

# **Response of Sugarcane to Different Levels of Nitrogen in Four Estates of the Sudanese Sugar Company**

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## **Abstract**

The response of sugarcane to applied nitrogen was studied at 4 Sugar Estates of the Sudanese Sugar Company, for two seasons 2003-04 and 2004-05. Nitrogen rates ranging from 69–138 kg N/fed were tested in the plant crop cycle. Leaf nitrogen concentration increased only slightly by adding nitrogen above 69 kg N/fed. Neither cane nor sugar production was significantly affected by increasing nitrogen dose above 69 kg N/ fed. in the plant cane cycle.. Based on the statistical and economic analysis of these experiments which show the superiority of low application rate of nitrogen fertilizer to the plant cane cycle, the study recommended to apply 69 kg N/fed instead of the current rate of 92 kg N/fed .

## **Introduction**

The Sugarcane estates of the Sudanese sugar Company lie within the Central Clay Plain. The heavy biomass of sugarcane and its prolonged growing period dictate the addition of nitrogenous fertilizers for sustainable sugar production .Early research work at GSCRC recommended application of 71.8 kg N/fed (4N). Later this dose was raised to 92 kg N/fed. without proper research .

Many questions were raised about the validity of this recommendation. EL Fadel (1972, 73) studied the effect of nitrogen and water interval on cane yield at New Halfa. He concluded that while water interval significantly affected cane yield, nitrogen did not have any effect. Ibrahim (1972, 78) applied rates of nitrogen ranging from 0 to 8 N with three modes of application: two month from planting (A), splitting the dose at 2 and 4 month (B) and the whole dose at 4 month (C). In 2 of the 4 seasons of the trial 2N gave the highest yield. In the last season 4N gave the highest yield. EL Fadel (1974) at Guneid found significant increase in cane yield up to 6N. Mohammed (1981-82) trying to avoid the inconsistency obtained when nitrogen was applied to soils left fallow for more than 2 years had chosen soils with a short fallow. He found that increasing the rate of nitrogen above zero level significantly increased the yields of cane and sugar. Four N and 6N gave higher yields than 0 and 2N. The difference between the former two levels was not significant. ELTom (1986) studied the effect of 4 nitrogen levels (0, 2, 4 and 6 N) on 5 sugarcane cultivars and concluded that cane yield significantly increased in 2 and 4 N nitrogen levels then declined.

Re-evaluation of the fertilization program was required to cope with the influx of new high yielding cultivars and the improved management level which included well land preparation, proper irrigation, good weed control and improvement on other agronomic practices. This study aims at determining the nitrogen level best suited for high cane and sugar production under the current husbandry standard.

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## Materials and Methods

### Sites Characterization:

#### Guneid

Soils are Suleimi soil series which are clayey Smectitic alluvium . Moderately suitable, of clay content 58–61%, bulk density 1.6–1.7 gm cm<sup>-3</sup>, hydraulic conductivity 0.6–0.7 cm hr<sup>-1</sup>, organic carbon 0.3–0.4 %, N 0.03–0.04, available P 0.9–3.0 mg P/kg soil (Olsen), Exchangeable K 0.6–0.9 cmol<sup>+</sup>/kg soil and CEC 58–61, and pH 8.1 (paste).

#### New Halfa

Soils are Khashm elgirba series, which are clayey Smectitic, moderately suitable, high content of swelling clay (> 65 %), air bulk density 1.7– 1.8 gm cm<sup>-3</sup>, hydraulic conductivity 0.6–0.7 cm hr<sup>-1</sup>, organic carbon 0.2–0.4 %, available P 3.8–4.2 mg P/kg soil (Olsen) . Exchangeable K 0.6–0.9 cmol<sup>+</sup>/kg soil. CEC 55– 60 and pH 8.3 (paste).

