



Response of Sickle Senna (*Cassia tora*) to Nitrogen Fertilizer and Sowing Methods in Sudan Savanna Ecological Zone, Nigeria

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ABSTRACT

Field trials were conducted during the 2024 rainy season at the Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri, Nigeria, to evaluate the effect of Nitrogen fertilizer and sowing methods on the growth and yield of Sickle Senna (*Cassia tora*). The treatments consisted of five Nitrogen rates (0, 30, 60, 90 and 120 kg ha⁻¹) and three sowing methods (broadcasting, dibbling and drilling) which was laid out in a Randomized Complete Block Design (RCBD) replicated three times. Data were collected on growth characters (plant height, number of leaves per plant, and leaf area index) and yield characters (pod length, fresh leaves yield per hectare, pod yield per hectare and total yield per hectare) which were measured and recorded. The results showed that N fertilizer significantly influenced all measured parameters, with growth and yield increasing as fertilizer rates increased. The highest fertilizer rate of N fertilizer (120 kg ha⁻¹) resulted in taller plants, higher number of leaves, higher leaf area index and higher yield. However, there were no significant differences between 90 and 120 kg ha⁻¹ for some characters (plant height, leaf area index, pod yield ha⁻¹ and total yield ha⁻¹). The control treatment consistently recorded the lowest values across all characters. Similarly, drilling sowing method which was comparable to dibbling for some characters observed had significant edge over the sowing methods used in the experiment. Therefore, based on the results of these trials it could be concluded that application of N fertilizer at 90 kg ha⁻¹ and drilling sowing method which gave higher growth and yield characters and is being recommended for optimum Sickie senna production in the Sudan Savanna ecological zone of Nigeria.

Keywords: Sickie Senna, nitrogen fertilizer, sowing methods, broadcasting, dibbling, drilling

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INTRODUCTION

Sickle senna or Sickie pod (*Cassia tora* L.), is a plant belonging to the family *Fabaceae* and the sub family *Caesalpinioideae*. It is an annual herb that thrives in semi-arid regions as a weed. It is popularly called tafasa in Hausa and is widely distributed in the Sudano-Sahelian savanna of Nigeria (Steven *et al.*, 2017). *Cassia tora* grows erect with multiple branches, reaching up to a height of 90

cm (Akobundu and Agyakwa, 2017). The plant's resilience and invasive nature allow it to dominate farmlands, primarily due to its high seed production. It typically germinates after the first rains of the season, providing an early source of pasture for grazing animals. Its adaptability to dry and nutrient-poor soils allows it to thrive in various environments, including roadsides, fallow lands, and

abandoned fields (Aliyu *et al.*, 2021). *C. tora* leaves are obovate and consist of three pairs of opposite, pinnately arranged leaflets. The plant produces bright yellow flowers and rhombohedral brown seeds enclosed in curved, dehiscent pods measuring 12-18 cm in length and containing 18-28 seeds. These features make it a valuable species for ecological restoration and soil stabilization, as its extensive root system helps prevent erosion and improve soil structure (Kumar *et al.*, 2019).

All parts of Sickie senna (*C. tora*) have various uses. The leaves are widely consumed as food, often mixed with groundnut cake (kuli-kuli) among the Hausa community. The dried leaves are also a valuable export commodity, traded between Nigeria and Niger Republic (Muhammad *et al.*, 2017). It also has a long history of use in ethno-medicine for various purposes. Its leaves are used in mild laxatives, eye disease treatments, liver stimulants, heart tonics, and anthelmintics for relieving constipation. Additionally, they are used in northern Nigeria for treating ulcers, ringworm, and other parasitic skin diseases (Clement, 2021). The seeds have been valued in traditional Chinese medicine, while the leaves contain chrysophanic acid-9-anthrone, a natural fungicide and pesticide commonly used in organic farming in India. *C. tora* plays a crucial role in ecological restoration. It acts as a pioneer species in degraded landscapes, contributing to nitrogen fixation and enriching the soil, thereby enhancing biodiversity (Singh and Rastogi, 2020).

