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Full Length Research Paper

Effect of nitrogen fertilizer levels on fresh leaf yield of spider plant (*Cleome gynandra*) in Western Kenya

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This study was conducted in Moi University, Kenya to investigate the effect of nitrogen fertilizer on fresh leaf yield of spider plant (*Cleome gynandra*). The objectives were to determine the plant height, number of shoots, number of marketable leaves and fresh leaf weight under different nitrogen fertilizer levels. The crop was planted during the short rains of 2003. The treatments were CAN (26%N) at 0 (control) 50, 80 and 106 Kg ha^{-1} in randomized complete block (RCBD) design with three replications. Data on growth parameters were collected one week after top dressing at intervals of seven days for three weeks. Type of data collected included; plant height, number of shoots, number of marketable leaves and fresh leaf weight. Data collected were subjected to analysis of variance (ANOVA) and the means separated by Duncan's multiple Ranges Test (DMRT) at p<0.05. The results indicated that nitrogen fertilizer increased plant height, number of marketable leaves, number of shoots and fresh yield. During the first week, there was no significant difference (p<0.05) in all parameters, while in the second and third weeks there was a significant difference (p<0.05) in the third treatment. Use of increased N levels increases plant height, number of shoots, marketable leaves and yield. Farmers are advised to use 80 kg ha^{-1} of N for growing spider plant.

Key words: Cleome gynandra, Kenya, leaf yield, nitrogen fertilizer.

INTRODUCTION

In the past, traditional societies have exploited edible wild plants resources to obtain their nutritional requirements (Korte, 1973; Abe and Imbamba, 1997). Recent studies on the agro-pastoral societies of Africa indicate that these plant resources still play a significant role in nutrition, food security, medicine and income generation (Grivetti, 1976; Fleuret, 1979). However, dietary utilization of non-domesticated plants has received little attention and a dramatic narrowing of the food base has occurred in many societies. The incorporation or maintenance of edible wild plant resources could be beneficial to nutritionally marginal population, especially in developing counties. However, most farmers' throughhout Africa have been abandoning traditional varieties of crops in preference to introducing high yielding varieties. This has led to large-scale genetic erosion of important food crops in their traditional areas of cultivation, including their wild relatives in their natural environment (Chweya and Mnzava, 1997).

Little domestication has been done. With increasing pressure on agricultural land, its ecological niches are fast disappearing; hence genetic erosion is bound to be rapid. In general, little is known about the cultivation techniques, the extent and structure of genetic variation and leaf yield production of these wild edible plant resources (Chweya, 1997). Domestication and cultivation of wild edible plant is therefore essential in broadening the food base in developing countries. Among the wild edible plants, indigenous leafy vegetables feature prominently in the diet of many African communities.

In Kenya, the indigenous vegetables commonly grown include: spider plant (*Cleome gynandra* L.), cowpea (*Vigna unguiculata*), black night shade (*Solanum nigrum*) and amaranrhus (*Amaranthus hibridus)* (Ivens, 1967; Chweya and Mnzava, 1997).These species are recognized as vegetables that need to be cultivated in small sectors of the farm such as kitchen gardens and along

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along the rows of staple crops (Chweya, 1997). However, these African indigenous vegetables have received little attention in the improvement of fresh leafy yield production from scientists and policy makers (Chweya, 1997).

The aim of the study therefore was to investigate the effect of nitrogen fertilizer levels on fresh leaf yield of spider plant. The specific objectives were to determine the plant height, number of shoots, number of marketable leaves and fresh leaf weight (yield) under different nitrogen fertilizer levels.

Spider plant is used as vegetable where the tender shoots and leaves are boiled and eaten as herb, tasty relish, stew or side dish. The high fibre content of the leaves enables them to be stored for a long time. Indigenous knowledge possessed by rural women in Kenya indicates that spider plant has several medicinal uses (Opole et al., 1995). In some communities, it is believed that regular consumption of the leaves by expectant women eases childbirth by reducing the length of labor, helps them to regain health faster and stimulates milk production in lactating mothers (Kokwaro, 1976). The concoction made from the leaves is believed to treat scurvy and marasmus, while the sap from pounded leaves is squeezed into ears, nostrils and eyes to treat epileptic fits and recurrent malaria (Opole et al., 1995).