#### Sennar

Dinder soil where the study was conducted, the soils are dinder soil series which are clayey Smectitic moderately suitable, of high clay content 55–60 %, air dry bulk density 1.7–1.8 gm cm<sup>-3</sup>, hydraulic conductivity 0.6–0.7 cm hr<sup>-1</sup>, N 0.02–0.03% available P 3–4 mg/kg soil (Olsen), Exchangeable K 0.6–0.9 cmol<sup>+</sup>/kg soil, CEC 50–60 and pH 7.9– 8.2 ( paste).

#### Assalaya

Soils are characterized as Sulemi soil series which are clayey Smectitic cracking clays , moderately suitable of high clay content 50–52 % , air dry bulk density 1.6–1.7 gmcm<sup>-3</sup> (cone method), hydraulic conductivity 0.6–0.7 cm hr<sup>-1</sup>, organic carbon 0.2–0.4 %, N 0.02–0.03% available P 1.3– 3.4 mg/kg soil. Exchangeable K 0.6–0.9 cmol<sup>+</sup>/kg soil, CEC 49–50, and pH 7.9–8.3 (paste).

### The experiments

On–station experiments were conducted at Guneid, New Halfa, Sennar and Assalaya Sugar Estates to study the effect of different levels of nitrogen on the cane and the sugar yields. On–farm (large scale) trials were done in N Halfa, Sennar and Assalaya. The experiments were conducted in season 2003-04 and season 2004-05. The levels of nitrogen were 69, 80.5, 92, 103.5, 115, 126.5 and 138 kg N/fed in the small scale (on-station) trials and 69, 92, 115 and 138 kg N/fed in the large scale (on–farm) trials. The test cultivar was Co 6806 which occupies about 90 % of the commercial sugar cane fields. The treatments were laid out in a randomized complete block design replicated three times. The subplot area was 6x10 m for the small scale and one feddan for the large scale. The planting and harvesting dates for New Halfa were: 5/11/2003 to 24/11/2004 for plant cane, while at Sennar the dates were 30/1/2003 to 5/1/2005 for plant cane at Guneid Research Center farm plant cane was 21/1/2004 10/2/2005. The irrigation interval was within the recommended range of 10-12 days the land preparation was: uprooting of previous crop stools, deep plowing, harrowing, leveling, and furrowing at distance of 1.5 m. The on–farm trials (one feddan per subplot) were selected to include the crop cycle and soil variation within the specific scheme. Similar to the standard practice, urea levels were applied 8 weeks after planting for the plant

cane. Phosphorus was applied for the plant cane only, prior to planting at a rate of 46 kg P<sub>2</sub>O<sub>5</sub>/fed.as TSP. Soil samples, to determine its major characteristics, were taken before planting and after harvest.

Growth and yield components: height, thickness (not reported) and number of millable cane stalk per unit area were measured at monthly interval for 6 months in 3 plants tagged in each subplot. These parameter were not determined at Sennar due to some difficulties. Leaf tissue samples composed of the leaves number 3, 4, 5 and 6 of 4 stalks from each sampling site were collected at 6 month age of cane. The blades were separated for N determination and the sheath for P and K determinations. Cane was harvested and the yield determined at age 14 for the plant crop cycle. Ten stalk samples were collected and the sugar analyzed following the ICUMSA (International Commission for Uniform Methods of Sugar Analysis) system for determination of pol %, Brix % and fiber %. Yield data on all parameters were statistically analyzed.

## Results and Discussion

### Yield components

#### *Plant height:*

Plant height is a major parameter of growth and yield. Although length , thickness and shape of the internodes are varietal characteristics, yet the rate of elongation and length of the internodes and hence plant height provide information about the general condition of the crop. In Table 2. applied nitrogen did not affect plant height in any particular trend. Plants were taller in New Halfa and Assalaya than in Guneid, averaging 194, 193 and 189 cm, respectively. These values are within the range of plant height in a normal crop

#### *Stalk population:*

The number of millable stalks is also a major constituent of cane yield. Tillering which provides the plants with the optimum number of stalks needed for a good yield is known to be affected by the availability of various nutrients. The millable stalk number ranged from about 32 to 35 thousand / feddan in the locations of the experiments (Table 2). There was no significant effect of the applied nitrogen.

