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RESPONSE OF YIELD AND QUALITY OF SUGAR CANE TO NITROGEN AND ZINC FERTILIZATION

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Abstract

Two field experiments were carried out at Shandaweel Research Station, Upper Egypt in the two successive growing seasons of 1997/ 1998 and 1998/1999 to study the effect on nitrogen and zinc fertilization on yield and quality of sugar cane plant crop. Each trial included nine treatments representing the combination between three nitrogen levels (160, 190 and 220 kg N/fed) and three doses of zinc (0, 25 and 50g Zn/fed). A complete randomized block design with three replications was used. Results showed that zinc levels significantly affected sugar yield, reducing sugar % and sucrose % in the 1st and 2nd seasons. On the other hand, it was noticed that cane yield significantly responded to zinc levels in the second season while number of millable cane significantly responded to zinc levels in the first season. Generally, applying 50 g Zn/fed produced the highest production of the studied characters. Regarding the effect of nitrogen levels, it was revealed that except for sugar yield, number of millable cane, cane yield, reducing sugar, sucrose % and purity % significantly responded to applied nitrogen levels in the 1st and 2nd seasons. Mostly, increasing N fertilizer up to 220 kg N/fed increased the values of studied traits.

INTRODUCTION

Nitrogen is considered one of the most important elements which has a direct effect on plant growth, yield and juice quality. Zinc is one of the micro-nutrients which is necessary for the growth of sugar cane where it affects the synthesis of tryptophan which lead directly to the synthesis of the hormone indol-acetic acid (Auxin). The function of auxins in plants is regulative and has to do with root formation, stem cell elongation and maintenance of dormancy in lateral buds. Varma *et al.* (1987) showed that application of different rates of zinc at 3.75, 5.0 and 7.5 kg/ha at 75, 105 and 135 days after planting increased cane yield and improved juice quality. Mohamed *et al.* (1990) found that spraying Zn-chelate increased cane and sugar yields by 10 and 25% over the untreated, respectively. Azzazy (1991) obtained a gradual increase in reducing sugars and purity % with inceasing N levels while sucrose% was decreased with increasing N levels. He found that cane and sugar yields responded significantly to N and

Zn levels up to 240 kg N/fed and 33 g zn/fed, respectively. Narasimham and Ramalingaswamy (1991) found that sugar yield increased significantly as N application rates increased from 0 to 112 kg/ha; sugar yields obtained were 10.6, 13.9 and 13.6 ton/ha at 0, 112 and 224 kg N/ha, respectively. Abd El-Gawad, et al. (1992-a) found that cane yield responded positively and significantly to nitrogen fertilizer up to 240 kg N/fed. Morever, application of 33g Zn/fed or 66 g Zn/fed gave an advantage in cane yield amounted to 1.74 and 2.23 tons/fed, respectively over the yield of unfertilized treatment. Abd-El-Gawad, et al. (1992-b) obtained a high value of sucrose % when zinc element was added at the rate of 33 g Zn/fed. They found a negative response in juice purity due to the increase in nitrogen doses (120, 180 and 240 kg N/fed). Lestari (1992) applied nitrogen fertilizer on sugarcane as 125, 157.5 or 190 kg N/ha. He showed that sugar yield was higher with 157.5 than with 125 kg N/ha. Abd El-Hadi et al. (1994) mentioned that juice quality in terms of purity and recovery percentage were not clearly affected by adding nitrogen fertilizer at rates of 150, 175 and 200 kg N/fed. El-Geddawy et al. (1997) found that both cane and sugar yields significantly increased by increasing nitrogen up to 210 kg/fed. Also he demonstrated that sucrose, purity and recovery percentages showed a reverse relationship due to nitrogen fertilizer application.

MATERIALS AND METHODS

The present work was conducted on G.T. 54-9 sugar cane variety at Shandaweel Research Station, Upper Egypt in the two successive seasons of 1997/1998 and 1998/1999 to study the effect of nitrogen and zinc fertilization on yield and quality of sugar cane plant crop. Each trial included nine treatments represented the combination between three nitrogen levels (160, 190 and 220 kg N/fed) and three doses of zinc (0, 25 and 50g Zn/fed). A complete randomized block design with three replications was used. Physical and chemical properties of the upper 30cm of soil of the experimental site were clay loam, available N 25.8 ppm, P 20.52 ppm and K 520 ppm. Sub-plot area was 42 m2 with 6 ridges of 7 meters in length and 1.0 m apart. Sugar cane variety viz. G.T. 54/9 was planted in spring season (during the 1st week of April 1997 and 1998 seasons).