Spider plant has been observed to have insecticidal, anti-feedant and repellent characteristics (Verma and Pandey, 1987). The leaves have anti-tick, repellent and acaricidal properties to larvae, nymphs and adult ticks (*Rhipicephalus appendiculatus*) (Chandel et al., 1987). The plant has anti-feedant action against the tobacco caterpillar, while the extract from the mature seeds is toxic to brinjal aphid and larvae of American bollworm (*Heliothis armigera*), and lipids from the seeds can be used in soap manufacture (Verma and Pandey, 1987). The plant is highly nutritious leafy vegetable rich in vitamin A and C, calcium, iron and proteins (Abe and Imbamba, 1997). Existing evidence suggest that spider plant is endowed with higher levels of nutrients than its counterparts (Chweya and Mnzava, 1997). During the period of abundance, the leaves and young tender shoots are sold both in the rural and urban markets hence it is a source of income to the rural poor and the unemployed.

MATERIALS AND METHODS

Site description

The study was carried out at Chepkoilel campus, Moi University, Uasin Gishu district in western Kenya. The site is located at Lat 00° 35'N, Long 350° 18'E and altitude of 2140 m above sea level. The soils are acidic ferralsols with low to medium fertility. This site receives annual rainfall of 1124 mm in one season from March to September with a mean temperature of 18°C (Jaetzold and Schmidt, 1983).

Experimental design

The experiment was designed and carried out in October, 2003 with the aim of determining the plant height, number of shoots, number of marketable leaves and fresh leaf weight (yield) under different nitrogen fertilizer levels. The seeds were obtained from merchants in Eldoret town and no seed treatment was done. Prior to the experiment the soil nutrient status was established based on the analysis by Okalebo et al. (1999). The experiment was laid out in randomized complete block design (RCBD) with 4 treatments replicated 3 times. The treatments were randomly allocated (randomization) using random numbers. The treatments were: 0, (control), 50, 80, and 106 kg ha^{-1} (0, 5, 8 and 10.6 g m^{-2}) of CAN fertilizer. These treatments were established on the recommendation of 60 Kg N ha^{-1} (FURP, 1994). The field was divided into three blocks each with four plots. Each plot size was 2.5 by 1.5 m with an interplot spacing of 0.5 m.

Land preparation was carried out by clearing the weeds followed by deep ploughing. Harrowing was done using a fork jembe and leveled with a rake. Half a bucket of manure was applied and incorporated thoroughly in each plot and raised the beds 10 cm above ground. Manure adds organic matter in the soil and also provide N but present in less soluble form than in inorganic fertilizers. Planting was then carried out during the short rains on 10th October, 2003 by making furrows 2 cm deep across the plot with interrow spacing of 30 cm by drill. DAP fertilizer was thoroughly mixed with the soil along the furrows to avoid direct contact with seeds, at the rate of 75 g plot^{-1} (200 kg ha^{-1}). The seeds were then sown in the field directly by drilling along the furrows and covered with a thin layer of soil. The plots were then mulched and watered. This was done to conserve moisture in the soil. Before planting, spider plant seeds were pre-germinated on 5th October, 2003 according to ISTA (1985). Weeding was done on the 3rd and 5th week after germination. Application of nitrogen fertilizer was done after three weeks. The application was carried out in two splits; the 1st after weeding on the 3rd week and the 2nd after weeding on the 5th week at 0, 25,40 and 53 kg ha $^{-1}$ (0, 2.5, 4, 5.3 g m^{-2}) of CAN fertilizer to be utilized by the plants before taking sample data. Watering and monitoring was carried out thoroughly during the growing season

Data collection

Ten randomly selected plants per plot were harvested and measurements for every parameter taken at intervals of 7 days for three weeks. The following data were recorded: plant height, number of marketable leaves, number of shoots and fresh leaf weight (yield). The fresh weight was determined using electric sensitive balance to ensure accuracy.