### Plant nutrient concentration

**Nitrogen.** Nitrogen affects the development of the cane plant in term of yield and sugar . Excessive quantities of N can prolong the vegetative growing cycle , there by delaying crop maturity. Data in Table 3. presents N, P and K concentrations at 6 month age of cane in the locations of the experiments. This is the boom stage of the cane growth. The mean leaf-N percentage increased slightly when the nitrogen dose was increased to 92 kg N/fed and above. Higher Leaf-N increases due to nitrogen application to sugarcane were reported in previous findings, (Ibrahim, 1979). The highest level of leaf- nitrogen percent increase was in Sennar. However, the leaf-N concentration in all treatments was within the sufficiency level as reported by Humbert (1968).

**Phosphorus.** Plant phosphorus as determined in the index tissue (cane leaf sheath ) is presented in Table 3. The highest P concentration was associated with the lowest N level (69 N/fed) at Sennar and Assalaya, while comparatively lower P concentration was found in the higher level of N. This could be due to the imbalance caused by high N application.

**Potassium.** Potassium concentration in the index tissue varied considerably among locations. The lowest level was at Sennar (0.89%). The highest level was at Assalaya (2.26%), may be due to the fact that White Nile water is rich in soluble K (Ali, 2001).

### **Cane yield**

Table 4a presents plant cane yield (tc/fed), estimated recoverable sugar (ERS) and sugar yield (ts/fed) for the nitrogen levels at New Halfa, Sennar and Assalaya in season (2003-04). Cane yield was noticeably higher at Assalaya compared with the other two sites may be due to the high and good distribution of rains. Which occurred in this season.

Table 4b presents plant cane yield, estimated recoverable sugar (ERS) and sugar yield for the nitrogen levels at New Halfa, Sennar and Assalaya in season (2004-05). Cane yield was similar at N Halfa and Assalaya while Sennar gave the lowest cane yield in both seasons of the experiments. Cane yield within the same locations did not show any significant difference due to increasing the nitrogen application above 69 kg/fed. The differences among locations could be attributed to edaphic factors and management practices .

### **Cane Quality**

#### ***Juice quality:***

The quality parameters which include percent sugar (pol%), estimated recoverable sugar (ERS) and the sugar yield (ts/fed) were not affected in any particular trend by increasing nitrogen application above 69 kg/fed in the small scale trials (Table 5a). This could be due to the early application of nitrogen (8 weeks after planting). Thus the detrimental effect of high nitrogen on juice quality was minimized before the maturity age of cane .

#### ***Fiber % cane:***

Percent fiber at Guneid, Sennar and Assalaya was within the acceptable range of 15–17 % (Table 5b). The nitrogen treatments did not affect fiber % cane, but there was noticeable location differences. As shown in (Table 5b) New Halfa gave the highest fiber % cane due to the dryer weather conditions and shortage of irrigation water.

### **Sugar Yield**

Since the sugar yield is dependent on the cane yield , it followed the same pattern as the cane yield discussed above. Assalaya gave the highest sugar yield in season 2003/2004 . In the second season of the experiments New Halfa and Assalaya gave equally high sugar yields while sennar gave the lowest sugar yield in both seasons (Table 4a and 4b) .

Table 5a shows the results of cane yield, sucrose content (pol% cane) for the plant crop in the on-station trials. Figure 1 shows pol % cane in all experimental locations over N–treatments. Lack of response of the plant crop cycle to nitrogen application was evident in all locations. The results show no significant differences of the parameters measured as a response to the different levels of nitrogen for the plant crop cycle. This could be due to the fallow which usually precedes the plant cane cycle (Ibrahim,-1979). Also, the intensive tillage operations practiced before planting the cane improves the soil physical and chemical properties which favorably affect the performance of the plant crop. Moreover, the method of application of nitrogen, i.e. broadcast without

covering similar to the standard practice, is an inefficient method resulting in great losses from the added fertilizer. Rapid hydrolysis and losses during subsequent transformation of nitrogen has been reported by many workers (Ali et al., 1990, Ayoub, 1984).

