

COMPARISONS OF A HAND HELD N TESTER WITH THE CONVENTIONAL LABORATORY METHOD IN PREDICTING ADEQUACY IN LEAF NITROGEN

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Abstract

A portable hand held nitrogen metre (N Tester) used for measuring nitrogen in field crops with a view to fine tune a nitrogen programme at short notice was evaluated in sugarcane nutrition experiments to determine validity under Jamaican conditions. Nitrogen experiments conducted on various soil types and varied ecological conditions resulted in positive responses to increased dressings. Standard levels of nitrogen in leaves for adequate nutrition and crop performance were confirmed by laboratory procedures. Positive correlations between % nitrogen by laboratory and N - Tester values were determined in 3 of the 6 evaluations for which N Tester readings and laboratory nitrogen in BJ78100 and J9501 followed a more or less exponential response pattern. However, N Tester values compared to laboratory nitrogen were erratic in BJ8859 and BJ8534 which may exhibit differences in leaf composition and for which further evaluations are required.

The N Tester held promise for quick nitrogen diagnosis in sugarcane though further work is needed in calibration of the equipment.

Keywords

Nitrogen tester, leaf nitrogen

INTRODUCTION

Investigations in Jamaica into nutrient requirements for optimum yields of commercial varieties began in 1949 by the then Sugar Research Department of the Sugar Manufacturers Association of Jamaica Ltd. Standard levels of nitrogen in leaves as a measure of adequate nutrition were established and later confirmed in various trials, (Anon.1987), Anon. 1991, Fearon and Wright, 1991). However, variable levels of adequacy observed under different conditions suggest that factors such as micro-climate, variety, crop age, and growing conditions may contribute to crop responses to added nitrogen. Standard leaf nitrogen levels depicting adequacy for plant canes were found within the range of 1.55-1.90% N at 6 months in the third visible dewlap (TVD) but higher values of up to 2.10% N are sometimes encountered in some varieties.

Nitrogen dosages required to achieve adequate nutrition vary quite markedly between varieties - 130 kg N/ha for BJ7627 compared with 50 kg N/ha for BJ7504 in plant cane, Fearon and Wright (1999). It is also now generally agreed that blanket fertilizer dressings may not equally meet the needs of all varieties (Fearon 2007) and may be inappropriate depending on the planting season.

Split applications of nitrogen, except in plant canes, are usually considered uneconomic under conventional rain-fed and furrow irrigation. With the advent of drip and centre pivot irrigation on some farms since the mid-1990s, nitrogen dressings have been applied incrementally for up to 20 weeks of growth. A quick method of determining nitrogen needs would be an advantage for canes grown under such conditions as adjustments may be made instantaneously. With this in mind, the Sugar Industry Research Institute entered into partnership with the Department of Food Production at the University of the West Indies to evaluate the hand held N Tester in sugarcane.

The N Tester, a product of Minolta Camera Co Ltd, Japan is battery powered and equipped with a measuring device in which the leaf is inserted. With the leaf inserted and the measuring device gently pressed on the leaf lamina, a reading is recorded based on light absorption at 2 wavelengths (650 & 940 nm). The ratio between the 2 measurements is stored in memory as a dimensionless value. A minimum of 30 leaves must be inserted before an average N Tester value is recorded on a screen instantaneously. A reference standard was provided for calibration checks during reading intervals.

There are no records of use of the N Tester in sugar cane agronomy but the manufacturer of the equipment suggested a maximum leaf thickness of 1.2 mm for correct assessment of nitrogen.

This paper compares results of leaf nitrogen tests using conventional laboratory procedures with those from the hand held N Tester on sugar cane varieties grown under varied soil conditions, nitrogen and irrigation regimes.

EXPERIMENTAL PROCEDURE

Trial 1

An experiment was laid out in early June 2006 at Wallens farm in the St Catherine uplands on soil classified according to the USDA system as Typic Haplustalfs and known locally as Brysons Clay Loam. The test varieties, BJ8859 and BJ8534, were planted in un-replicated plots measuring 8 rows x field length (144 m). Nitrogen as sulphate of ammonia was applied at 50, 80, 100 and 125 kg/ha and blanket dressings of phosphorus and potassium made at 35 and 100 kg/ha. Four growth stations, each consisting of 1 m row length, were established in each plot.

