

Morphological Characteristics of Vegetative and Reproductive Growth of *Senna sophera* (L.) Roxb. (Caesalpiniaceae)

M.A.A. Nassar, H.R.H. Ramadan and H.M.S. Ibrahim

Department of Agricultural Botany, Faculty of Agriculture, Cairo University, Giza, Egypt

Abstract: In this study, morphological information is produced as evidence for proper delimitation of *Senna sophera* (L.) Roxb. taxonomy. The field work was carried out during the growing season of 2008 in order to follow up the morphology of vegetative and reproductive growth of studied species throughout the successive stages of its entire life span. Germination of seeds and yield components at harvest time were also taken in consideration. Such knowledge may fulfill information acquisition in this concern. The morphology of vegetative growth includes: plant height, length and diameter of the main stem, number of internodes of the main stem, number of primary branches developed on the main stem, lengths of primary branches at maturity, fresh weight of leafless shoot per plant, total number of leaves per plant, total leaf area per plant and fresh weight of leaves per plant. Moreover, keen observations and descriptive morphology of the root and the shoot were under consideration. The morphology of reproductive growth includes: flower bud differentiation, full blooming, fruit set and maturity. In addition, the yield characters at harvest time were investigated; i.e., number of matured dry pods per plant, number of seeds per pod, number of seeds per plant, yield of matured dry seeds per plant and specific weight of seeds.

Key words: *Senna sophera* • Caesalpiniaceae • Morphology • Vegetative growth • Reproductive growth

INTRODUCTION

Senna sophera (L.) Roxb.; commonly known as Algarrobilla, Sickie Cassia and Pepper-leave Senna is typically a shrub or a sub shrub, native to Tropical America, spreading throughout the world tropics. *S. sophera* is widely grown as an ornamental. As for the medicinal uses, *S. sophera* has been reported to contain anthraquinones, including chrysophanol and emodin, a leaf infusion is drunk to treat fever and malaria, extracts of all plant parts are used to treat epilepsy, the seeds are used to treat fever. It is also employed as an expectorant and as a remedy for rheumatic and inflammatory fevers. In addition to these applications, the leaves are used for wound healing and as an antipyretic. *S. sophera* is used also as a pesticide; powdered dry leaves are traditionally used to control insect pests of stored grain and pulses. The seeds and roasted leaves serve as a coffee substitute [1]. Bilal *et al.* [2] recorded that *Cassia sophera* L. is an important drug of Islamic System of Medicine (Unani Medicine). According to the

physicians of Unani medicine, three plants viz., *Cassia occidentalis* L., *Cassia sophera* L. and *Cassia sophora* L. var. *purpurea*, Roxb. are varieties of "Kasondi" and are invariably used in similar pathological conditions. "Kasondi" is described in Unani literature to be repulsive of morbid humours (specially phlegm) resolvent, blood purifier, carminative, purgative, digestive, diaphoretic and reported to be useful in epilepsy, ascites, dyscrasia of liver, skin disorders, piles, jaundice, fever, articular pain and palpitation. In ethno botanical literature it is mentioned to be effective in the treatment of pityriasis, psoriasis, asthma, acute bronchitis, cough, diabetes and convulsions of children.

Considering the morphological characteristics of *S. sophera*, only few records were observed [1,3-5] Therefore, the pinpoint objective of the present investigation was to start a phytochemistry study of *S. sophera* including various botanical attributes under local conditions to get a better insight on morphology of this important economic plant species throughout the consecutive periods of its entire life span.

MATERIALS AND METHODS

The present investigation was conducted in the wire green-house of Agricultural Botany Department, Faculty of Agriculture, Cairo University, Giza, Egypt during the growing season of 2008 in order to introduce a phytography study including morphology of vegetative and reproductive growth of *Senna sophora* (L.) Roxb. (Pepper-leaved Senna).

Seeds of Pepper-leaved Senna were obtained from El-Orman Botanic Garden, Ministry of Agriculture, Giza, Egypt. Treatment of seeds by boiling water and then soaking in tap water for 12 hours before sowing was found the best method to soften the testa and facilitate germination. Seeds were then sown on fourteenth March, 2008 to provide the experimental plant materials.