Yields in general were higher in season 2003-04 in New Halfa and Assalaya compared to the cane yield in season 2004-05 probably because of the higher rainfall in the former season (296 mm in New Halfa and 410 mm in Assalaya ). The rainfall in season 2004-05 was 103 mm in New Halfa and 188 mm in Assalaya .

### **Post harvest soil analysis**

The data in Table 7 present soil-N content and the organic carbon in the various N-fertilizer treatments in samples analyzed after harvest at (0- 30 cm) depth. There is a noticeable accumulation of the mean organic carbon percentage in all sites of the experiments. This could result from continued incorporation of sugar cane trash and stubble during cultivation. Soil-N is also higher than originally reported in the soils of the Central Clay Plain where all the sugar cane estates exist. The carbon: nitrogen ratio is below 20 except for one location where it is 25. The C: N ratio below 20 usually results in release of mineral nitrogen early in the decomposition process (Tisdale and Nelson, 1969).

## **Conclusions**

From the foregoing results, the statistical analysis for the plant cane revealed no significant differences between the application of nitrogen fertilizer at 69 Kg N/fed and 92 Kg N/fed on cane and sugar production in the small and large scale experiments in all locations for both seasons. The benefit of saving one sack (23 kg N/fed) is equivalent to about SD 5,000 per feddan. Such saving in an area of 24,000 to 26000 feddan as plant cane for one season in the four above mentioned schemes which belong to the Sudanese Sugar Company will save about SD 135 million. This is a saving in the fertilizer cost only without considering handling and application costs. The results of the study conclude that 69 kg N/fed is the most economically viable fertilizer level for the plant cane.

## **Recommendations**

Based on the findings of the study, we recommend for the plant cane cycle (cultivar Co 6806) 69 kg N/fed equivalent to 150 kg urea/fed broadcast within 8 weeks of the crop age at Guneid , New Halfa , Sennar and Assalaya cane estates .

## **Acknowledgments**

The authors gratefully thank Prof. Hassan S. Ibrahim for his invaluable help in reviewing and critical reading of this paper. We are also indebted to Dr. Abbas Elsir for his help in the economic evaluation in this work. Sincere gratitude is also extended to Prof. Elnaeem Abdalla for his help and guidance .

## References

- Ali, N.A., Elshiek, O.M. and Sidahmed, O.A. (1990). Influence of the nitrogen form on soil nitrate, nitrite and nitrate reeducates activity of cotton grown under Sudan Gezira conditions. *Sudan Agric. J.* 13: 27 – 41.
- Ali, O.A. (2001). Sugarcane Nutrition . Kenana Sugar Research Department report
- Ayoub, A. T. 1984. Urea hydrolysis and subsequence transformation in the Gezira soil. *Acta Horticulturae.* 143: 279 – 287.
- Blockhuis (1993). Vertisols of the Central clay plains of the Sudan.
- El Fadel, A. Guneid Sugarcane Research Station Annual Report (1972/ 1973).
- El Tom, E. A. (1986). Response of five sugar cane varieties to Nitrogen fertilization at two location unpublished M.Sc. Thesis University of Khartoum.
- Humbert, R.P. (1968). Sugarcane nutrition. In: *The Growing of Sugarcane* . pp: 133 – 140. Pub. Elsevier Publishing Company, Amsterdam – London – New York.
- Ibrahim, H.S. (1973). Guneid Sugarcane Research Station Annual Report.
- Ibrahim, H.S. (1978). The potassium status of the sugarcane areas of the Sudan . *The International Sugar Journal* , 1978 , 80 , 44 - 45 .
- Ibrahim, H.S. (1979). Effect of N fertilizers on sugarcane in the Sudan . *Experimental Agriculture* , 14 : 273 - 276 .
- Idris, M.A. (1990). Re-valuation of Guneid Scheme Land potentials for sugarcane production. Report 139, SSA. Medani.
- Mohamed, E.Y. Guneid Sugarcane Research Station Annual Report 1981.
- Schneider, F. (1979). ICUMSA Methods of Analysis. In: *Cane Sugar Handbook*. Pub. British Sugar Corporation. London.
- Tisdale, S.L. and Nelson, W.L. (1969). Nitrogen transformations in soils. In: *Soil Fertility and Fertilizers*. Pp133-138. Macmillan Publishing Co., Inc. New York.
- Landon, L.A. (1987) Booker Tropical Soil Manual.