At 6 months growth, 30 leaves at TVD were removed according to standard leaf sampling procedures and N tester readings were taken from the 10 cm central portions of leaves and the average reading recorded. The same 30 leaves minus mid-ribs were submitted to the laboratory for nitrogen analyses. Stalk population was taken at 26 weeks in each growth station and data recorded. Ten randomly selected stalks were taken at 44 weeks from three locations (rows 2, 3 and 5 of each plot) and mean stalk weights recorded.

At 12 months, canes from the middle 4 rows x field length were harvested and weighed and the data together with mean stalk weight and stalk population analysed.

Trial 2

Un-replicated plots of J9501 and BJ78100 measuring 4 rows x field length (98m) were established at Frome in early June 2006 on soil classified as Typic Paleudult, and locally as Roaring River Clay. Treatments were the same as in Trial 1.

Data collection followed similar guidelines except that final yield data was calculated from 10 randomly selected stalks from two locations in row 2 and two locations in row 3. Yield was estimated from mean stalk weight and stalk population.

Trial 3

In this trial, un-replicated plots of plant cane, BJ78100, measuring 8 rows x field length (95m), were established at New Yarmouth in mid June 2006 on a Fluvaquentic Ustropept, known locally as Agualta Clay. Nitrogen as sulphate of ammonia was applied at 70, 100, 125 and 150 kg/ha. Blanket dressings of phosphorus (55 kg P/ha) and potassium (100 kg K/ha) were also applied. Water was delivered by furrow irrigation in one section and by centre pivot in the other.

Yield data was taken at 10 months of growth by removing 10 randomly selected stalks from rows

2, 3 and 4 and estimations of yield made from mean stalk weight and stalk population.

RESULTS AND DISCUSSION

At Wallens, highest cane yield (119.15 tc/ha) was obtained with dressings of 80 kg N/ha in BJ8859, **Table 1**. Corresponding leaf nitrogen by laboratory test was 1.93% whereas the N tester reading was 442. The correlation between leaf N by laboratory method and N Tester values was negatively associated ($r = - 0.73$) suggesting a reversal of the expected close relationship between laboratory nitrogen and N - Tester readings for validation the N- Tester.

Variety BJ8534 yielded 127.19 tc/ha with dressings of 80 kg N/ha - an increase of over 14 tc/ha higher than the lowest rate of 50 kg N/ha. Cane tonnage remained statistically similar above 80 kgN/ha and nitrogen in leaf by the standard laboratory method tended to decrease slightly above the 50 kg/ha. However, N - Tester values remained above 405 determined at 80 kgN/ha with incremental nitrogen so that there was no positive correlation between either method of leaf nitrogen determination because of diminishing trend in leaf nitrogen with nitrogen addition.

Table 1. Cane tonnage of 12 months plant cane and corresponding leaf N by laboratory and N Tester in response to nitrogen rates at Wallens

	BJ8859			BJ8534		
kgN/ha	tc/ha	Leaf N (TVD)	N Tester	tc/ha	Leaf N	N Tester
50	110.63	1.90	456	112.83	2.13	437
80	119.15	1.93	442	127.19	2.08	405
100	116.38	1.99	425	131.24	2.03	433
125	112.93	1.92	480	128.65	2.04	421
SED	2.95			2.95		
LSD 0.05	6.19			6.19		

Sugar recovery for BJ8859 improved by approximately 1 ts/ha when nitrogen dressing increased from 50 to 80 kg/ha and there was no significant increase beyond this rate, **Table 2**. Meanwhile, laboratory N (1.90 %) determined at 50 kg N/ha increased to 1.93 % at 80 kgN/ha and to a maximum of 1.99% at 100 kgN/ha. N- tester values, on the other hand, fluctuated.

BJ8534 showed an impressive yield increment of 2.35 ts at 100 kg N/ha over the lowest rate and laboratory N (2.13%) was recorded with 50 kg N/ha compared with a slight decline to 2.03% at 100 kgN/ha. The laboratory nitrogen values were within adequacy for plant canes. At the same time N tester N readings (437) at 50kgN/ha and 433 at 100 kgN/ha were recorded.