Data analysis

The data collected were subjected to multivariate analysis of variance (ANOVA), and descriptive analysis. Data sets were analyzed using Statistical Package for Social Scientists (SPSS). Levels of significance, means and standard deviations were obtained for various data sets. The differences were accepted as significant at $p<0.05$ and post hoc separation of means was done using Duncan multiple range.

RESULTS AND DISCUSSION

Germination percentage was 60-70%. Effect of nitrogen fertilizer levels on plant height are indicated by the means

Table 1. Effect of nitrogen fertilizer levels on plant height of Spider plant at Chepkoilel.

Treatment	1st week	2nd week	3rd week
0 Kg (control)	4.217a	6.3200ab	14.8600a
50 Kg/ha (5 g/m^2) of CAN fertilizer	4.4433a	7.4633b	18.4600ab
80 Kg/ha (8 g/m^2) of CAN fertilizer	5.4150b	10.5133c	22.8833b
106 Kg/ha (10.6 g/m^2) of CAN fertilizer	5.2167b	5.4400a	11.8833a

Each mean represents an average of three replicates.
Mean separation by DMRT at 5% level
Means with same letter are not significantly different at 5% level.

Table 2. Effect of nitrogen fertilizer levels on number of shoots of Spider plant at Chepkoilel.

Treatment	1st week	2nd week	3rd week
0 Kg (control)	1.67a	1.00a	2.67a
50 Kg/ha (5 g/m^2) of CAN fertilizer	1.00a	1.67a	4.33a
80 Kg/ha (8 g/m^2) of CAN fertilizer	1.00a	3.67b	5.00a
106 Kg/ha (10.6 g/m^2) of CAN fertilizer	1.67a	2.33ab	7.67b

Each mean represents an average of three replicates.
Mean separation by DMRT at 5% level.
Means with same letter are not significantly different at 5% level.

Table 3. Effect of nitrogen fertilizer levels on number of marketable leaves of spider plant at Chepkoilel.

Treatment	1st week	2nd week	3rd week
0 Kg (control)	2.00a	1.67a	2.67a
50 Kg/ha (5 g/m^2) of CAN fertilizer	2.00a	2.33ab	3.33a
80 Kg/ha (8 g/m^2) of CAN fertilizer	3.00a	4.00c	5.67b
106 Kg/ha (10.6 g/m^2) of CAN fertilizer	3.00a	2.33ab	4.33ab

Each mean represents an average of three replicates.
Mean separation by DMRT at 5% level
Means with same letter are not significantly different at 5% level.

of the observations recorded for three weeks (Table 1). There was no significant difference of the effect of nitrogen fertilizer, on mean plant height, in the first week in the first two and the last two treatments. This was due to uniformity of the DAP-Diamonium Phosphate fertilizer used in planting which contains nitrogen giving all treatments equal early start. In the second and third weeks, there was a significant difference ($p<0.05$) in the means of their third treatments (80 Kgha^{-1} (8 gm^{-2}). This indicated that nitrogen fertilizer had effect on plant height hence increased the height of spider plants. The fourth treatment had the lowest mean in the third week due to the fact that the amount applied was excess, which reduced the plant height (Table 1).

Results on the effect of nitrogen fertilizer levels on number of shoots (Table 2), indicated that in the first week, there was no significant difference ($p<0.05$) in the mean number of shoots across all treatments. In the second week, there was also no significant difference ($p<0.05$) between the control and the second (50 Kg ha^{-1} CAN) and the fourth (106 Kg ha^{-1} CAN) treatments. However, there was a significant difference ($p<0.05$) between the control and the third (80 Kg ha^{-1} CAN) treatment. The high number of shoots in the third (80 Kg ha^{-1}) treatment contributed to high fresh yield. In the third week, there was no significant difference ($p<0.05$) in the means of the control, the second and the third treatments while there was a significant difference ($p<0.05$) in the fourth treatment (the highest level of fertilizer). This implies that increase in nitrogen fertilizer had an effect on spider plant shoots and therefore increased the number of shoots hence increase in fresh yield.