**Table 1. Soil characteristics of the trial sites**

	<b>Location</b>			
	<b>Guneid</b>	<b>New Halfa</b>	<b>Sennar</b>	<b>Assalaya</b>
Nature of parent material origin	Clayey Smectitic Alluvium	clayey Smectitic Alluvium	clayey Smectitic Alluvium	clayey Smectitic Alluvium
Current land Suitability subclass	S2 v	S2 v	S2 v	S2 v
<i>Physical characteristics</i>				
% clay	52 – 55 *	> 65	55 – 60 **	50 – 51
Air dry bulk density(gm cm <sup>3</sup> )	1.6 – 1.7	1.7 – 1.8	1.7 – 1.8	1.6 – 1.7
Hydraulic conductivity(cmhr <sup>-1</sup> )	0.6 – 0.7	0.6 – 0.7	0.6 – 0.7	0.6 – 0.7
Available water capacity at 0- 30 depth	7 – 8	6 – 7	6 – 7	7 – 8
<i>Chemical characteristics</i>				
% CaCo <sub>3</sub>	3.5 – 5	3 – 5	3 – 5	0.4 – 1.0
Ece (ds/m) at 0- 30 cm	2 – 3	3 – 4	1.5 – 2.5	0.91 – 2.2
% N	0.03	0.04	0.03	0.01 – 0.03
% O.C	0.3 – 0.4	0.2 – 0.4	0.2 – 0.3	0.2 – 0.4
Available P (mg P/ kg soil)	0.9 – 3.0	3.8 – 4.2	3 – 4	1.8 – 3.4
Exchangeable K cmol <sup>+</sup> / kg soil	0.6 – 0.9	0.6 – 0.9	0.6 – 0.9	0.6 – 0.9
CEC	58 - 61	50 – 55	50 – 60	49 – 50
pH – paste	8.10	8.3	7.9 – 8.2	7.9 – 8.3

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S2 = moderates soil

V = high content of swelling clay

Sources : a) Blockhuis, W.A (1993) b) Idris,M.A.(1990) .

**Table 2. Effect of nitrogen levels on some yield components of sugar cane (season 2004-05), vegetative characteristics at 9 month.**

N levels Kg/fed	Guneid		New Halfa		Assalaya	
	Plant height cm	Stalk No./ fed x 1000	Plant height cm	Stalk No./ fed x 1000	Plant height cm	Stalk No./ fed x 1000
69	189.94	36.03	193.35	31.00	193.96	34.21
80.5	188.94	34.15	186.28	30.90	204.95	35.45
92	189.69	33.45	196.43	32.60	180.88	35.96
103.5	185.91	35.37	189.53	29.00	191.68	33.82
115	191.50	35.94	196.53	31.70	187.90	34.70
126.5	190.69	34.80	194.85	33.50	197.84	35.67
138	186.25	33.76	202.93	32.10	191.96	35.83
Mean	188.99	34.79	194.27	31.54	192.74	35.09
CV %	4.95	9.20	4.81	12.24	4.67	10.46
SE ±	9.35	3.17	9.33	3.86	7.07	3.67
Sig .	(ns)					