Table 2. Sugar recoveries of 12 months plant cane and corresponding leaf N by laboratory and N Tester in response to nitrogen rates at Wallens

	BJ8859			BJ8534		
kgN/ha	ts/ha	Leaf N	N Tester	ts/ha	Leaf N	N Tester
50	13.13	1.90	456	12.42	2.13	437
80	14.10	1.93	442	13.59	2.08	405
100	14.25	1.99	425	14.87	2.03	433
125	14.19	1.92	480	14.09	2.04	421
SED	0.35	0.18		0.35		
LSD 0.05	0.72	0.38		0.72		

In the trial at Frome, BJ78100 yielded a maximum of 106.82 tc/ha with dressings of 100 kg N/ha compared to 94.46 tc/ha with dressings of 50 kg/ha, **Table 3**. The improved tonnage (over 12.36tc/ha) coincided with laboratory leaf nitrogen (1.79%) and N Tester (484). Positive correlation ($r = 0.53$) was determined between laboratory nitrogen and N-Tester measurements, thereby validating the meter in this trial. Nitrogen adequacy (1.79 %N, 6 MonthsTVD) was confirmed in the Frome trial, and so the corresponding N tester reading (484) may be considered for adequacy.

Variety, J9501, yielded over 121tc/ha with nitrogen dressings of 80 kg/ha compared to just over 113 tc/ha at 50 kg N/ha and there was no further increase in tonnage with nitrogen increment. Positive correlation ($r = 0.54$) for leaf nitrogen assessment by the varied methods was again confirmed.

Table 3. Cane tonnage of 12 months plant cane and corresponding leaf N by laboratory and N tester in response to nitrogen rates at Frome

	BJ78100			J9501		
kgN/ha	tc/ha	leaf N (TVD)	N Tester	tc/ha	Leaf N	N Tester
50	94.46	1.77	450	113.34	1.78	553
80	100.66	1.78	496	121.47	1.75	557
100	106.82	1.79	484	117.80	1.85	569
125	100.18	1.82	489	115.87	1.85	556
SED	2.27			2.27		
LSD 0.05	4.76			4.76		

BJ78100 yielded 14.72 ts/ha with dressings of 100 kgN/ha which was the maximum obtained, Table 4. Corresponding laboratory N (1.79 %) also fell within adequacy range and the associated N -Tester reading was 484. In the case of J 9501, sugar yield remained statistically the same with up to 100 kgN/ha and declined appreciably beyond this rate. The highest sugar yield (15.58 ts/ha) was obtained at 80 kgN/ha whereas nitrogen in leaf by laboratory was 1.75% N and the corresponding N tester value was 557.

Table 4. Sugar recoveries of 12 months plant cane and corresponding leaf N by laboratory and N Tester in response to nitrogen rates at Frome

kgN/ha	BJ78100			J9501		
	ts/ha	Leaf N (TVD)	N Tester	ts/ha	Leaf N	N Tester
50	12.67	1.77	450	15.27	1.78	553
80	14.07	1.78	496	15.58	1.75	557
100	14.72	1.79	484	15.07	1.85	569
125	13.36	1.82	489	13.82	1.85	556
SED	0.57			0.57		
LSD 0.05	1.19			1.19		

Cane tonnage for BJ78100 under furrow irrigation at New Yarmouth, Table 5, increased to a maximum of 72.98 tc/ha with 125 kgN/ha. The associated leaf % nitrogen by laboratory was 1.65% and nitrogen by N tester was 332. Strong correlation ($r = 0.60$) was detected between laboratory leaf nitrogen and N Tester values.

Pivot irrigated plots of the same variety yielded at best 75.93 tc/ha with nitrogen dosage of 125 kg/ha and the associated leaf nitrogen were 1.64% for laboratory and 320 for N Tester. Nitrogen % determination in laboratory and N - Tester was weakly correlated ($r = 0.28$)

The low cane yield determined under pivot in this trial was far removed from the average yield (over 130 tc/ha) experienced on other areas of the farm. This was considered associated with the poor drainage at the experiment site which was confirmed by gleying in the soil profile. Gleying is a bleached appearance of clays as a result of water logging.

