

SHORT NOTE

Effect of nitrogen and zinc plus copper on sugarcane (*Saccharum* spp) plant crop in Guneid and Assalaya Sugar Estates, in central Sudan

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Sugarcane cultivation started in Sudan in the early 1960s. Since then it has been expanding considerably. Sugarcane is grown mainly in the central clay plain (Vertisols) of Sudan which are characterized by moderate chemical fertility, high contents of smectitic clays, high pH values, low N and organic carbon contents. Nitrogen content of these soils ranges from 0.03 to 0.045% (Idris, 2001). Likewise, these Vertisols are low in available P, Fe, Mn, Zn, and Cu. The diethylene triamine penta acetic acid (DTPA) available Cu and Zn for the 0 – 30 cm soil depth at Guneid and Assalaya locations ranges from 0.34 to 0.48 and 0.17 to 0.23 mg kg⁻¹ soil, respectively (Elhagwa, 2000).

The poor or lack of response of the plant cane (PC) to N application was reported by several workers (Ali, 2003). In this regard, the application of N coupled with Zn plus Cu may prove to be more beneficial to sugarcane because in the past only N, and more recently N and phosphorus fertilizers were added to the sugarcane fields in Sudan.

The objective of this study was to investigate the response of sugarcane to different rates of nitrogen alone or in combination with Zn plus Cu. The soils of the two experimental locations (Guneid and Assalaya) belong to Remaitab soil series and, therefore, they are more or less similar in their physical and chemical characteristics. They were classified as Haplusterts, fine, smectitic, isohyperthermic (Soil Survey Staff, 1999).

The treatments were three rates of N: 150, 200 and 250 kg urea/feddan (164, 219 and 274 kg N ha⁻¹); and two rates of each of Zn and Cu: Zero and 500 g /feddan of (zero and 1.19 kg ha⁻¹). The 3 x 2 factorial experiments were laid out in a randomized complete block design with four replications in each of the two locations. The experimental plots consisted of four rows; each was 10 m long and 1.5 m wide. The sugarcane variety was Co 6806. The experiments were planted in the farm of Guneid Sugarcane Research Centre in the last week of October 2005 and in Assalaya Sugar Estate farm in the first week of November 2005. The adopted husbandry practices in the sugarcane estates were closely followed. Urea was applied at both sides of the row of cane plants, similar to machine application when the cane was 45 to 60 days old as has been practiced in the commercial cane fields. Zn as ZnSO₄.7H₂O and Cu as CuSO₄.5H₂O were applied in a mixture as foliar spray (Zn and Cu salts were dissolved in 60 liters of water /feddan [143 l ha⁻¹] for a single application). The dose was split into two: One half was applied when the cane was five months old, and the other half at seven months old. Leaf samples were periodically collected from each experimental plot and composite samples were made for each treatment and analysed for mineral content. Total leaf N (%) was determined using Kjeldahl method. Zn and Cu were determined using atomic absorption spectrophotometry.

The plant crop was harvested after 14 months from planting. Only the two central rows were used for data collection. The number of millable stalks, stalk height and yield of cane were recorded at harvest.

For cane quality determination, 10 stalks were randomly taken from each experimental plot at harvest and the following quality parameters were determined according to the International Commission for Uniform Methods of Sugar Analysis (ICUMSA, 1979):

1. Brix (%) cane [total soluble solids(%)].
2. Pol (%) cane (Sucrose content of cane).
3. Fiber (%) cane.
4. Estimated recoverable sugar (ERS) (%).

Sugar yield: ERS (%) x yield of cane (ton cane /feddan).

The results showed that N rates had no significant effects on cane yield or yield components (Tables 1 and 2). The yield of cane at both locations, was relatively higher compared to that of the commercial cane fields in general for the three rates of urea. Moreover, the cane yield was higher at Guneid compared to that of Assalaya. This was probably due to the longer resting period (nine months) preceding planting of cane in Guneid compared to only five months resting period at Assalaya. The lack of response of the plant cane crop to N has already been documented (Ali, 2003). This study also showed that the parameters of cane quality exhibited insignificant differences in response to urea rates. However, the lower rate of applied urea in both locations gave slightly higher values of pol (%) cane, ERS (%) and to some extent sugar yield/feddan when compared to the higher rates of urea (Tables 1 and 2). It is known that increasing N application beyond a certain level will adversely affect the quality of cane (Rathey and Hogarth, 2001).

