio-dose	3.59	10.35
	60kg N/ fad +two bio-dose	3.74	11.25
L.S.D. at 0.05 level of significance		N.S	N.S

CONCLUSION

It could be noted that nitrogen fertilization was superiority in all characters than any N mineral + any biofertilizer dose and there were no significant differences between seeds whether washed or not before inoculation. Generally, biofertilizer with two recommended dose plus 60 kg N/fad were not significantly with 90 kg N/fad alone in all characters under study. While, sucrose percentage recorded the highest values with 60 kg N/fad + one recommended dose of biofertilizer.

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الملخص العربى

تأثر محصول وجودة بنجر السكر بالتسميد الآزوتى الحيوى والمعدنى

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معهد بحوث المحاصيل السكرية– مركز البحوث الزراعية– الجيزة

نظراً لأهمية عنصر النتروجين ومصادره المعدنية أو الحيوية أقيمت تجربتان حقليتان لدراسة تأثير التسميد الآزوتى الحيوى و المعدنى ومدى تأثير المبيدات التى تغلف أو تخلط مع البذور لحمايتها أثناء الإنبات على المحصول ومكوناته خلال الموسمين الزراعيين ١٩٩٩/٢٠٠٠ – ٢٠٠٠/٢٠٠١ فى المزرعة البحثية لمحطة سخا للبحوث الزراعية بكفر الشيخ. وقد اشتملت التجربة على ٩ معاملات زراعية كالأتى:

١- تسميد آزوتى معدنى كامل بمعدل ٩٠ كجم ن /فدان

٢- ٣٠ وحدة آزوت /فدان معدنى + كيس سيريالين (مخصب حيوى) موصى به /فدان

٣- ٣٠ وحدة آزوت /فدان معدنى +٢ كيس سيريالين (مخصب حيوى) موصى به /فدان

٤- ٦٠ وحدة آزوت /فدان معدنى + كيس سيريالين (مخصب حيوى) موصى به /فدان

٥- ٦٠ وحدة آزوت /فدان معدنى + ٢ كيس سيريالين (مخصب حيوى) موصى به /فدان

٦- ، ٧ ، ٨ ، ٩ نفس المعاملات من ٢-٥ مع غسيل بذور بنجر السكر بالماء قبل عملية التلقيح البكتيرى للبذور.

وقد تم استخدام تصميم القطاعات الكاملة العشوائية فى ثلاث مكررات وتم زراعة التجربتين فى الاسبوع الأول والثانى من شهر أكتوبر فى خلال الموسمين على التوالى. وأظهرت النتائج أن التسميد فقط بمعدل ٩٠ كجم ن /فدان أو بمعدل ٦٠ كجم ن /فدان بالإضافة إلى السماد الحيوى أدى إلى زيادة كلا من محصول الجذور والعرش والسكر وكذلك النقاوة ونسبة الجذور/العرش ، بينما أدى السماد المعدنى فقط إلى نقص معنوى فى نسبة السكروز. وأن التسميد الحيوى إدى إلى تعويض نقص معدل التسميد الأزوتى من ٩٠ كم إلى ٦٠ كجم ن /فدان حيث إنه لم يظهر فروق معنوية بين المعاملتين فى محصول الجذور والأوراق والنقاوة والمحصول الاقتصادي من السكر. كذلك تشير النتائج إلى انه لا يوجد فروق معنوية فى كل الصفات تحت الدراسة ترجع إلى غسيل البذور قبل التلقيح البكتيرى بالسيريالين أو عدم غسيلها من المبيدات التى تخلط مع البذرة لحمايتها أثناء الإنبات أى أنه يمكن استخدام الأسمدة الحيوية بدون غسيل البذور من المبيدات المعاملة بها دون خوف منها.