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RESPONSE OF SLENDERLEAF (*Crotalaria brevidens* Benth) TO INORGANIC NITROGEN APPLICATION

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ABSTRACT

Slenderleaf is one of African Leafy Vegetables that has been grown and consumed in Kenya for a long time, its young leaves and shoots are used as a cooked vegetable. Slenderleaf acts as an agent to promote suicidal germination of Striga, a parasitic plant that is a major problem weed for maize and millet growers. One of the major constraints in its production has been poor quality seed and lack of technical packages for optimal production. Although slenderleaf has high germination percentage that occurs within 5 days, there is hardly any information on nitrogen nutrition and the longevity of slenderleaf seed and factors affecting them.

The objectives of this study therefore were: to investigate the effect of nitrogen rates on growth, leaf and seed yield of *Crotalaria brevidens* and to study the effect of storage period on germinability of *Crotalaria brevidens*. Seeds of slenderleaf were obtained from Maseno University, Botanic garden and subjected to germination tests and then planted in the field in a well prepared seed bed at Maseno University experimental plots at a spacing of 30x30cm.

The design of the experiment was RCBD with 6 treatments and three replications and each plot measured 1.5 x 2m. The treatments included six nitrogen rates (0, 10, 20, 40, 80 and 100 kg N per hectare). Measurements on plant height, number of leaves, number of branches and number of flowering plants were taken regularly. Seeds were harvested, processed and seed yield determined and the seeds from the various treatments were kept in airtight containers and stored at room temperature in September 2003.

Germination tests were carried out by placing 50 seeds from each treatment randomly selected into a Petri-dish lined with a wet filter paper every 6 months commencing September 2003 for a period of two years and germination percentage determined. Results indicated that nitrogen rates did not have a significant ($p>0.05$) effect on growth, leaf and seed yields. Seed yields varied from 0.42 to 0.59 kg/m^2. Nitrogen rates had no significant ($p>0.05$) effect on the germination percentage in the period of storage. In September 2003, the mean germination percentage was 96.8% while in September 2005 it was 95%. The findings of this study indicate that Nitrogen application may not always be necessary for growing slenderleaf and seed can be stored for 2 years without loss of germinability and viability.

KEY WORDS: slender leaf, nitrogen, growth, yields

INTRODUCTION

Plants in the *crotalaria* genus belong to the family Fabaceae/Leguminaceae [1, 2]. The genus *crotalaria* includes about 500 species of herbs and shrubs of which 400 species can be found in Africa [1].The two African species used as a vegetable are *Crotalaria ochroleuca* and *Crotalaria brevidens.* The former has a mild taste whereas the latter has a bitter taste, but both species are commonly called rattle pod, rattle box, sunnhemp or slenderleaf. *Crotalaria ochroleuca* has bright green leaves, and grows to a height of 250cm. The flowers are pale yellow or creamish in colour and the seeds are normally but not always light yellow and the pods are wider in diameter and big [1]. *Crotalaria brevidens* has bluish green leaves, and grows to a height of 210 cm and has bright yellow flowers and the seed colour normally contains anthocyanin and is light brown in colour and the pods are small and narrow in shape.[2]. The main distinguishing features of the two species is the taste and pod size. The centre of diversity of both species is believed to be Africa and the two *crotalaria* vegetable species are commonly cultivated and consummed throughout East Africa and to a limited extent in West Africa.

Slenderleaf (*Crotalaria brevidens*) is one of the important African indigenous vegetables whose young leaves and shoots are consumed and contributes 100% of the daily dietary requirement for vitamin A, vitamin C, iron calcium and 40% of proteins when 100g of the fresh weight are consumed [3, 4]. Slenderleaf has medicinal applications where it has been implicated in treating stomach related ailments and malaria.[2, 5]. Slenderleaf has been reported to have several agronomic advantages that include: ability to produce seed under tropical conditions, performs well in nitrogen stressed soils due to its ability to fix atmospheric nitrogen, drought tolerance and intercropping suitability [2, 7] and has been used as a fodder crop and as green manure.