The experiment included three replicates; each was represented by one plot. The plot was 3x3 m, 5 ridges 60 cm apart. Seeds were sown in hills spaced 30 cm. After one month from sowing date, the plants were thinned to one plant per hill. All field practices were carried out as recommended for such plant in the vicinity.

Recording of Data

Seed Germination and Seedling Growth: For this purpose, a pot experiment was carried out. Seeds were sown in pots (5 cm diameter) filled with light loamy soil. Seedlings were taken out daily for morphological investigations up to the end of the seedling stage (14 days).

Morphological Investigations: The field experiment was carried out for this purpose. Nine plants, three plants from each of the three replicates, were assigned at four-week intervals to follow up the morphology of vegetative and reproductive growth of Pepper-leaved Senna. At each sampling date, the root and the shoot systems were described morphologically. The branching system of the shoot was followed up to determine the plant habit of growth. Time taken for different reproductive developmental stages was recorded including flowering period (onset and end of flowering dates), fruit set and fruit maturity. The inflorescences were studied as to their external morphology and sites of their differentiation. In addition, the following characters were recorded monthly.

- Plant height (cm), measured from the cotyledonary node up to the uppermost point of the plant.
- Main stem length (cm), measured from the cotyledonary node up to the shoot apex.

- Diameter of the main stem (mm) at its median portion by means of a clipper.
- Number of internodes of the main stem.
- Number of primary branches developed on the main stem.
- Lengths of primary branches at the age of 24 weeks (full fruiting stage).
- Fresh weight of the leafless shoot (g) per plant.
- Number of leaves per plant.
- Total leaf area (cm²) per plant using leaf area meter.
- Fresh weight of leaves per plant (g).
- Yield characters at harvest time including:
 - Average number of pods per plant.
 - Average number of seeds per pod.
 - Average number of seeds per plant.
- Specific weight of seeds (weight of 1000 seeds in grams)
- Yield of seeds (g) per plant.

Statistical Analysis: Data were subjected to conventional methods of analysis of variance according to Snedecor and Cochran [6]. Computer designed software (Microsoft Office Excel 2007) was used.

RESULTS AND DISCUSSION

Germination of Seeds and Seedling Growth: Germination starts when the seed absorbs soil water by imbibition. Consequently, the seed testa softens, swells and ruptures. This leads to the emergence of the radicle through the seed coat. This occurs after 48 hours of sowing. Seed germination of Pepper-leaved Senna is epigeal where; the hypocotyl elongates and raises the two cotyledons above the ground together with the enveloping remains of the seed. Cotyledons are dark green in colour and almost square-shaped. The hypocotyl is curved inside the soil then straightens as it is raised above the ground. This takes place almost a week after seed sowing. By then, the plumule develops upwards and the secondary roots start to develop.

Seedling stage comes to an end at the age of 14 days. By then, the first foliage leaf is formed (Fig. 1). The first foliage leaf is paripinnately compound and dark green in colour with two pairs of ovate leaflets. The radicle averages 4.5 cm. and the hypocotyl is some 3 cm. long.

External Morphology of the Root System: The tap root of Pepper-leaved Senna develops directly below the hypocotyl. During early stages of growth, the root and hypocotyl are almost similar in thickness. As growth advances, the root increases in thickness and becomes



Fig. 1: A photograph of *S. sophora* seedling, two weeks old, showing its epigeal pattern of growth where the two cotyledons are brought above the soil. The first foliage leaf is developed; it is paripinnately compound with two pairs of ovate leaflets

tapered towards its apex. Lateral roots develop acropetally towards the apex and extends horizontally in the soil. At advanced stages of growth, the root system is completely developed, mainly composed of a stout tap root developing a few number of lateral roots, strongly established in a semi-horizontal position.

As it is difficult to get intact root samples due to their rupture when pulled out, no measurements could be taken for the root system

External Morphology of the Shoot System

Keen Observations on Shoot Development: By the end of the seedling stage (two weeks old), the plumule starts a consistent development to produce the shoot. At four weeks old, stem erect, 3 to 4 internodes are developed; plant height is about 10.2 cm. About 4 to 6 foliage leaves are developed. Leaves are alternate and paripinnately compound. Leaflets in each of the first two leaves are found in 2 pairs and then in 3 pairs, lanceolate in shape.