Despite the agronomic, medicinal, and ecological significance of Sickie senna (*Cassia tora*), limited research has been conducted on the optimal nutrient requirements for its growth under cultivation, especially in regions with semi-arid climates like Maiduguri and Damaturu. In many parts of the Semi-arid region, soil fertility is challenged by low organic matter, erratic rainfall and frequent droughts, resulting in inadequate nutrient availability for plant growth. This situation is further exacerbated by the limited use of fertilizers among local farmers due to cost and limited knowledge of optimal fertilization practices for indigenous plants such as *Cassia tora*. In Maiduguri, poor soil fertility and frequent droughts hinder the growth potential of many plants, including *Cassia tora*. Our local farmers and stakeholders lack clear guidelines on the appropriate levels and timing of N fertilization to achieve optimal results for *Cassia tora* cultivation. Additionally, the effects of N fertilizers on the growth characters of this crop in the Sudan savanna have not been systematically explored, leaving a gap in knowledge that requires inputs in researches. Thus research was conducted to determine the optimum rate of N fertilizer and effect of sowing methods on the production of Sickie senna in the Sudan savanna ecological zone of Nigeria.

MATERIAL AND METHODS

Experimental sites

The study was conducted in the 2024 rainy season at the

Teaching and Research Farm, Faculty of Agriculture, University of Maiduguri, (11° 48' N; 13° 12' E and altitude of 319 meter above sea level) in Borno State. It falls within the Sahelian region (semi-arid zone) of West Africa which is characterized by hot dry season and short duration of rainfall. The dominant texture class of the soil is sandy loam. The soils were generally well drained and appeared to be fairly homogenous. The climate of the area is semi-arid climate with wide seasonal and diurnal temperature ranges from 34-40°C. The dry season is between 8-9 months, followed by a single rainy season of about 3-4 months. The mean annual rainfall is about 625 mm and means annual air temperature is between 27 °C to 32 °C. The pattern of the rainfall is a single peak type, beginning in late May with maximum rainfall in August and ends late October. The months between November – March are dry with a few light showers occurring in April and early May. The temperature is highest in the months of April and May (Abubakar, 2002).

Treatments and experimental design

The treatments consisted of five rates of N fertilizer (0, 30, 60, 90 and 120 kg ha⁻¹) and three sowing methods (broadcasting, dibbling and drilling). The experiment was laid-out in a Randomized Complete Block Design (RCBD) replicated three times. Alley path ways of 0.5 m and 1 m were left between plots and replicates, respectively. Each gross plot measured 3m x 3m (9 m²) and net plot measured 3 m x 2 m (6 m²)

Land preparation and crop management

The experimental sites were cleared of vegetation and leveled using rakes. The lands were harrowed and divided into gross plots (9 m²) and net plots (6 m²) separated by alley ways of 0.5 m and 1.0 m between plots and replicates, respectively. Prior to the land harrowing, soil samples were collected randomly within the experimental plots at the depths of 0 – 30 cm. These were appropriately labeled, bulked, air dried and subjected to routine analysis as suggested by Blake and Hartge, (1986).

Sickie senna (*Cassia tora*) seeds were obtained from a certified supplier at Dambo'a and were selected for their uniformity, good viability and freedom from damage or contamination to ensure reliable results in the experiment. The seeds were treated with Apron-star against soil borne pests and diseases. The seeds were then sown manually according to treatments at a depth of about 2 cm using equal seeds rate of 5 kg ha⁻¹ or all the sowing methods. Sowing was conducted on 28th June and 4th July, 2024 at Maiduguri and Damaturu, respectively. Inter and intra-row spacing of 40 cm x 20 cm was used for dibbling. Drilling was done at inter-row spacing of 40 cm while broadcasting was done manually without sowing specification.

Manual weeding was carried out three times at 3, 6 and 9 weeks after sowing (WAS). Fertilizers were applied in two split doses as per treatment using side placement.

The first application took place at 3 WAS using NPK 15:15:15 to obtain N, P₂O₅ and K₂O at 30:30:30 kg ha⁻¹ while the remaining N was supplemented using urea (46% N) and divided into 2 doses which were then applied at 6 WAS. Thus irrespective of the treatment 30 kg ha⁻¹ each of P₂O₅ and K₂O were applied at the first fertilizer application. The plants were harvested at maturity (90 days after sowing) when pods had fully developed and turned brown.

Data collection and analysis

Data were collected for growth characters on 5 tagged plants within the net plots while the yield characters were collected after harvest which includes the following characters;

Plant height (cm)

The heights of the plants were measured from the base to the tip using a measuring tape at 6 WAS and the mean recorded.

Number of leaves

The number of leaves of the plants was counted manually at 6 WAS and the mean recorded.

Leaf area index (LAI)

This was taken at 6 WAS and was calculated using the formula;

$$LAI = \frac{\text{Total leaf area per plant}}{\text{Area of ground covered}}$$

Pod length (cm)

This was determined by measuring the length of pod selected from the net plot at harvest. The pods were measured from the distal to the proximal end and the average recorded.