The results also revealed that application of Zn + Cu had no significant effects on cane yield, yield and quality components in both locations (Tables 1 and 2). Although the soils of Guneid and Assalaya are low in available Zn and Cu, yet visual deficiency symptoms of these two elements in sugarcane have not been reported. It can be perceived that the sugarcane crop presumably takes its requirements of Zn and Cu from the soil irrespective to their contents. These findings were in conformity with those of Abdelwahab (1994) who reported that application of Zn with or without other micronutrients in Dinder soil series (Vertisols) in Kenana Sugar Company resulted in insignificant increases of cane yield components and yield. Further, Elhagwa (2000) indicated that application of Zn and P to sugarcane in Dinder and Hagu soil series at Sinnar Sugar Factory significantly increased their leaf nutrient content but this increase was not reflected in a significant increase in cane yield. It is worth mentioning that no interactions between urea with Zn + Cu were found in the two locations, thus, their respective data were not presented.

Nitrogen concentrations in leaf blade numbers 3, 4, 5 and 6 fell within the sufficiency level for sugarcane as reported by Humbert (1968), i.e., from 1.5 to 2.5%, however, the effect of the rate of urea on leaf N concentration did not show any consistent trend.

The data in Table 3 revealed that there were slight increases of the concentrations of Zn and Cu of the cane leaves for treatments that received such nutrients, and that all concentrations for both elements in the leaves

Table 1. Effect of nitrogen and Zn plus Cu on yield components, yield and quality of sugarcane, plant crop. (Guneid 2006/07).

Parameters	Urea (kg/f)			S.E. (±)	Zn + Cu (g/fed.)		S.E. (±)	C.V. (%)
	150 (164)*	200 (21)*	250 (264)*		0	500+500 (1.19)*		
No. of millable stalks /f	51787.0	51952.0	49678.0	720.00	50221.0	52057.0	588.00	3.98
Stalk height (cm)	270.0	269.0	268.0	4.96	271.0	267.0	4.05	5.22
Yield of cane (ton /f)	67.9	68.5	67.0	1.80	67.3	68.3	1.47	7.50
Brix% cane	15.7	15.8	15.4	0.12	15.6	15.7	0.10	2.23
Pol% cane	11.8	11.6	11.2	0.21	11.5	11.5	0.17	5.21
Fiber% cane	16.7	15.7	16.4	0.36	16.3	16.2	0.29	6.21
ERS (%)	9.6	9.4	9.0	0.23	9.4	9.3	0.19	6.89
Sugar yield (ton/f)	6.6	6.4	6.1	0.27	6.3	6.4	0.22	11.98

* kg N ha⁻¹.¹ kg ha⁻¹.

Table 2. Effect of nitrogen and Zn plus Cu on yield components, yield and quality of sugarcane, plant crop, (Assalaya 2006/07).

Parameters	Urea (kg/f)			S.E. (±)	Zn + Cu (g/fed.)		S.E (±)	C.V. (%)
	150 (164)*	200 (219)*	250 (264)*		0	500+500 (1.19) ¹		
No. of millable stalks/f	54828.0	54555.0	57390.0	1619.00	56283.0	54898.0	1322.00	8.2
Stalk height (cm)	309.0	297.0	289.0	9.48	292.0	305.0	7.74	9.0
Yield of cane (ton /f)	61.8	60.1	61.6	2.46	62.2	60.1	2.01	11.4
Brix (%) cane	17.9	17.3	17.5	0.26	17.5	17.6	0.21	4.2
Pol (%) cane	14.9	14.3	14.4	0.22	14.5	14.5	0.18	4.3
Fiber (%) cane	14.5	14.2	14.1	0.28	14.4	14.2	0.23	5.6
ERS (%)	11.9	11.3	11.4	0.22	11.5	11.5	0.18	5.5
Sugar yield (ton /f)	7.3	6.8	7.0	0.33	7.1	6.9	0.27	13.2

* kg N ha⁻¹.¹ kg ha⁻¹.Table 3. Concentration of leaf Zn and Cu (mg kg⁻¹ DM) for Guneid and Assalaya sites.

