South African Sugar Industry
Agronomist's Association

Code : GM/3/99
Project no: 4876
Cat no: 2189

Title: Evaluation of the effects of summer green manure crops on soil properties and sugarcane yield response.

1. **Particulars of the project:**

This crop	: 1st Ratoon cane	Soil Analysis: 30/11/1999					
Site	: Kearsney research farm	pH	OM%	Clay%	Sand%		
Region	: Stanger, KwaZulu-Natal	4.79		29			
Soil system	: Coastal Lowlands			Ppm			
Soil form	: Oakleaf (Levubu)	P	K	Ca	Mg	Zn	Al
Design	: Randomised blocks	19.3	74.96	138	40.5	2.3	40
Variety	: N16						
Fertilizer	: N P K	Age: 10.0 (26/06/01 – 25/04/02)					
(kg/ha)	120 60 125	Rainfall: 1242mm					
	Split into 2 applications	Irrigation: Nil					

2. **Objectives:**

2.1 To evaluate the potential of three legume species - soybeans, sunn hemp and cowpeas - as green manure crops for the summer season on the KwaZulu-Natal north coast.

2.2 To quantify the yield response of sugarcane following cover cropping and a bare fallow, through at least one ratoon.

3. **Treatments:**
1st ratoon sugarcane following:

1. Bare fallow control
2. Bare fallow + fertilizer
3. Soybeans
4. Soybeans + fertilizer
5. Sunn hemp
6. Sunn hemp + fertilizer
7. Cowpeas
8. Cowpeas + fertilizer

Notes on treatments:

- The cover crops were grown for a period of 98 days starting on the 2nd of December 1999, and incorporated into the soil on the 9th of March 2000.
- The fertilizer treatment was applied at 75% of the FAS fertilizer recommendation.

Rainfall (mm):

	Jan	Feb	Mar	Apr	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001					64	7.5	6.1	180.4	190.2	157.8	181.2
2002	245	138.1	35.6	71.2							

4. Results and discussion:

The legume species evaluated in this trial were grown during summer, from early December 1999 until March 2000. The overall dry matter production and the nutrient loading rates are given in Table 1.

Table 1: Cover crop dry weight and nutrient content as at 91 days after planting.

Cover crop	Dry weight *(tons/ha)*	Nitrogen (N) *(kg/ha)*	Phosphorus (P) *(kg/ha)*	Potassium (K) *(kg/ha)*
Soybeans	0.907	17.0	3.0	17.0
Sunn hemp	5.415	88.8	11.4	99.6
Cowpeas	3.582	73.1	8.6	91.4

Sunn hemp produced the greatest overall biomass over the summer season, as well as showing the highest nutrient loading rates (Table 1). However, per unit biomass, the cowpeas were more efficient at taking up and/or fixing N, as well as taking up P and K. The soya beans performed poorly overall in terms of biomass and nutrient loading rates, possibly indicating a lack of adaptation to the prevailing conditions.

These results suggest that both sunn hemp and cowpeas are well adapted to cultivation the region during the summer months. Both produced a large biomass within the 3 month growth period.

After incorporation of the green manure crop, cane was planted in the plots. Yield data for the plant cane crop are presented in Table 2.

Table 2: Averages of plant cane properties and yields at harvest (15.6 months – planted on 15 March 2000 and harvested on 26 June 2001).

Treatments: Cane after	**Stalk pop.** *(thd/ha)*	**Stalk length** *(cm)*	**Cane yield** *(t/ha)*	**Pol** *(%cane)*	**Sucrose** *(t/ha)*
Bare fallow	113	189	67.2	12.8	10.4
Bare fallow + fertilizer	126	193	76.9	12.9	11.1
Soybeans	116	188	78.1*	12.6	11.1
Soybeans + fertilizer	135*	190	88.3*	12.8	12.6*
Sunnhemp	124	198	86.7*	12.9	12.5*
Sunnhemp + fertilizer	128*	193	84.3*	12.7	12.0
Cowpeas	114	191	73.7	12.8	10.6
Cowpeas + fertilizer	127	197	89.3*	12.8	12.8*
SED	7.0	6.3	5.3	0.3	0.9
$LSD_{(0.05)}$	14.1	12.8	10.7	0.67	1.77