At 8 weeks of age, plant height reaches 51.7 cm. Total internodes of the main stem about 12 in number and 46.7 cm long. Number of compound leaves ranges from 11 to 15; the newly developed leaves are paripinnately compound with 6 lanceolate leaflets.

When plants are 12 weeks old, plant height is about 113.3 cm, stem reaches to 106.8 cm. in length and to 9.1 mm in diameter at its median portion. Numbers of internodes of the main stem ranges from 18 to 25. Primary

branching starts, about 4 to 9 in number develop on the main stem. First branch is developed on the sixth node. Total number of leaves ranges between 41 and 62. The number of the leaflets developed on the compound leaf increases from base of plant to top from 8-12-16 lanceolate leaflets.

At 16 weeks of age, plant height reaches to 164.9 cm. Main stem is about 154.7 cm in length and 11.7 mm in diameter. Total internodes of the main stem ranges from 32 to 40. Number of developing branches on the main stem ranges from 11 to 18. Total number of leaves per plant ranges from 113 to 141 with 14-16-18-20-22 lanceolate leaflets increases from base to top of plant.

When plants are 20 weeks old, plant height is about 223.8 cm. Number of internodes of the main stem ranges from 45 to 60. Main stem is about 213.9 cm long and 15.4 mm in diameter. Number of developing branches on the main stem ranges from 19 to 25. Total number of paripinnately compound leaves per plant ranges from 117 to 225 with now-constant number of leaflets, being 22. At the end of this age, flowering stage starts.

Full blooming and start of fruit formation takes place at the age of 24 weeks. Flowers are bright yellow, few, in short axillary racemes in the axils of uppermost leaves on the main stem and branches. At this age, the plant almost attains its maximum height (about 241.3 cm). The main stem reaches 225.2 cm in length and 18.6 mm in diameter at its median portion. Number of internodes of the main stem ranges from 48 to 61. Number of developing branches on the main stem reaches its maximum, being 26. Total number of paripinnately compound leaves per plant ranges from 191 to 253.

At the age of 28 weeks, plants are in full fruiting stage. Growth starts to slow down towards the end of the season. Plant height is almost indifferent with that of the previous age (237.9 cm). The same applies to main stem length (226.5 cm), diameter (19.1 mm), number of internodes (47 to 62), number of branches (26) and total number of leaves (186 to 262) where, all values are insignificant with those recorded at the age of 24 weeks. Harvest took place at the end of the 8th month.

Pepper-leaved Senna is an erect, short-lived perennial shrub, about 1-3 m high with striate branches. Leaves are paripinnately compound, leaflets are in 6-9 (-12) pairs, ovate-oblong, elliptic or lanceolate. Petiole is about 3.5-5 cm long, with narrow, acutely clavate purplish gland on the upper surface near the point of insertion on the stem. Flowers are bright yellow, few in very short axillary racemes in the axils of the uppermost leaves of the main stem and branches.

Table 1: The periodic growth and statistical parameters of vegetative characters of *S. sophora* throughout the growing season

Plant age in weeks	Plant height (cm)	Length of the main stem (cm)	Diameter of the main stem (mm)	No. of internodes of the main stem	No. of primary branches on the main stem	Fresh weight of leafless shoot (g) per plant	Total number of leaves per plant	Total leaf area (cm ²) per plant	Fresh weight of leaves (g) per plant
4	10.2±1.00E	8.5±0.76E	—	3.3±0.33E	—	1.06±0.21E	4.7±0.33E	158±11.2E	1.78±0.13E
8	51.7±4.4D	46.7±3.91D	6.2±0.53E	12.3±0.84D	—	15.73±0.98E	13.3±1.17E	624±44.9E	19.35±2.15E
12	113.3±7.3C	106.8±6.29C	9.1±0.62D	22.9±1.57C	6.7±0.92C	69.15±3.04D	49.7±3.28D	7503±395.2D	103.65±11.73D
16	164.9±8.7 B	154.7±7.66B	11.7±0.75C	36.7±1.94B	14.3±1.57B	183.27±8.16C	127.4±3.92C	20256±803.1C	262.51±27.09C
20	223.8±10.2A	213.9±8.49A	15.4±0.88B	55.3±2.77A	23.3±2.14A	459.18±19.74B	198.2±8.31B	32445±1259.3B	413.78±38.46B
24	241.3±9.9A	225.2±9.27A	18.6±0.22A	56.9±3.21A	24.7±1.98A	582.73±23.86A	237.6±11.74A	39679±1861.6A	510.49±41.82A
28	237.9±10.6A	226.5±8.84A	19.1±1.34A	56.3±3.28A	24.0±1.73A	446.26±22.15B	221.9±9.68AB	37057±1516.5A	465.26±35.39A
L.S.D. (0.05)	22.81cm	19.36 cm	2.4mm	5.21 Internodes	3.22 Branches	47.59 g	32.6 Leaves	3274 cm ²	47.25 g