Table 5. Yields of 10 months plant cane, BJ78100, and corresponding leaf N by laboratory and N tester in response to nitrogen rates under furrow and pivot irrigation at New Yarmouth.

kgN/ha	Furrow			Pivot		
	tc/ha	leaf N (TVD)	N Tester	tc/ha	Leaf N	N Tester
70	58.15	1.61	303	64.21	1.59	318
100	69.18	1.65	308	69.73	1.62	359
125	72.98	1.65	332	75.93	1.64	320
150	70.50	1.59	307	74.33	1.65	342
SED	4.31			4.31		
LSD 0.05	9.39			9.39		

Significant ($p < .05$) improvement in sugar recovery (8.60 ts/ha) at 125kg N/ha compared to lower rates was found in furrow irrigated plots. Plots under pivot yielded only 7.89 ts/ha at 125 kgN/ha with associated nitrogen of 1.64% by laboratory and 320 by N Tester. The relatively low %N in leaf in plant cane at this site, again, suggested the presence of adverse soil conditions detrimental to nutrient uptake and yields.

Table 6. Sugar yields of 10 months plant cane, BJ78100, and corresponding leaf N by laboratory and N tester in response to nitrogen rates under furrow and pivot irrigation at New Yarmouth.

kgN/ha	Furrow			ts/ha	Pivot	
	ts/ha	leaf N (TVD)	N Tester		Leaf N (TVD)	N Tester
70	5.57	1.61	303	5.73	1.59	318
100	7.74	1.65	308	6.68	1.62	359
125	8.60	1.65	332	7.89	1.64	320
150	7.52	1.59	307	7.22	1.65	342
SED	0.26			0.26		
LSD 0.05	0.57			0.57		

Determinations of laboratory % N versus N Tester values and associated cane tonnage showed 3 positive correlations in a total of 6 evaluations. Data depicting nitrogen uptake in response to nitrogen rates showed the familiar exponential yield response pattern in the 3 positive results of laboratory leaf nitrogen versus N –Tester values, **Figs 1, 2 & 3**. However, this was not expressed in N - Tester values for BJ8859 and BJ8534 evaluated at Wallens, Figs 5 & 6, which may be due to differences in leaf composition of the varieties. Further investigations are, therefore, warranted.

Fig 1. Relationship between Nitrogen rates, N-Tester values and Laboratory nitrogen Frome BJ78100

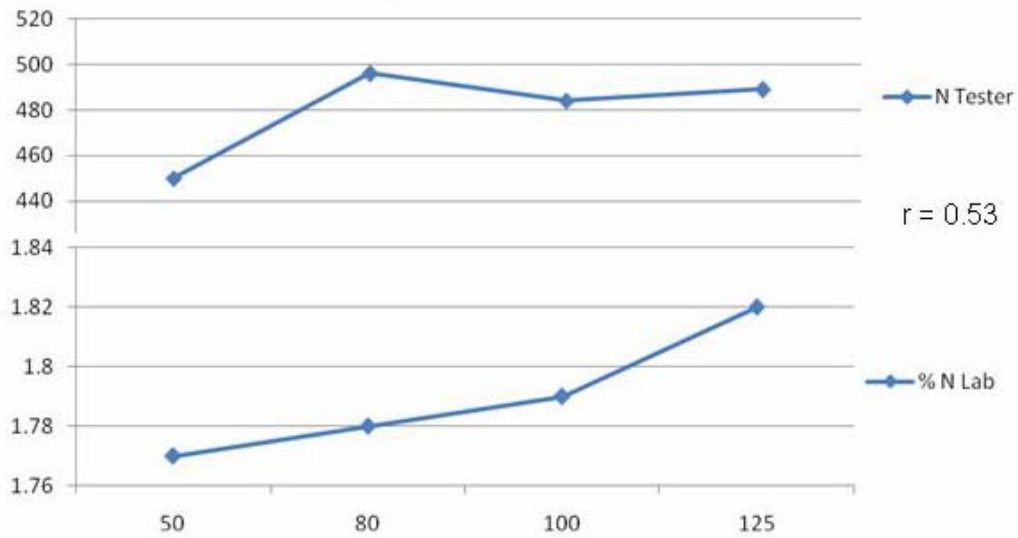


Fig 2. Relationship between Nitrogen rates, N-Tester values and Laboratory nitrogen Frome J 9501