Micronutrient	Age (month)	Zn		Cu	
		Treatments		Treatments	
Site		(Zn +Cu) ₀	(Zn +Cu) ₁	(Zn + Cu) ₀	(Zn +Cu) ₁
Guneid	6.5	41.96	49.16	16.58	21.09
Assalaya	7.5	40.37	41.53	21.00	22.42

Note: Ranges without deficiency symptoms of Zn and Cu in sugarcane are 10 to 100 and 5 to 100 mg kg⁻¹ leaf DM, respectively (Humbert, 1968).

(Zn +Cu)₀: No application of either Zn or Cu.(Zn +Cu)₁: Application of 500 g/f of each Zn and Cu.

fell within the sufficiency levels (Humbert, 1968). This is presumably the reason for the lack of significant differences in yield components and yield of treatments receiving Zn and Cu and treatments that did not receive such nutrients.

In view of the present study, the rate of 150 kg urea /feddan (164 kg N ha⁻¹) is recommended for the plant cane crop. No application of Zn plus Cu is currently needed for the plant cane crop.

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تأثير النيتروجين و الزنك زاندا النحاس على محصول قصب السكر الغرس في كل من مشروع الجنيدي و عسلاية في وسط السودان

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الخلاصة

أجريت التجارب الحالية في موسم 06/2005 في مزرعتي مصنعي سكر عسلاية و الجنيدي التابعتين لشركة السكر السودانية، في السهل الطيني الأوسط. كانت أهداف هذه الدراسة بحث استجابة محصول قصب السكر (محصول غرس) لجرعات مختلفة من النيتروجين في شكل سماد اليوريا مصحوبة بعنصري الزنك زاندا النحاس. كانت جرعات اليوريا 150 و 200 و 250 كجم للفدان. أضيفت هذه الجرعات بعد 45 إلى 60 يوما من الزراعة حسب ما هو متبع في الحقول التجارية لقصب السكر. و كانت الجرعة المستخدمة من الزنك والنحاس هي صفر و 500 جم لكل (خليط) في شكل ملح كبريتات و قسمت هذه الجرعة إلى نصفين: أضيف النصف الأول عندما كان عمر المحصول خمسة شهور، كما أضيف النصف الثاني عند عمر سبعة شهور في شكل سماد ورقي. وضع هذا الترتيب العاملين في تصميم القطاعات العشوائية الكاملة. أوضحت النتائج عدم وجود فروقات معنوية في مكونات الإنتاجية و الإنتاجية و مكونات جودة السكر و إنتاجية السكر لمحصول القصب الغرس بين جرعات النيتروجين المستخدمة، إلا أن جودة السكر قد انخفضت قليلا بزيادة جرعة النيتروجين انخفاضا غير معنوي. كما أبانت الدراسة أيضا عدم وجود فروقات معنوية في الإنتاجية و مكونات جودة السكر و إنتاجية السكر لمحصول القصب الغرس بين إضافة عنصري الزنك زاندا النحاس مقارنة مع عدم إضافتهما في كل من موقعي الدراسة. كما أوضحت الدراسة عدم وجود تفاعل بين النيتروجين و الزنك زاندا النحاس. كان تركيز عناصر النيتروجين و الزنك و النحاس في أوراق نبات قصب السكر في المدى من 1,9 إلى 2,5 % و 40,37 إلى 49,16 و 16,58 إلى 22,42 مجم لكل كجم مادة جافة على التوالي لكل الوحدات التجريبية في التجريبتين. و تعتبر هذه التركيزات في الحدود الكافية لنبات قصب السكر. أبانت الدراسة أن الجرعة 150 كجم يوريا للفدان (164 كجم نيتروجين للهكتار) هي الجرعة المناسبة لكل من إنتاجية القصب و السكر في محصول الغرس مقارنة بالجرعة العادية 200 كجم للفدان (219 كجم نيتروجين للهكتار) في حقول قصب السكر التجارية. كذلك إن إضافة عنصري الزنك و النحاس لمحصول الغرس لم تثبت أنها ذات فائدة لفلاحة قصب السكر في هذه المرحلة.