Fresh leaves yield per hectare (t ha⁻¹)

This was extrapolated from leaves weight per plot from the harvested leaves. The leaves were weighed using a digital weighing scale immediately after harvest.

Pod yield per hectare (ha⁻¹)

This was extrapolated from pod weight per plot from the harvested pods. The pods were weighed using a digital weighing scale immediately after harvest.

Total yield per hectare (ha⁻¹)

This was obtained from the summation of the fresh leaves

yield and pod yield per hectare. All data collected were subjected to Analysis of Variance (ANOVA) using GenStat 17th edition while Duncan's Multiple Range Test (DMRT) was employed to separate the means at 5% level of probability ($p < 0.05$).

RESULTS

Effect of nitrogen fertilizer and sowing methods on growth characters of sickle Senna

Table 1 shows the effect of N fertilizer and sowing methods on growth characters of Sickle senna at Maiduguri and Damaturu. Effect of treatments on plant height was significant at both locations. At Maiduguri, each increase in N rate from the control up to 90 kg ha⁻¹ resulted in significant increase in height; further increase to 120 kg ha⁻¹ has no significant effect on this character. However, at Damaturu increase in fertilizer from the control up to 60 kg ha⁻¹ recorded in significantly taller plants but further increase to 90 kg ha⁻¹ has no significant effect on this parameter beyond which recorded taller plants. Similarly, at both locations the effect of sowing method shows that drilling and dibbling methods recorded similar and taller plants than broadcasting. There was no significant interaction recorded between the treatments.

The effect of treatments on number of leaves on *Cassia tora* was also significant at both locations. Generally, increase in N rate from the control up to 60 kg ha⁻¹ resulted in significant increase in the number of leaves per plant but further increase to 90 kg ha⁻¹ resulted in similar number of leaves. Furthermore, increase in N rate from 90 to 120 kg ha⁻¹ resulted in plants with many leaves. However, for the sowing methods at both locations drilling method recorded plants with many leaves while broadcasting recorded fewer leaves.

The effect of treatments on leaf area index (LAI) showed that there were significant differences between the treatments at both locations. At Maiduguri increase in N from the control to 30 kg ha⁻¹ had no significant effect on this parameter but beyond this up to 90 kg ha⁻¹ each increase in N level resulted in significant increase in the LAI beyond which was similar. Similarly, at Damaturu, application of N at 90 and 120 kg ha⁻¹ recorded similar plants with higher leaf area index than other treated plants which were at par. The effect of sowing method on the LAI at both locations showed that broadcasting recorded lower LAI while drilling recorded the higher, but at Damaturu it was comparable to dibbling with respect to this parameter.

Effect of nitrogen fertilizer and sowing methods on yield characters of sickle Senna

Table 2 shows the effect of N fertilizer and sowing methods on yield characters of Sickle senna during 2024 at Maiduguri and Damaturu. The effect of treatments on pod length was significant at both locations. Generally, application of N fertilizer at highest rate (120 kg ha⁻¹)

Table 1: Effect of N Fertilizer and Sowing Methods on Growth Characters of *Cassia tora* During 2024 Rainy Season at Maiduguri and Damaturu, Sudan Savanna, Nigeria.

Treatments	Plant Height (cm)		Number of Leaves		Leaf Area Index	
	Maid	Dam	Maid	Dam	Maid	Dam
Nitrogen Fertilizer (N) kg ha ⁻¹						
0	69.77 ^d	62.43 ^d	68.53 ^d	72.53 ^d	0.63 ^c	0.85 ^b
30	87.05 ^c	72.10 ^c	76.03 ^c	84.33 ^c	0.75 ^c	0.89 ^b
60	100.11 ^b	85.20 ^b	89.18 ^b	88.33 ^b	0.91 ^b	1.02 ^b
90	111.02 ^a	87.10 ^b	88.50 ^b	90.33 ^b	1.26 ^a	1.36 ^a
120	114.19 ^a	107.53 ^a	101.51 ^a	96.01 ^a	1.31 ^a	1.47 ^a
SE (±)	3.376	3.026	1.929	1.143	0.049	0.078
Sowing Methods (S)						
Broadcasting	86.23 ^b	91.11 ^b	81.01 ^c	67.49 ^c	0.93 ^c	1.01 ^b
Dibbling	99.17 ^a	102.07 ^a	88.51 ^b	79.86 ^b	1.07 ^b	1.34 ^a
Drilling	105.11 ^a	106.90 ^a	92.87 ^a	90.87 ^a	1.33 ^a	1.43 ^a
SE (±)	2.440	2.237	1.857	1.662	0.047	0.049
Interaction						
N x S	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment column are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT). NS = not significant, Maid = Maiduguri, Dam = Damaturu,

Table 2: Effect of N Fertilizer and Sowing Methods on Yield Characters of Sickie Senna (*Cassia tora*) During 2024 Rainy Season at Maiduguri and Damaturu, Sudan Savanna, Nigeria.