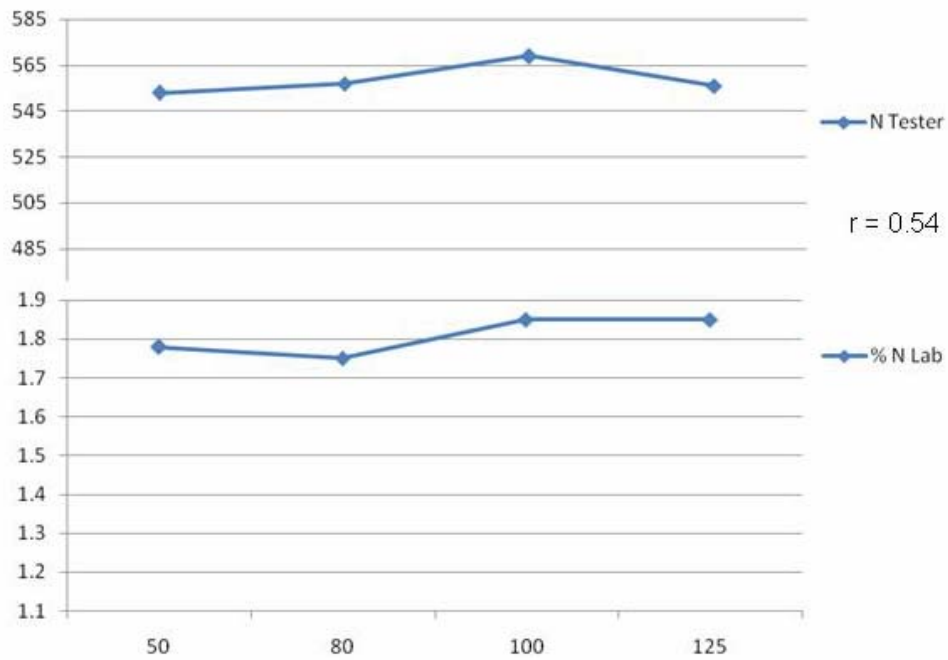


Fig 3. Relationship between Nitrogen rates, N-Tester values and Laboratory nitrogen N Y BJ 78100 (Furrow)