**Table 3. Effect of nitrogen levels on nutrients N, P and K percent in index tissue at 6 months age of cane, season 2004-05**

N levels kg/fed	N %			P %			K %		
	New Halfa	Sennar	Assalaya	New Halfa	Sennar	Assalaya	New Halfa	Sennar	Assalaya
69	2.06	1.99	2.11	0.05	0.2	0.25	1.22	0.89	2.3
92	2.07	2.02	2.3	0.2	0.1	0.1	2.23	0.82	2.19
115	2.12	2.15	2.36	0.15	0.15	0.15	1.93	1	2.31
138	2.21	2.12	2.38	0.05	0.1	0.1	2.26	0.85	2.27
Mean	2.12	2.07	2.29	0.11	0.14	0.15	1.91	0.89	2.27

**Table 4a. Effect of nitrogen levels on plant cane yield (tc/fed), estimated recoverable sugar (ERS) and sugar yield (ts/fed) of cv. Co 6806 plant cane, season 2003-04**

N levels kg/fed	Season 2003/04								
	New Halfa			Sennar			Assalaya		
	tc/fed	ERS	ts/fed	tc/fed	ERS	ts/fed	tc/fed	ERS	ts/fed
69	44.23	11.52	5.10	42.12	12.32	5.19	61.08	11.40	6.96
92	47.70	10.00	4.77	40.44	11.91	4.82	60.70	11.67	7.08
115	46.70	11.60	5.42	37.72	11.84	4.47	59.84	11.00	6.58
138	47.05	10.66	4.71	41.69	11.02	4.59	62.66	10.55	6.61
Mean	46.42	10.95	5.00	40.49	11.77	4.77	60.07	11.16	6.81
CV %	11.93			12.88			6.63		
SE ±	5.59			3.81			4.05		
Sig.	ns			ns			Ns		

**Table 4b. Effect of nitrogen levels on cane yield (tc/fed), sugar yield (ts/fed) and estimated recoverable sugar (ERS) of cv. Co 6806 plant cane, Season 2004/2005**

N levels kg/fed	Season 2004/2005								
	New Halfa			Sennar			Assalaya		
	tc/ fed	ERS	ts/fed	tc/fed	ERS	ts/fed	tc/fed	ERS	ts/fed
69	55.47	11.87	6.58	40.76	11.33	4.62	61.60	12.32	7.59
92	57.12	12.10	6.91	42.38	11.53	4.89	55.48	11.98	6.65
115	52.49	11.63	6.10	41.81	12.11	5.06	60.87	12.03	7.32
138	53.32	11.58	6.17	43.16	11.34	4.89	59.47	12.17	7.24
Mean	54.60	11.80	6.44	42.03	11.58	4.87	54.36	12.13	7.20
within location									
CV %	6.56			6.57			11.06		
SE ±	2.07			1.59			3.47		
Sig.	ns			ns			ns		

**Table 5a. Effect of nitrogen levels on cane yield (tc/fed), sucrose content ( pol% cane) and ton sugar (ts/fed) of cv. Co 6806 plant cane Season 2004-05**