Means having the same letter are not significantly different at 0.05 level

The morphological description previously given for shoot of Pepper-leaved Senna plant is generally in accordance with that recorded by Bosch [1], Townsend and Guest [3], Egziabher *et al.* [4] and Ibrahim [5] on *Senna sophora* (L.) Roxb.

Morphology of Vegetative Growth

Plant Height: It is clear from Table 1 that the plant height increased consistently during the entire life span of the plant. The maximum height was recorded at the age of 24 weeks (241.3 cm), which in turn being statistically indifferent with the height recorded at the age of 20 weeks (223.8 cm). No further increment was recorded till the end of the growing season (the age of 28 weeks). This means that Pepper-leaved Senna plant attains its maximum height at the age of 20 weeks.

It is obvious that the elongation of plant continued at almost a uniform rate throughout the consecutive periods. However, the elongation of plant was much higher in the periods from 12 to 16 weeks and from 16 to 20 weeks old. Through these two periods the plant height reached 89.6, 147.4 and 216.7 cm at 12, 16 and 20 weeks; respectively. The most active period of elongation occurred through flowering stage which starts at plant age of 16 weeks and continued till plant age of 20 weeks, through this period the plant height increased from 147.4 to 216.7 cm. Such increment (69.3 cm) represents 30.3% of the final plant height (228.5 cm).

The Stem

Length of the Main Stem: It is realized from Table 1 that a significant increment in length of the main stem occurred from the age of 4 weeks till the age of 20 weeks where the average length was 213.9 cm. The maximum length was achieved at the age of 24 weeks (225.2 cm), which in turn being statistically indifferent with the length that was recorded at the age of 20 weeks. No further increment was recorded till the end of the growing season. Worthy to note that the period of 16 to 20 weeks old was the most effective one throughout the entire growing season, since

the length of the main stem increased from 154.4 to 213.9 cm. Such increment (59.5 cm), which was added during such period of plant growth, represented 26.3% of the final length of the main stem (226.5 cm).

Diameter of the Main Stem: Data presented in Table 1 reveal that a significant increment in diameter continued during most of the entire life span of the plant at almost a uniform rate throughout consecutive periods. The maximum diameter was recorded at the age of 28 weeks (19.1 mm), which being statistically indifferent with the diameter recorded at the age of 24 weeks (18.6 mm).

This means that no further increment was recorded till the end of the growing season and main stem of Pepper-leaved Senna plant attains its maximum diameter at the age of 28 weeks. Worthy to note that the period of 16 to 20 weeks was the most active one throughout the entire growing season, since the diameter of the main stem increased from 11.7 to 15.4 mm. Such increment (3.7 mm) which was added during this period represented 19.4 % of the final diameter of the main stem (19.1 mm).

Number of Internodes of the Main Stem: Results in Table 1 indicate that a significant increment in number of internodes of the main stem of Pepper-leaved Senna plant occurred from the age of 4 weeks till the age of 20 weeks where the average number of internodes was 55.3. The maximum number was detected at the age of 24 weeks being 56.9 internodes, which in turn being statistically indifferent with the number that was recorded at the age of 20 weeks. No further increase in number of internodes was recorded till the end of the growing season.

Worthy to note that the growth rate in number of internodes of the main stem conformed to those of plant height and main stem length, previously mentioned. It was found that no substantial increase in these characters was recorded after the age of 20 weeks. This proved the determinate pattern of growth in the main stem of Pepper-leaved Senna plant.