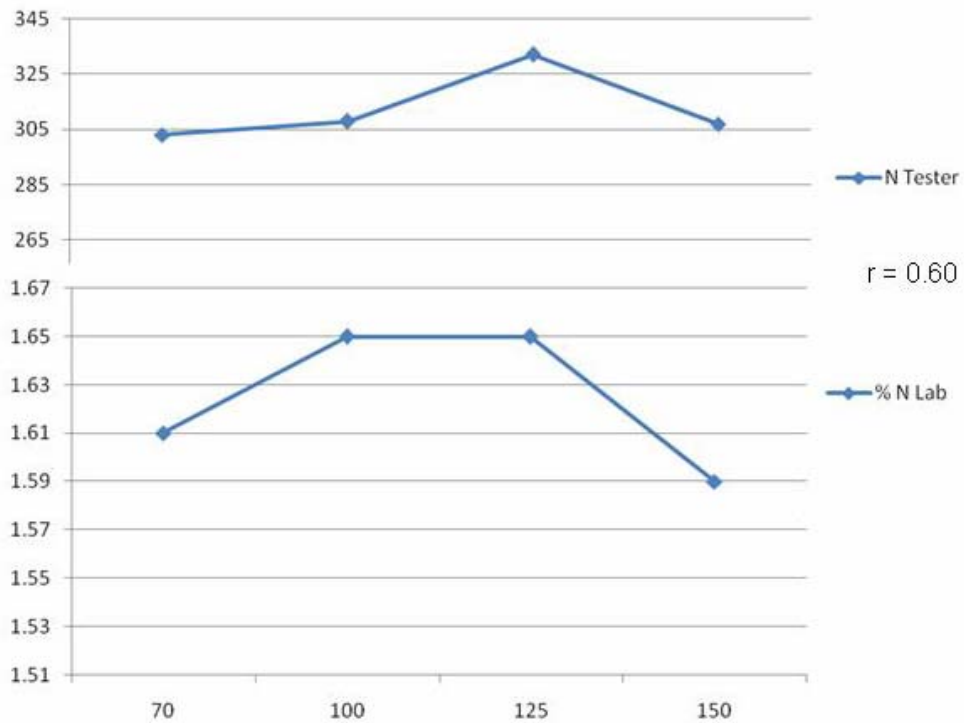


Fig 4. Relationship between Nitrogen rates, N-Tester values and Laboratory nitrogen N Y BJ 78100 (Pivot)

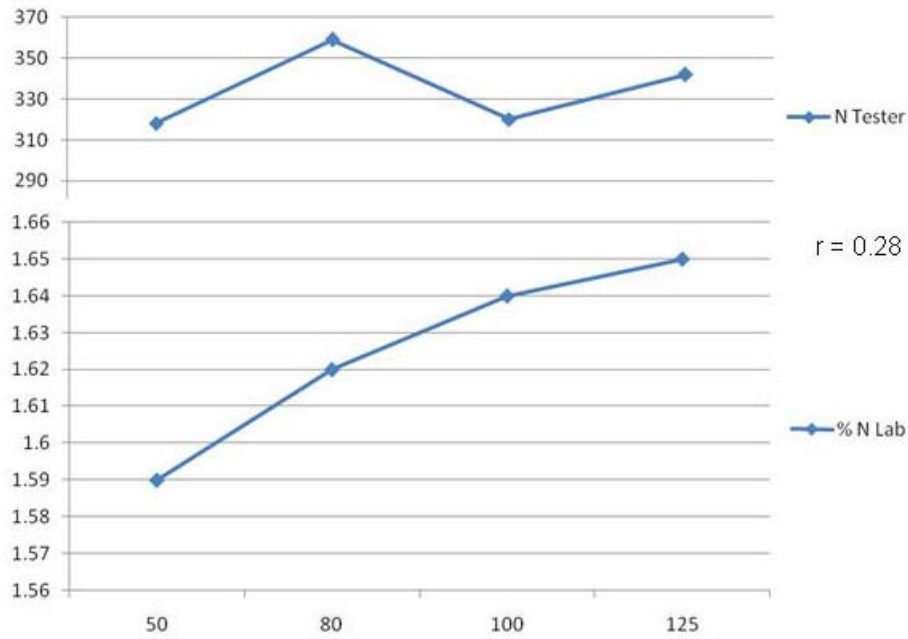


Fig 5. Relationship between Nitrogen rates, N-Tester values and Laboratory nitrogen Wallens BJ 8859