On the effect of fertilizer levels on the number of marketable leaves (Table 3), there was no significant difference ($p<0.05$) in the number of marketable leaves at 5% level in all the four treatments in the first week. In the second week, there was a significant difference ($p<0.05$) in the mean of the third (80 Kg/ha) treatment but no

Table 4. Effect of nitrogen fertilizer levels on fresh leaf weight (yield) of Spider plant.

Treatment	1st week	2nd week	3rd week
0 Kg (control)	21.6533a	42.5667a	41.8000a
50 Kg/ha (5 g/m^2) of CAN fertilizer	24.1167a	47.6200ab	76.7667b
80 Kg/ha (8 g/m^2) of CAN fertilizer	25.5800a	68.7300ab	112.5733c
106 Kg/ha (10.6 g/m^2) of CAN fertilizer	27.7300a	46.7267ab	66.4667ab

Each mean represents an average of three replicates.
Mean separation by DMRT at 5% level
Means with same letter are not significantly different at 5% level.

significant difference ($p<0.05$) in the other treatments. The third treatment had the highest mean while control had the lowest. This could be attributed to depletion of soil nutrients. In the third week there was a significant difference in the number of marketable leaves in the third treatment while in the control, second and fourth treatments, there was no significant difference ($p<0.05$)

The results of effect of nitrogen fertilizer levels on fresh weight (yield) indicate that there was no significant difference in the means of all the treatments ($p<0.05$) in the first week (Table 4). However, there was a significant difference ($p<0.05$) in the third treatment in the second week. The third treatment had the highest fresh leaf yield as the increase in nitrogen level increased the fresh yield. In the fourth treatment, the increase in nitrogen fertilizer decreased the fresh yield of spider plant. In the third week, there was a significant difference ($p<0.05$) between the control and the third treatment while there was no significant difference between the control and the second and fourth treatments. This implies that increase in nitrogen fertilizer increased fresh yield. The control had lowest yield due to the depletion of nutrients in the soil. Plants with deficient nutrients were looking spindly, stunted growth and pale in colour when compared to healthy plants. Nitrogen deficiency limits the production of protein and other materials essential for production of new cells, thus lowering the yield.

Application of 106 Kg/ha of nitrogen fertilizer contributed excess supply levels, which produced dark green leaves that became succulent and prone to deterioration. The response of increased nitrogen fertilizer showed an increase of leaf and shoot number, and weight per plant with time. This signified leaf senescence, which prolonged the harvesting period. Excess nitrogen fertilizer also resulted in clustering of the shoots at the base, which contributed to high yield initially but for a short period of time.

Conclusion

The results of the study indicated that the use of nitro-gen fertilizer improved the quality of spider plant leaves. Use of increased nitrogen fertilizer levels increased the plant height, number of shoots, number of marketable leaves and fresh weight. The highest yield was realized in the third week. The amount of nitrogen fertilizer level for high yield was 80 Kg ha^{-1} (8 g m^{-2}). Yield of spider plant increased with increase in nitrogen levels. Further increase in nitrogen levels lead to decline of fresh leaf yield and poor quality vegetables. Use of nitrogen fertilizer also prolonged harvesting period, hence desirable for farmers. The control (0 Kg ha^{-1}) gave the lowest leaf yield and the number of marketable leaves, due to depletion of nutrients in the soil.

Recommendations

The public should be sensitive on the value of using indigenous vegetables especially spider plant (*C. gynan-dra*) as the plant is highly nutritious, source of income, has medicinal properties, anti-feedant action and anti-tick properties. Farmers are advised to use 80 Kg ha^{-1} (8 g m^{-2}) of nitrogen fertilizer for growing spider plant, as it improves the quality, increases the yield and prolongs the harvesting period of spider plant vegetables. Further research should be carried out to determine the optimum economical level of nitrogen fertilizer on spider plant.

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