Number of Primary Branches: Up to the age of 12 weeks, Pepper-leaved Senna plant formed 6.7 primary branches. This number was almost doubled throughout the following period; i.e., the age of 16 weeks recording 14.3 primary branches. At the age of 20 weeks, the number increased significantly reaching 23.3 branches. No substantial increment was achieved after this sampling date (20 weeks old); i.e., the developing primary branches were the same till the end of the growing season (Table 1). Worthy to state that lateral branches play a vital role in yield production, where any of the primary branches bears from 3 to 4 secondary order ones.

Length of Primary Branches: Data pertaining to length of primary branches of Pepper-leaved Senna plant towards the end of growing season (24 weeks old) are illustrated histogrammatically in Fig. 2. Lateral shoot of Pepper-leaved Senna plant developed in acropetal succession; i.e., from the base towards the apex. The lengths of primary branches don't follow a fixed trend; i.e. lengths vary from base to top. The longest of branches reaches about 102 cm.

Fresh Weight of Leafless Shoot: It is clear from Table 1 that the average fresh weight of the leafless shoot was small till age of 8 weeks, being 15.73 g. Thereafter, a gradual significant increase in fresh weight was observed till the age of 24 weeks where the fresh weight of the leafless shoot reaching the maximum, being 582.73 g. However, the fresh weight was decreased significantly at the age of 28 weeks, being 446.26 g due to the obvious slow-down in growth towards the end of the growing season.

Worthy to note that the fresh weight of the leafless shoot increased noticeably during the period of 16 to 20 weeks, where the weight increased from 183.27 to 459.18 g. Such increment (275.91 g) represented 61.8 % of the final weight (446.26 g).

The Leaf: Leaves are paripinnately compound, alternate, petiolate (Fig. 3). Rachis is 10-15 cm. long. Petiole is about 3.5-5 cm long with a narrow, acutely clavate purplish gland on the upper surface near the point of insertion on the stem (Fig. 4). Leaflets are in 8-11 pairs, ovate-oblong, elliptic or lanceolate, broadest at or below the middle, acute at the apex. Midrib prominent beneath, pale, secondary venation fine, margins pilose particularly in the lower half, midrib glabrous or sparsely hairy beneath, lower leaf surface glabrous, glaucous; petiolules are very short, 1-2 mm long.

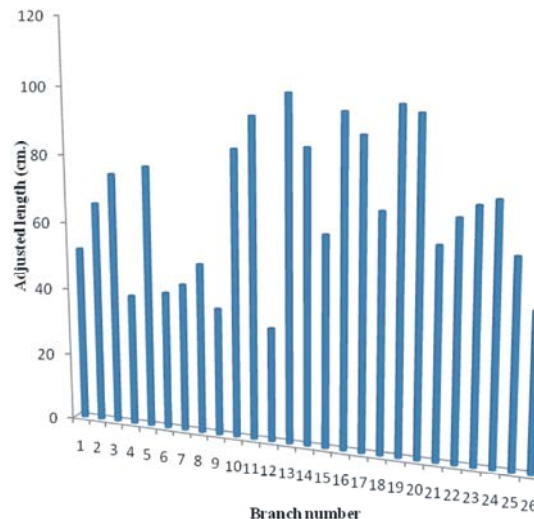


Fig. 2: Histogramme representing length of primary branches of *S. sophora* at the age of 24 weeks



Fig. 3: A photograph represents a well developed paripinnately compound leaf of *S. sophora*; the leaf comprised 11 pairs of lanceolate leaflets



Fig. 4: A photograph showing a large sessile clavate purplish gland on the upper surface of the petiole near its base

The above mentioned description is in accordance with that reported by Bosch [1], Townsend and Guest [3], Egziabher *et al.* [4] and Ibrahim [5].

Number of Leaves / Plant: Data presented in Table 1 clearly show a significant increase in number of leaves per Pepper-leaved Senna plant occurred from the age of 8 weeks till the age of 24 weeks where the average number of leaves per plant was 237.6. This value represents the maximum number of leaves recorded during the growing season, which statistically does not differ from that recorded at the age of 28 weeks (221.9 leaves). At this age, the number of leaves is decreased slightly due to the general slow-down in growth towards the end of the growing season. The value recorded at 28 weeks of age (221.9 leaves) is statistically indifferent with that recorded at the age of 20 weeks (198.2 leaves); i.e., during the peak of growth.