It also causes suicidal germination of striga weed (*Striga hermonthica*) an obnoxious cereal cropweed, and has potential use in reduction of *Striga* seed population in the soil [2]. The bitter taste of slenderleaf could be attributed to the presence of alkaloids and phenolic compounds[1]. A market survey conducted in three markets in western Kenya revealed that slenderleaf was among the top ten priority African indigenous vegetables in the region [6] and in Kenya [7].

Studies have been carried out on *Crotalaria brevidens* plant density, harvesting heights and intercropping and hardly any on nitrogen rates [7]. It has been reported [8] that at a plant density of 17 plants/m^2, optimal harvesting height of 15 cm, *Crotalaria brevidens* gave the highest leaf yield of 8 tons per hectare. *Crotalaria brevidens* has been found to be suitable intercrop for *Eleusine corocana* with land equivalent ratio(LER) of greater than one [8].

Despite the many advantages that have been attributed to slenderleaf, its potential has not been fully exploited. One of the major constraints of production has been poor quality seed. Farmers normally produce their own seed from their farms and may

store them for as long as 3 years. Although according to work done earlier, slenderleaf exhibits high germination percentage (>90%) compared to other African indigenous vegetables(<50%) [2], there is hardly any work reported on the storability and longevity of seeds of slenderleaf and factors affecting it and effects of nitrogen application. This study set to investigate effects of nitrogen rates on growth, leaf and seed yield and the effect of storage period on germinability of *Crotalaria brevidens.*

MATERIALS AND METHODS

Effect of nitrogen rates on growth, leaf yield and seed yield of *Crotalaria brevidens*

The study was conducted at Maseno University in the Department of Botany and Horticulture between January, 2003 and December, 2005. Seeds of slenderleaf were obtained from Maseno University, Botanic garden and subjected to germination tests. Fifty (50) seeds of slenderleaf were placed on individual Petri dishes lined with a wet filter paper replicated four times. Water was added to the Petri dish regularly to ensure that the filter paper is kept moist throughout the experimental period. Daily measurements on the number of germinated seeds were recorded for one week, and then percentage germination calculated at the end of the experiment. Seed germination protocol used was according to International Standards for testing Seed Vigour [9].

Soil sampling was done in the experimental plots before the seeds were planted to determine the soil nutrient status at the time the experiment commenced. The soil samples were then air dried and passed through a two millimetre sieve. The fraction which passed through the sieve was used to analyze total nitrogen, exchangeable cations, organic carbon, available P and pH using described analytical methods [10, 11, 12] and available nitrogen analysis was determined using fresh soils. Seeds were then planted on 20th April, 2003 by drilling in rows 30 cm apart in the field in well prepared seed beds at Maseno University experimental plots.

The seedlings were then thinned two weeks later to a spacing of 30x30cm.The experimental plots were kept weed free throughout the experimental period and Triple super-phosphate at the rate of 200kg per hectare were applied at planting time. The design of the experiment was Randomized Complete Block Design (RCBD) with 6 treatments and three replications and each plot measuring 1.5 x 2m. The treatments included six nitrogen rates (0, 10, 20, 40, 80 and 100 kg N per hectare).

Parameters measured included plant height, leaf number, number of branches, number of flowering plants per plot, leaf yield and seed yield. Non destructive measurements were taken weekly commencing two weeks after planting and destructive measurements on leaf area and leaf yields were taken only twice just before onset of flowering (eight weeks after sowing) and one week later. Plant height was taken by selecting two plants per plot and tagging them and their heights measured using a ruler from the soil surface to the apical bud. Number of emerged leaves and number of branches per plant of the tagged plants were counted. The number of flowering

plants per plot were counted and then the percentage of flowering plants in each plot determined. Leaf yield per plant was determined by harvesting two plants per pot and cutting off the edible parts, including leaves, young branches and shoots and weighed on a balance. Seeds were harvested when mature but before drying up and shattering, they were dried, threshed, winnowed and seed yield determined at 8% moisture content and the germination percentage of the seed lot was also determined. The same procedure was repeated during the short rains when sowing was done in the field on 20th of September, 2003.