Nitrogen fertilizer was added as urea (46% N) in two equal doses; the first dose was applied after two months from planting (1st June) and the second one was added one month later (1st July). Zinc was applied in form of zin sulphate and sprayed on the plants after two months from planting. Potassium fertilizer at rate 100 kg potassium

sulphate (48% K_2O) was added as one dose with the first nitrogen dose. Calcium super phosphate at rate of 400 kg (15.5% P_2O_5) was added with preparing the soil to planting. Other cultural practices were done according to the region.

Data Recorded

1. Number of millable can/fed.
2. Cane yield (tons/fed).
3. Sucrose percentage.
4. Purity % was calculated according to the following equation:
   Purity % = sucrose % / birx % 100.
5. Reducing sugars percentage.
6. Sugar yield (tons/fed) was estimated according to the following equation:

Sugar yield = cane yield (ton/fed) x sugar recovery %. The collected data were statistically analyzed according to Snedecor and Cochran (1981).

RESULTS AND DISCUSSIONS

1. Number of millable cane:

Results obtained in Table (1) clarified that number of millable cane (MC) significantly responded to the applied zinc levels in the first season only. It was noticed that 50 g Zn/fed produced the maximum value of number of millable cane (48.87 and 55.31 1000 plants/fed) compared with the other (0 and 25 g Zn/fed) zinc levels in the 1st and 2nd season, respectively.

Table 1. Number of millable cane (1000 plants/fed) as affected by zinc and nitrogen levels.

Zinc levels (g Zn/fed)	1997/1998 season				1998/1999 season			
	Nitrogen levels (kg N/fed							
	160	190	220	Average	160	190	220	Average
0	42.00	46.30	48.17	45.49	48.78	54.03	56.47	53.09
25	44.43	47.50	49.77	47.23	50.60	55.18	58.50	54.76
50	47.50	48.70	50.40	48.87	50.73	54.68	60.52	55.31
Average	44.64	47.50	49.44	47.20	50.04	54.63	58.49	54.39

LSD at 5% level:		
Zink levels (Z)	1.02	NS
Nitrogen levels (N)	1.02	1.96
Z x N	NS	NS

Regarding the nitrogen levels, there was a significant effect on the number of millable cane in first and second seasons. Increasing N level up to 220 kg N/fed increased of number of millable cane by (4.80 and 1.94) and (8.45 and 3.86 1000 plants/fed) compared with the other (160 and 190 kg N/fed) N levels in the 1st and 2nd season, respectively.

The interaction between zinc and nitrogen levels had no significant effect on this trait.

2- Cane yield:

Data illustrated in Table 2 showed that zinc levels significantly affected cane yield in the second seaon only. Applying 50 g Zn/fed outyielded the other (0 and 25 g Zn/fed) zinc levels by 2.78 and 2.29 tons/fed, respectively. This result is confirmed by those obtained by Abd El-Gawad et al. (1992-b) and El-Geddawy et al. (1997).

Regarding the effect of nitrogen levels, cane yield was significantly affected by nitrogen levels in the first and second seasons. Increasing N levels from 160 kg N/fed up to 190 and 220 kg N/fed increased cane yield by (3.52 and 6.29) and (2.96 and 5.96) tons/fed in the 1st and 2nd season, respectively. This results is in general agreement with that reported by Abd El-Gawad et al. (1992-b) and El-Geddawy et al. (1997).

The results showed insignificant effect of the interactions between the levels of fertilizers on this trait in bothn seasons.

Table 2. Cane yield (tons/fed) as affected by zinc and nitrogen application.