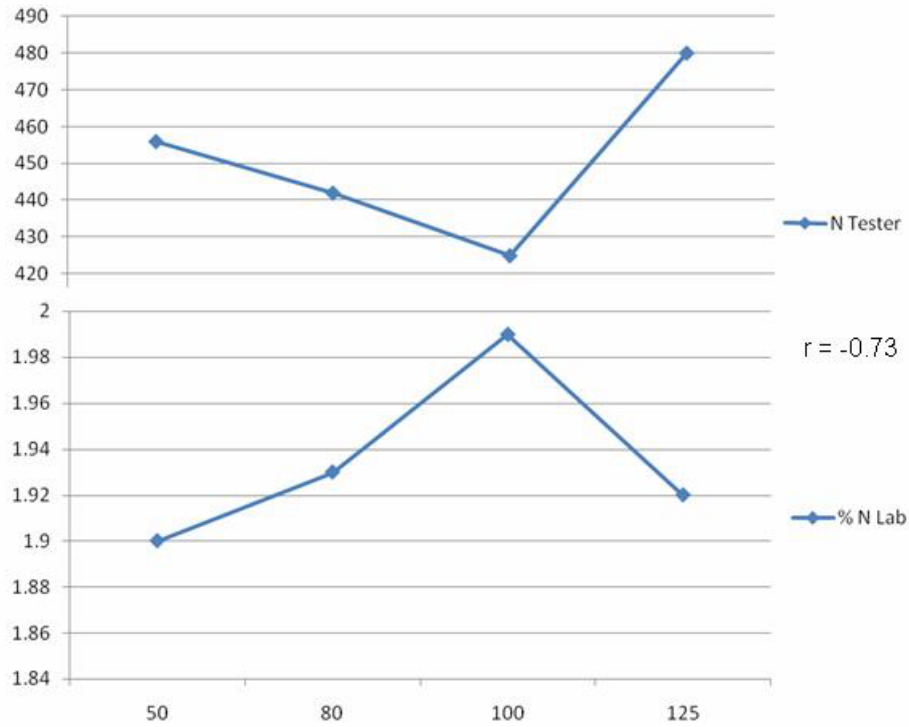
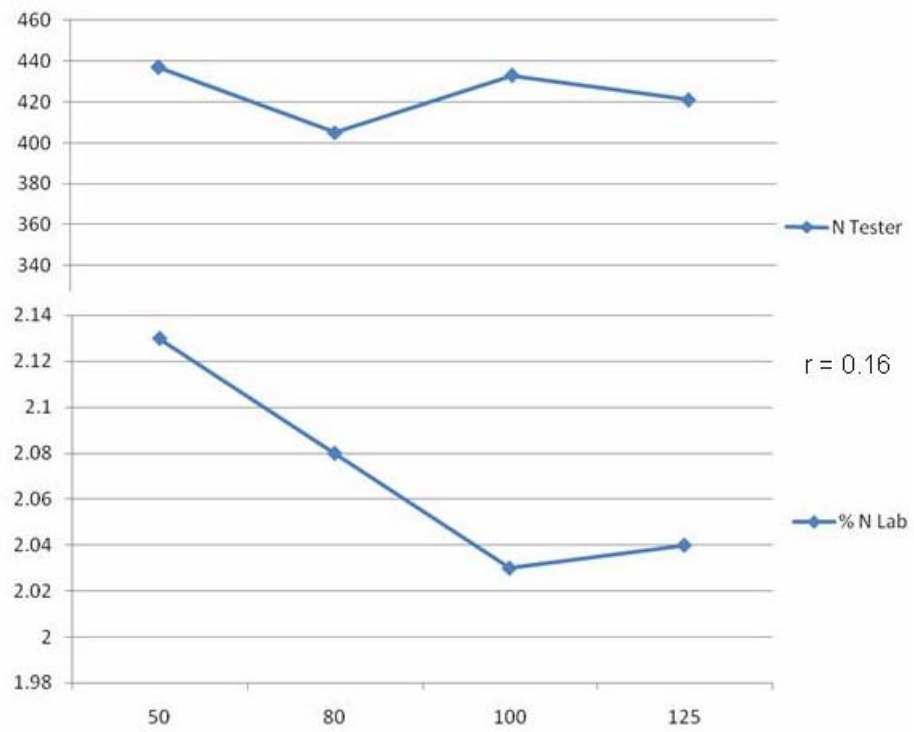


Fig 6. Relationship between Nitrogen rates, N-Tester values and Laboratory nitrogen Wallens BJ 8534



CONCLUSION

Comparisons of nitrogen in leaf by laboratory procedure and N tester methods were made with a view to determine suitability for predicting nitrogen adequacy in sugarcane under varied soil conditions in Jamaica. Positive correlations between % nitrogen by laboratory and N - Tester values were determined in 3 of the 6 evaluations for which N Tester readings and laboratory nitrogen in BJ78100 and J9501 followed a more or less exponential response pattern. N – Tester values compared to laboratory nitrogen were erratic in BJ8859 and BJ8534 which may be due to differences in leaf composition and for which further evaluations are required. The N tester appeared to hold promise for quick foliar diagnosis of nitrogen needs but more field investigations are required to calibrate the N Tester readings for soils, varieties and environment.

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