Storage period on germinability of *Crotalaria brevidens*

Seeds from the long rains crop for various treatments were kept in airtight containers and stored at room temperature (24±3. In September, 2003 seed storage and germinability studies commenced by placing 50 seeds from each treatment randomly selected into a petri-dish lined with a wet filter paper every six months for a period of two years and germination percentage determined. Each time the germination was done it was replicated 3 times.

Data obtained was subjected to Analysis of Variance (ANOVA) to determine whether treatment effects were significant at 5, 1 and 0.1% and separation of means was done by Least Significance Difference ($LSD_{5\%}$) for those parameters where the treatment effects were significant.

RESULTS

Soil Analysis Results

The results of the soil chemical and physical properties are shown in table 1. The pH of the soils was 6.3 which is within the optimal pH for most vegetable crops of 5.5-6.8 [14]. Available Phosphorus was 1.6 ppm and available Nitrogen 0.12ppm with balanced clay, sand and silt distribution. The table also shows exchangeable cations, Potassium, Magnesium, Calcium and Aluminium.

Effect of nitrogen rates on growth, leaf yield and seed yield of *Crotalaria brevidens*

The germination percent was 100% and correlated positively with the field seedling emergency which was over 95 % in all the plots. Nitrogen rates had no significant ($p>0.05$) effect on all growth parameters, leaf and seed yield of *Crotalaria brevidens.* At eight weeks after sowing the following ranges were observed: plant height varied from 45 cm to 60 cm, number of leaves, 39-55, number of branches, 11-16 and % number of flowering plants per plot were 15-35%. Leaf yields varied from 26 to 30 g/plant. Table 2**.**

Effect of nitrogen rates on germination% of stored slenderleaf seeds

Nitrogen rates had no significant ($p>0.05$) effect on germination percentage of slenderleaf seeds that were stored for two years at room temperature (Table 3).
The mean germination percentage for September 2003, March 2004, September 2004, March 2005 and September 2005 were 96.8, 95.2, 94.7, 93.5 and 95, respectively.

DISCUSSION

Soil analysis results

It has been reported that the soils in Maseno area are deep, and deficient in Phosphorus and Nitrogen, with moderate phosphorus fixation [13]. The results of soil chemical and physical properties confirm these reports. Phosphorus levels were 1.6 ppm which is low according to Marschner [14] as it falls in the deficient range of 0-5ppm and available N of 0.12ppm is on the lower side according to the report of Onyango *et al.* [15]. The pH of 6.3 falls within the optimal range for vegetable growing of 5.5-6.8 [14].

Effect of Nitrogen rates on Growth and Leaf Yield of *Crotalaria brevidens*

The failure of slenderleaf (*Crotalaria brevidens*) to respond to nitrogen rates agrees with other previous studies that have shown lack of response even to nitrogen rates as high as 150kg/ha [16] .The observed ranges of growth parameters like plant height, leaf and branch number are within what has been reported by Chweya [7] Seed yields of 0.42-0.59 kg/m^2 are slightly lower than those reported earlier of 0.77kg/ m^2 [16]. It was reported that there was no response to nitrogen rates of 0, 60, 80 and 100 kg of N per hectare by cowpeas (*Vigna unguiculata*). [18].