Zinc levels (g Zn/fed)	1997/1998 season				1998/1999 season			
	Nitrogen levels (kg N/fed							
	160	190	220	Average	160	190	220	Average
0	47.67	48.79	53.23	49.96	53.00	53.00	54.90	53.63
25	48.00	51.13	53.27	50.80	51.00	53.33	58.03	54.12
50	47.20	53.33	55.23	51.92	51.33	57.60	60.28	56.41
Average	47.62	51.14	53.91	50.89	51.78	54.64	57.74	54.72

LSD at 5% level:		
Zink levels (Z)	NS	2.19
Nitrogen levels (N)	2.53	2.19
Z x N	NS	NS

3. Sucrose percentage

Results obtained in Table 3 recorded a significant response in sucrose % due to the applied zinc levels in the first and second seasons. Applying 50 g Zn/fed superior by (0.84, 0.8%) and (0.64, 0.09%) than the other two levels of zinc (0 and 25 g Zn/fed) in the 1st and 2nd season, respectively. This finding was in general agreement with that obtained by Abd El-Gawad et al. (1992-b).

Concerning the effect of nitrogen, there were a significant and reverse effect on this trait due to nitrogen levels in the first and second seasons. Adding N fertilizer at the rate of 160 kg N/fed increased sucrose % by 0.69, 0.31% and 0.5, 0.5% compared with the other (190 and 220 kg N/fed) nitrogen levels in the 1st and 2nd season, respectively. This result is in line with that recorded by El-Geddawy et al. (1997).

The interaction between zinc and nitrogen levels had no significant effect on this trait.

Table 3. Sucrose percentage as affected by zinc and nitrogen application.

Zinc levels (g Zn/fed)	1997/1998 season				1998/1999 season			
	Nitrogen levels (kg N/fed							
	160	190	220	Average	160	190	220	Average
0	19.00	18.27	18.43	18.57	19.32	18.93	18.92	19.06
25	18.88	183.39	18.55	18.61	20.13	19.45	19.25	19.61
50	19.70	18.86	19.66	19.41	19.92	19.48	19.71	19.70
Average	19.19	18.50	18.88	18.86	19.79	19.29	19.29	19.46

LSD at 5% level:

Zink levels (Z)	0.35	0.33
Nitrogen levels (N)	0.35	0.33
Z x N	NS	NS

4. Purity percentage:

Data presented in Table 4 cleared that purity percentage was not significantly affected by zinc levels in the first and second seasons. However, increasing zinc levels up to 50 g Zn/fed produced a gradual increase in purity percentage.

Regarding the effect of nitrogen, there was a significant effect on purity percentage due to the nitrogen levels in the first and second seasons. Adding 160 kg N/fed gave the highest value of purity percentage in the 1st and 2nd seasons. This results is in harmony with that reported by Azzazy (1991) and El-Geddawy et al. (1997).

The results showed no significant effect of the interactions between the levels of the two fertilizers on this trait in both seasons.

Table 4. Purity percentage as affected by zinc and nitrogen application.

Zinc levels (g Zn/fed)	1997/1998 season				1998/1999 season			
	Nitrogen levels (kg N/fed							
	160	190	220	Average	160	190	220	Average
0	81.01	81.77	75.93	79.57	80.78	78.29	75.04	78.06
25	79.36	80.69	75.79	78.61	82.02	79.52	77.38	79.64
50	84.57	81.95	79.12	81.88	83.54	79.62	76.11	79.76
Average	81.65	81.47	76.95	80.02	82.14	79.14	76.17	79.15

LSD at 5% level:

Zink levels (Z)	NS.	NS
Nitrogen levels (N)	2.71	1.88
Z x N	NS	NS

5. Reducing sugar percentage:

The results obtained in Table 5 revealed that reducing sugars percentage was significantly affected by zinc levels in the first and second seasons. Increasing zinc levels up to 50 g Zn/fed produced the lowest value of reducing sugars percentage. This result clears the reverse effect between zinc application and reducing sugars percentage. This results is in general agreement with that reported by Azzay (1991).

Regarding the effect of nitrogen, there was a significant effect on purity percentage due to the nitrogen levels in the first and second seasons. Increasing N leaves from 160 kg N/fed up to 190 and 220 kg N/fed increased reducing sugar percentage by (0.18, 4.7%) and (3.0, 5.97%) in the 1^{st} and 2^{nd} season, respectively. This result is in harmony with that reported by Abd-El-Gawad, et al (1992-b) and El-Geddawy et al. (1997).

Table 5. Reducing sugar percentage as affected by zinc and nitrogen application.