Treatments	Pod Length (cm)		Fresh Leaves Yield (t ha ⁻¹)		Pod Yield (t ha ⁻¹)		Total Yield (t ha ⁻¹)	
	Maid	Dam	Maid	Dam	Maid	Dam	Maid	Dam
Nitrogen Fertilizer (N) kg ha ⁻¹								
0	4.98 ^c	4.78 ^c	4.07 ^c	4.78 ^e	0.37 ^c	0.46 ^c	4.44 ^c	5.25 ^b
30	5.04 ^c	5.00 ^b	4.80 ^{bc}	4.95 ^d	0.46 ^{bc}	0.55 ^{bc}	5.36 ^{bc}	5.34 ^b
60	5.85 ^b	5.00 ^b	5.10 ^b	5.19 ^c	0.52 ^b	0.61 ^b	5.64 ^b	5.51 ^b
90	6.23 ^b	5.22 ^a	5.55 ^b	5.51 ^b	0.65 ^a	0.74 ^a	6.87 ^a	6.64 ^a
120	7.16 ^a	5.24 ^a	6.64 ^a	6.07 ^a	0.77 ^a	0.86 ^a	7.50 ^a	6.72 ^a
SE (±)	0.133	0.106	0.312	0.043	0.041	0.040	0.024	0.207
Sowing Methods (S)								
Broadcasting	5.19 ^b	4.37 ^c	4.91 ^b	5.11 ^b	0.58 ^c	0.49 ^c	5.49 ^c	5.60 ^c
Dibbling	5.37 ^{ab}	4.75 ^b	5.57 ^a	5.72 ^a	0.65 ^b	0.64 ^b	6.22 ^b	6.36 ^a
Drilling	5.57 ^a	5.64 ^a	5.71 ^a	5.69 ^a	0.74 ^a	0.72 ^a	6.45 ^a	6.41 ^a
SE (±)	0.123	0.109	0.177	0.103	0.017	0.015	0.074	0.072
Interaction								
N x S	*	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a treatment column are not significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT). NS = not significant, * = significant, Maid = Maiduguri, Dam = Damaturu.

recorded longer pods while shorter pods were recorded at the untreated control. However, at Damaturu, pod length recorded at 90 kg ha⁻¹ was comparable to 120 kg ha⁻¹. For the sowing methods, at both locations, drilling recorded longer pods while the shorter pods were recorded at the broadcasting method.

Interaction between N fertilizer and sowing methods on pod length of Sickie senna was significant at Maiduguri being presented in Table 3. The result showed that the longest pods were recorded at the drilling method on application of N at 120 kg ha⁻¹. This was comparable to application of N at 90 and 120 kg ha⁻¹ irrespective of the sowing methods used while shorter pods were recorded at the control at any of the sowing method used.

Within the same vein the effect of N and sowing methods on fresh leaves yield was significant (Table 2). The result at Maiduguri showed that increase in N up to 60 kg ha⁻¹ resulted in significantly higher fresh leaves yield than the control. Further increase to 90 kg ha⁻¹ has no significant effect on this character beyond which recorded higher

fresh leaves yield. However, at Damaturu each increase in N fertilizer rates from the control up to the highest rate resulted in significant increase in this character. The result on the sowing methods showed that dibbling and drilling recorded similar and higher fresh leaves yield than broadcasting method.

The results further showed that the effect of N fertilizer and sowing methods on pod yield per hectare were significant at both locations. Generally, similar and higher pod yield were recorded on application of N at 90 and 120 kg ha⁻¹ while lower yield was recorded at the control. Similarly, for the sowing methods, drilling recorded significantly higher pod yield while broadcasting recorded the lower pod yield.

Furthermore, the effect of treatments on total yield was significant at both locations. Generally, the control was comparable to application of N at 30 kg ha⁻¹ while at Damaturu it was also at par to application of N at 60 kg ha⁻¹. However, at both locations application of N at 90 and 120 kg ha⁻¹ recorded similar and higher total yield compared to

Table 3: Interaction between Fertilizer (N) and Sowing Methods on Pod Length of Sickle Senna (*Cassia tora*) During 2024 Rainy Season at Maiduguri, Sudan Savanna, Nigeria..