Note: * = Significantly different from the control (no fertilizer) at the 5 % level

The data presented in Table 2 show that, in the plant cane crop, the use of soybeans and sunnhemp as green manure crops significantly increased the cane yield when compared with the bare fallow treatment. When fertiliser was used in addition to the legume crops, the cowpea and soybean treatments yielded significantly better than the bare fallow + fertiliser. Sunn hemp significantly increased the yield of cane as well as tonnes sucrose per hectare without the addition of chemical fertiliser, which could be of benefit in a resource poor farming situation. Addition of fertiliser had a beneficial effect on cane yield, particularly in the case of cowpeas.

The trial was continued through a ratoon crop of cane, to investigate any residual effects of the green manure crop on the cane yield. Results of the ratoon crop are presented in Table 3.

Table 3: Averages of 1st ratoon cane crop properties and yields at harvest (10 months – 26 Jun 01 to 25 Apr 02).

Treatments	**Stalk pop.** *(thd/ha)*	**Stalk length** *(cm)*	**Cane yield** *(t/ha)*	**Pol** *(%cane)*	**Sucrose** *(t/ha)*
Bare fallow	99	174	53.6	12.82	6.9
Bare fallow + fertilizer	97	184	64.7*	12.00	7.8
Soybeans	98	175	61.7*	12.97	8.0*
Soybeans + fertilizer	99	181	65.1	12.48	8.1*
Sunnhemp	98	184	60.2	13.12	7.9*
Sunnhemp + fertilizer	101	181	61.7*	12.05	7.4
Cowpeas	101	182	60.7	13.15	7.9*
Cowpeas + fertilizer	104	183	67.7*	12.70	8.6*
SED	4.7	5.08	4.0	0.36	0.46
$LSD_{(0.05)}$	9.6	10.3	8.1	0.73	0.93

Note: * = Significantly different from the control (no fertilizer) at the 5 % level

The residual effects of the green manure crops without fertiliser application were minimal, with only the soybean treatment showing significant yield (tons cane per hectare) improvement over the bare fallow. However, all treatments that were fertilised showed significant yield improvement over the bare fallow. All treatments except sunn hemp + fertiliser yielded significantly more tonnes sucrose per hectare than the bare fallow. The use of sunn hemp, soybeans or cowpeas, even without application of chemical fertilisers, showed a positive residual effect on sucrose yield.

5. Conclusions

From the available data, all three legumes evaluated have potential as green manure crops. Despite the apparent poor performance of soybeans in terms of biomass, use of this legume still had positive effects on the yield and tons sucrose per hectare. Sunn hemp and cowpeas are particularly well suited to cultivation during the hot summer months in the Stanger region.

In the plant cane crop, yield responses could be attributed to all three legume treatments, and when fertiliser was added as well, cowpeas and soybeans demonstrated improved yield responses. The sunn hemp appears to give better response without the addition of chemical fertilisers in this trial, though the result was not significant. Sunn hemp usually grows well without fertilizer, making it an attractive and easy cover crop option. The data suggest that, in comparison to both the bare fallow and the fertilised bare fallow treatments, use of the green manure crops improved yield. Unfortunately a cane-on-cane control was not included in the initial trial, making further comparisons with current agronomic practices impossible.

In the first ratoon crop, the yield improvements were most evident where fertiliser had been added, however there were some residual responses to the green manure treatments. The response to green manure was not significant enough to warrant the use of both green manure crops and the addition of fertiliser, as the added cost of the green manure crop seed would not be offset by the increase in yield. Cowpeas prove to be an exception, however, as there appears to be a synergistic effect when using both cowpeas and fertiliser. There would be an economic advantage to the farmer when using this combination.

From the assessment of the nutrient loading rates of the legume species, it was evident that both sunn hemp and cowpea crops return a large amount of N to the soil that will become available to the following crop. Thus the N fertiliser recommendation for the plant cane crop could be reduced by up to 30 kg/ha, which translates to an estimated saving of R 160/ha if urea is used as an N source.

A residual effect of using green manure legumes was evident in the first ratoon crop, however the yield response was less than in the plant crop. The trial was terminated after the first ratoon crop.