Zinc levels (g Zn/fed)	1997/1998 season				1998/1999 season			
	Nitrogen levels (kg N/fed							
	160	190	220	Average	160	190	220	Average
0	0.88	0.99	1.06	0.98	1.00	1.11	1.34	1.15
25	0.78	0.92	1.01	0.90	0.90	1.04	1.15	1.03
50	0.78	0.88	0.88	0.85	0.96	0.99	1.05	1.00
Average	0.82	0.93	0.98	0.91	0.95	1.05	1.18	1.06

LSD at 5% level:

Zink levels (Z)	0.04	0.06
Nitrogen levels (N)	0.04	0.06
Z x N	NS	0.09

The results showed a significant effect of the interaction between the levels of the two fertilizers on this trait in the second season. The lowest value of reducing sugars was obtained by adding 25 g Zn/fed with 160 kg N/fed.

6. Sugar yields:

Results obtained in Table 6 clarified that sugar yield significantly responded to the applied zinc levels in the first and second seasons. It was noticed that 50 g Zn/fed produced the highest quantity of sugar (0.71, 0.67 ton/fed) and (0.96,0.39 ton/fed) compared with the other (0 and25 g Zn/fed) zinc levels in the first and second season, respectively. This result is in general agreement with that reported by Varma et al. (1987) and Mohamed et al. (1990).

Concerning the nitrogen levels, there was a significant effect on this trait due to nitrogen levels in first season. Adding 220 kg N/fed produced the highest sugar quantity. This result is in general agreement with that reported by Abd El-Gawad et al. (1992-a).

The interaction between zinc and nitrogen levels had no significant effect on this trait.

Table 6. Sugar yield (tons/fed) as affected by zinc and nitrogen application.

Zinc levels (g Zn/fed)	1997/1998 season				1998/1999 season			
	Nitrogen levels (kg N/fed							
	160	190	220	Average	160	190	220	Average
0	5.699	5.961	6.022	5.894	6.621	6.278	6.230	6.376
25	5.687	6.002	6.125	5.938	6.863	6.608	6.799	6.678
50	5.830	6.873	7.108	6.604	6.718	7.142	7.351	7.070
Average	5.739	6.279	6.418	6.145	6.734	6.676	6.794	6.735

LSD at 5% level:

Zink levels (Z)	NS	NS
Nitrogen levels (N)	2.71	1.88
Z x N	NS	NS

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إستجابة محصول وجودة قصب السكر للسماد الأزوتي والزنك

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أقيمت تجربتان حقليتان في محطة البحوث الزراعية بشندويل بمحافظة سوهاج خلال موسمي الزراعة ١٩٩٧ / ١٩٩٨ و ١٩٩٨ / ١٩٩٩ لدراسة تأثير ثلاث مستويات من السماد الازوتي (١٥٠، ١٩٠ و ٢٢٠ كجم ن/فدان) وثلاث مستويات من الزنك (صفر و ٢٥ و ٥٠ جم زنك/فدان) علي محصول وجودة قصب السكر. وقد استخدم تصميم قطاعات كاملة العشوائية في ثلاث مكررات. وكان الصنف المستخدم هو جيزة تايوان ٥٤-٩ .

أوضحت النتائج أن صفة عدد النباتات القابلة للعصير بالفدان ومحصول السكر والنسبة المئوية للسكروزوالنسبة المئوية للجلوكوز تأثرت معنويا من إضافة الزنك في موسمي ١٩٩٧ / ١٩٩٨، ١٩٩٨ / ١٩٩٩ بينما تأثر محصول العيدان معنويا في الموسم الثاني فقط أما صفة النسبة المئوية للنقاوة فلم تستجب معنويا لإضافة الزنك في كلاالموسمين.

أثرت إضافة التسميد الأزوتي معنويا علي صفة عدد النباتات القابلة للعصير بالفدان ومحصول العيدان والنسبة المئوية السكروز والنسبة المئوية للنقاوة والنسبة المئوية للجلوكوز في كلا الموسمين بينما استجاب محصول السكر لإضافة الأزوت في الموسم الأول فقط.

ويوصي هذا البحث بتسميد القصب بمعدل ٥٠ جم زنك مع ٢٢٠ كجم نيتروجين للفدان للحصول علي أعلي محصول من العيدان والسكر.