Treatments	Fertilizer (N) kg ha ⁻¹				
	0	30	60	90	120
Sowing Methods (S)					
Broadcasting	4.44 ^{ef}	5.98 ^{cd}	6.50 ^{bcd}	7.11 ^{abc}	7.30 ^{ab}
Dibbling	4.74 ^{ef}	6.81 ^{bcd}	6.81 ^{bcd}	7.30 ^{ab}	7.32 ^{ab}
Drilling	4.85 ^{ef}	6.91 ^{bcd}	6.59 ^{bcd}	7.36 ^{ab}	8.07 ^a
S.E (±)		0.333			

Means followed by the same letter(s) within and across column are not significantly different at 5% level of significance using DMRT.

other treated levels. The sowing methods showed that dibbling has significant edge over others but at Damaturu, dibbling and drilling were comparable but recorded higher total yield than broadcasting method. There was no significant interaction between the treatments observed (Table 3).

DISCUSSION

Effect of nitrogen fertilizer on growth and yield characters of sickle Senna

The results of this trial have shown that Sickie senna responded positively to N fertilizer. The effects of N fertilizer on the growth and yield characters of Sickie senna observed in this study indicated the critical role of N fertilization in enhancing plant performance. Failure of some untreated plants to achieve significant growth metrics indicated that nutrient deficiency might have limited their growth. According to Clement *et al.* (2021) nutrient deficiency can hinder metabolic processes necessary for optimal plant development and yield.

The application of N fertilizer significantly increased plant height at both locations. Treated plants with N fertilizer consistently recorded taller heights compared to the control, with the highest rate of 120 kg ha⁻¹ producing the tallest plants. This finding aligns with the report of Havlin *et al.* (2014), who reported that N significantly enhanced vegetative growth in plants.

The number of leaves was also significantly influenced by N fertilizer application. Treated plants exhibited a progressive increase in leaf number with higher fertilizer rate of 120 kg ha⁻¹ producing the highest number of leaves across the locations. This corroborates with previous studies indicating that sufficient nutrients availability promotes photosynthetic efficiency and leaf development (Williams *et al.*, 2019).

The LAI followed a similar trend, with significant differences observed among treatments. The control and the lower rates of N fertilizer recorded the lowest LAI values while the highest values were observed at 90 and 120 kg ha⁻¹. This indicates that higher N fertilizer rate improved the efficiency of light interception, which is crucial for biomass accumulation and yield.

The yield characters evaluated (Pod length, leaves yield

per hectare, pod yield per hectare, and total yield per hectare) also showed significant improvements with increased fertilizer application. The 120 kg ha⁻¹ rate recorded the highest values for these characters, although the application of 90 kg ha⁻¹ was comparable to 120 kg ha⁻¹ for pod yield and total yield. This indicated that while higher rates of N fertilizer enhanced vegetative yield, applications beyond 90 kg ha⁻¹ may not enhance pod yield. This corroborated Sharma *et al.* (2020) that N fertilizer encouraged vegetative growth in crops. The results of this study, therefore, highlighted the significant impact of N fertilizer on the growth and yield of Sickie senna.

Effect of sowing methods on growth and yield characters of sickle Senna

The effect of sowing methods on growth and yield characters of Sickie senna was significant in this experiment. All the characters observed were affected but mostly in favour of drilling method, although dibbling and drilling methods recorded similar but taller plants and higher leaves yield compared to broadcasting. This might be due to the advantages enjoyed by drilling method such as uniform germinations; better light interception for photosynthesis and transportation of assimilates for dry matter production and consequently yield. It had been reported that drilling method was the best sowing method of planting smaller seed cops and vegetables such as *Cassia tora* (Chhokar *et al.*, 2017).

Conclusion

The findings from this experiment indicated that N fertilizer application has a significant positive effect on the growth and yield of Sickie senna in the Sudan Savanna. The application of N fertilizer at 90 and 120 kg ha⁻¹ were mostly comparable and resulted in higher growth and yield characters evaluated. Similarly, drilling sowing method which was comparable to dibbling for some characters observed had significant edge over the sowing methods used in the experiment. Therefore, based on the results of these trials it could be concluded that application of N fertilizer at 90 kg ha⁻¹ and drilling sowing method which gave higher growth and yield characters and is being recommended for optimum Sickie senna production in the Sudan Savanna ecological zone of Nigeria.

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