Worthy to note that the growth rate in number of leaves/plant was much higher in the periods from 12 to 16 weeks and from 16 to 20 weeks. Through these two periods the number of leaves per plant reached 49.7, 127.4 and 198.2 leaves at 12, 16 and 20 weeks; respectively. The most active period occurred through flowering stage which started at plant age of 16 weeks and continued till plant age of 20 weeks, through this period the plant reached its maximum height and developed all secondary branches as well as the number of leaves/ plant increased from 127.4 to 198.2. Such increment (70.8 leaves) represented 31.9 % of the maximum number of leaves developed per plant of Pepper-leaved Senna (221.9 leaves).

Leaf Area per Plant: Total leaf area per plant increased slightly from sowing date up to the age of 8 weeks. Values obtained were statistically indifferent, reaching 624 cm². As plants were 12 weeks old, a significant enhancement was achieved in this concern. Total leaf area was 7503 cm². A steady increase continued throughout the following periods reaching a maximum of 39679 cm² at 24 weeks old. Then a slight decrease in total leaf area was observed in the following period (37057 cm²); i.e., at the end of the growing season (28 weeks old) due to the normal slow-down in growth and defoliation of the oldest leaves (Table 1).

Fresh Weight of Leaves/Plant: The growth pattern of leaves fresh weight per plant, as is expected, followed an identical manner to that of number of leaves as well as to

that of total leaf area given earlier (Table 1). Fresh weight of leaves per plant increased slightly from sowing date up to the age of 8 weeks. Values obtained were statistically indifferent, reaching 19.35 g. As plants were 12 weeks old, a significant increase was observed in this concern. Leaves fresh weight was 103.65 g. A steady increase continued throughout the following periods reaching a maximum of 510.49 g at 24 weeks old. Then a slight decrease in fresh weight of leaves per plant was recorded in the following period (465.26 g); i.e., at the age of 28 weeks due to the normal defoliation of the oldest leaves.

Morphology of Reproductive Growth

The Inflorescence and Flower: Formation of inflorescences started on August 20th during the year 2008. Plants were 20 weeks old. Full blooming and beginning of fruit setting took place at the age of 22 weeks.

Racemes corymbose (Fig. 5), 4-10 flowered, very short, almost umbellate, in the axils of the upper leaves; peduncle thinly hairy, 0.5-1.5 cm; flowers yellow, on 1-2 cm pubescent pedicels.

Flowers (Fig. 5 and 6), bright yellow in color, perfect, bisexual, pedicelled (1.0-1.8 cm long), nearly perigenous and irregular. Bracts green ovate, acute, 0.4-0.7 cm. long, pubescent, early caducous. Calyx of 5 sepals, free, descending imbricate aestivation, obovate, pale green, glabrous, blunt, about 0.3-1.0 cm long and 0.4-0.6 cm wide. Corolla of 5 petals, free, aestivation ascending imbricate, obovate to suborbicular, bright yellow, glabrous, about 1.2-2.0 cm long and 0.7-2.0 cm wide. Androecium composed of 10 stamens in two whorls; each of 5, free and some of the anthers abortive. Anthers unequal, basifixed and dehiscent by two terminal pores. Fertile stamens are six. The one lowest (anterior) stamen included with short filament and with small basifixed straight thinner anther, it is flanked by the two largest stamens (0.8-1.4 cm long) which are prominent on the lower side of the flower, as long as petals and with large slightly curved anthers. The four median stamens which occupy the centre of the flower are included and with filaments (0.3 cm long) and basifixed straight anthers (0.5 cm long). The remaining three upper (posterior) are staminodes with filaments (0.2cm long) and poorly developed anthers. Gynoecium is monocarpellary (simple pistil); ovary stipitate, flattened straight, pubescent, unilocular with numerous ovules. Style is short (0.3 cm long), glabrous, terete, incurved. Stigma is small and terminal. Placentation is marginal.