Site N levels kg /fed	Guneid			New Halfa			Sennar			Assalaya		
	tc/ fed	Pol %	ts/ fed	tc/ fed	Pol %	ts/ fed	tc/fed	Pol %	ts/f ed	tc/ fed	Pol %	ts/fed
<b>69</b>	61.4	14.4	6.3	41.7	11.9	3.4	72.9	14.3	4.6	44.9	14.5	5.6
<b>80.5</b>	58.7	13.2	6.2	41.6	12.1	3.9	68.0	13.9	4.7	45.7	14.8	5.6
<b>92</b>	56.4	14.1	6.4	44.7	12.3	4.2	72.8	14.1	4.4	46.6	14.2	5.4
<b>103.5</b>	63.9	13.5	6.1	44.9	11.4	4.1	74.0	14.3	5.7	46.9	14.9	7.8
<b>115</b>	63.5	13.8	6.2	47.9	12.6	4.5	69.0	14.2	6.0	45.1	14.7	6.4
<b>126.5</b>	64.5	14.1	6.1	45.3	11.6	4.0	75.9	14.6	5.4	46.7	14.9	6.8
<b>138</b>	62.1	13.5	5.7	42.9	12.2	4.1	65.5	14.4	5.1	43.2	14.3	5.6
<b>Zero</b>	61.7	14.3	7.4	-	-	-	-	-	-	-	-	-
<b>Mean</b>	61.6	13.9		44.2	12.0		71.3	14.3		45.6	14.6	
<b>Cv%</b>	15.7	3.0		16.9	3.1		10.5	3.5		13.1	2.8	
									7			
<b>SE±</b>	4.8	0.22		3.75	0.23		3.75	0.27		3.00	0.21	
<b>Sig</b>	ns	ns		ns	ns		ns	ns		ns	ns	

**Table 5b. Effect of nitrogen levels on sucrose content (pol%), estimated recoverable sugar (ERS%) and fiber % cane ( plant cane ) Season 2004-05**

Site N levels kg/fed	Guneid			New halfa			Sennar			Assalaya		
	Pol%	ERS %	Fiber %	Pol%	ERS %	Fiber %	Pol%	ERS %	Fiber %	Pol%	ERS %	Fiber %
<b>69</b>	14.39	12.42	16.72	11.94	9.79	21.39	14.34	12.36	18.03	14.49	12.53	15.71
<b>80.5</b>	13.27	11.22	16.13	12.10	9.96	21.03	13.93	11.93	18.13	14.77	12.83	16.10
<b>92</b>	14.05	12.05	17.23	12.30	10.18	19.53	14.08	12.09	17.98	14.18	12.19	15.14
<b>103.5</b>	13.50	11.46	16.30	11.42	9.24	20.00	14.28	12.30	17.83	14.98	13.05	17.01
<b>115</b>	13.79	11.78	17.85	12.59	10.47	21.18	14.16	12.17	18.23	14.65	12.70	16.22
<b>126.5</b>	14.06	12.06	16.21	11.61	9.44	21.04	14.60	12.64	18.20	14.98	13.05	14.97
<b>138</b>	13.50	11.57	16.48	12.22	10.09	20.24	14.43	12.46	18.00	14.31	12.33	15.85
<b>Zero</b>	14.27	-	17.34	-	-	-	-	-	-	-	-	-
<b>Mean</b>	13.86	11.79	16.78	12.02	9.88	20.63	14.26	12.28	18.05	14.62	12.67	16.01
<b>CV %</b>	3.00		6.08	3.12		2.83	3.46		7.21	2.83		5.62
<b>SE ±</b>	0.22		0.51	0.23		0.29	0.27		0.48	0.21		0.45
<b>Sig.</b>	ns		ns	ns		ns	ns		Ns	ns		ns

**Table 6. Effect of nitrogen levels on soil nitrogen and organic carbon, season 2004-05**

N levels kg/fed	69			92			115			138		
	O.C %	N %	C/N ratio	O.C %	N %	C/N ratio	O.C %	N %	C/N ratio	O.C %	N %	C/N ratio
New Halfa	0.790	0.045	17.26	0.821	0.050	16.80	0.733	0.070	10.47	0.760	0.066	11.52
Sennar	0.801	0.032	25.03	0.921	0.059	15.61	0.600	0.045	13.33	0.675	0.060	11.25
Assalaya	0.677	0.060	11.28	0.640	0.070	9.14	0.750	0.065	11.54	0.660	0.050	13.20
Mean	0.756	0.460	17.86	0.794	0.068	13.85	0.694	0.060	11.78	0.698	0.059	11.99

**Fig. 1 : Effect of urea doses on pol % small scale expt. plant cane**