This observation could be attributed to the ability of leguminous plants to which slenderleaf and cowpea belong, to fix atmospheric nitrogen through root-rhizobium symbiosis. It has been reported that most legumes can get 80-90% of their total nitrogen requirements through symbiotic fixation. Quantities of symbiotically fixed nitrogen in cowpea are reported to range between 150-354 kg of nitrogen per hectare [15]. It is envisaged that slenderleaf in this study being a leguminous plant fixed adequate amounts of nitrogen and utilized it in the production of dry matter. The accumulated dry matter was then re-translocated to the seeds during seed formation.

Effect of nitrogen rates on germination% of stored slenderleaf seeds

Nitrogen rates had no significant ($p>0.05$) effect on germination percentage of slenderleaf seeds that were stored for one a period of two years at room temperature. The mean germination percentage at the onset of the experiment in September 2003 was 96.8% and two years later in September, 2005 it was 95%. This shows that slenderleaf has not only high germination percentage but is able to maintain that germinability for two years or even longer.

The observed germination percentage was very high (over 90%) for the stored seeds. The minimum acceptable germination percentage for a seed lot is normally 85% [19]. Although this indicates that the germinability of the stored slenderleaf seed remains high for two years, it is imperative to check the vigour of the seedlings. Other important measurements that could be undertaken are the electrical conductivity and tetrazolium tests [19].

High germination% of over 90% is in line with earlier reports [19]. High germinability corroborates with reports indicating that, germination percentage for both farmers' and researchers' slenderleaf seeds had a germination percentage of 92% [4]. The most important factor that influences the potential longevity of seed is moisture content [19] and this could have contributed to the slenderleaf seeds under the current study that were stored at eight percent (8%) moisture content. However, it is important to note that germination test alone may be of limited ability in detecting physiological quality differences in stored seed.

A small difference in percentage germination represents a large difference in the progress of seed deterioration and a seed may be viable but still fail to germinate under stressful conditions. Slenderleaf is a promising vegetable crop since it can grow under nutrient deficient soils and can withstand some stress conditions like drought [2]. In addition its seeds can maintain viability for at least two years and has no dormancy problems. Further investigations relating to its optimal production are suggested.

CONCLUSIONS

- Nitrogen rates had no significant effect on growth, leaf and seed yield of slenderleaf.
- Nitrogen rates had no significant effect on germination percentage of stored slenderleaf seeds.
- Slenderleaf seeds can be stored for a period of 2 years without significantly affecting its germination percentage.
- Further research is needed on the effect of storage on seedling vigour and longevity of the seeds and other aspects like use as green manure, medicinal value and control of striga weed in cereals and its suitability as an intercrop.

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TABLES

Table 1: Soil chemical and physical properties at Maseno University

SOIL VARIABLE	Long rains 2003
pH(water)	6.3
Soil organic carbon (%)	1.20
Available P (mg/kg)	1.60
Available N(mg/kg)	0.12
Ex K (meq/100g)	0.12
Ex Mg.(meq/100g)	0.50
Ex Ca(meq/100g)	2.24
Ex Al(meq/100g)	1.07
%clay	34.3
%sand	36.5
%silt	29.3

Table 2: Effect of nitrogen rates on seed yields of slenderleaf

Treatment (kg of N per hectare)	Mean seed yields (kg/m^2)
0	0.42
10	0.44
20	0.50
40	0.58
80	0.46
100	0.59
Significance	Not significant (p>0.05)
$LSD_{5\%}$	-

Table 3: Effect of rates on germination percentage on stored slenderleaf seeds

Treatment (kg N/Ha)	%Germination September and March of each year					
	Sept 2003	**March 2004**	**Sept 2004**	**March 2005**	**Sept 2005**	**Mean**
0	95	94	94	95	95	94.6
10	100	99	100	95	96	98.0
20	94	93	92	94	97	94.0
40	99	92	93	94	95	94.6
80	93	94	92	93	92	92.8
100	100	99	97	90	95	96.2
Mean	96.8	95.2	94.7	93.5	95	**95.0**
Significance	ns	ns	ns	ns	ns	ns
$LSD_{5\%}$	-	-	-	-	-	-

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