Fig. 5: A photograph showing the paripinnately compound leaves and the inflorescence of *S. sophera*



Fig. 8: A photograph showing mature seeds of *S. sophera*

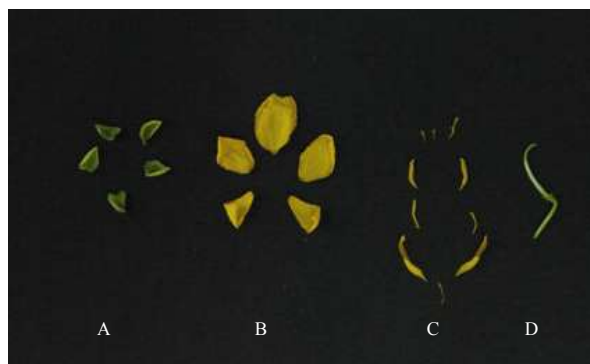


Fig. 6: A photograph showing the floral whorls of *S. sophera*
A, sepals; B, petals; C, stamens; D, carpel



Fig. 7: A photograph showing mature pod of *S. Sophera*

Table 2: Yield characters of *S. sophera* plant at harvest time, plants aged 28 weeks

Characters	Range	Mean \pm S.E.
Number of pods/plant	85 \square 216	142.40 \pm 9.5
Number of seeds/pod	29 \square 53	40.60 \pm 2.7
Number of seeds/ plant	4205 \square 6564	5371.00 \pm 279
Weight of 1000 seeds (g)	21.25 \square 22.28	21.71 \pm 0.5
Yield of seeds (g) /plant	93.7 \square 139.5	116.60 \pm 11.7

Floral formula: $\% \sigma^{\circ} \text{K}_5 \text{C}_5 \text{A}_{(3+4+3)} \text{G}_1 \text{Marginal}$

The aforementioned characters of Pepper-leaved Senna inflorescence and flower are in conformity with those described by Bosch [1], Townsend and Guest [3], Egziabher *et al.* [4] and Ibrahim [5].

The Fruit and the Seed: Full blooming of *S. sophera* occurred as the plants were 22 weeks old. In the meantime fruit setting started. Fruit (Fig. 7) is a legume, green in color, turns into brown with light brown edges when mature, simple, straight, linear, oblong, cylindrical or sub-cylindrical, about 5-20 cm long and 0.5-0.7 cm wide, late dehiscent along the ventral and dorsal suture, glabrous, coriaceous, containing numerous seeds and portioned crosswise. Seeds (Fig. 8), many, oblong-ovoid or roundish, transversely arranged, compressed to subtrigonal, dull mid-brown, 0.4-0.6 cm long and 0.3-0.4 cm, wide with an elliptic areole on each face, the endosperm copious, about 30-50 seeds per pod.

The previously mentioned characters of Pepper-leaved Senna fruit and seeds are in harmony with those given by Bosch [1], Townsend and Guest [3], Egziabher *et al.* [4] and Ibrahim [5].

Yield Characters: Results of yield characters of Pepper-leaved Senna at harvest time, the age of 28 weeks, are

given in Table 2. Average number of pods per plant was 142.4, average number of seeds per pod was 40.6 and average number of seeds per plant was 5371 which yielded 116.6 g where the average weight of 1000 seeds was 21.71 g.

REFERENCES

1. Bosch, C.H., 2007. *Senna sophera* (L.) Roxb. Plant Resources of Tropical Africa Database, Schmelzer GH and Gurib-Fakim A (Eds). PROTA, Wageningen, Netherlands.
2. Ahamad, B., A.K. Naeem, A. Ghufra and I. Inamuddin, 2005. Pharmacological investigation of *Cassia sophera*, Linn. var. *purpurea*, Roxb. Medical Journal of Islamic World Academy of Science, 15: 105-109.
3. Townsend, C.C. and E. Guest, 1974. Flora of Iraq. Republic of Iraq, Ministry of Agriculture and Agrarian Reform, 3: 10-21.
4. Egziabher, T.B.G., O. Hedberg, M. Tadesse, I. Frils, I. Hedberg and S. Edwards, 1989. Flora of Ethiopia, Vol. 3. Institute of Botany, Uppsala University, Addis Ababa and Asmara, Ethiopia and Uppsala, Sweden, pp: 49-63.
5. Ibrahim, N.M.F.A., 1998. Physiological and Cytological Criteria for Classification of Some Taxa of Genus *Cassia*. M.Sc. Thesis, Botany Dept., Fac. Sci., Zagazig Univ., pp: 101.
6. Snedecor, G.W. and W.G. Cochran, 1989. Statistical Methods. State University Press, 8th Ed., USA, pp: 1-491.