

Phenological Studies of Two Varieties of *Hibiscus cannabinus* Linn in Ile-Ife, South West, Nigeria

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Abstract

The phenological study of the flowering, fruiting, foliage and girth changes in two varieties of *Hibiscus cannabinus* L. with the aim of relating these stages to their different morphological characters. Seeds of the varieties identified as variety A and variety B were planted in different petridishes, they were later thinned down to five stands and finally planted in medium sized buckets. The time, duration and frequency of leafing, flowering, fruiting, were tracked weekly from the germination period until maturity. The two varieties are different in phenology and can be cultivated for different purposes; the different morphological characters might be under endogenous control. Leaf production is more rapid in Variety B than in variety A hence variety B is recommended for cultivation where numerous, broad and matured leaves are needed. The cultivation of variety B that flowers almost every day of the week is recommended for farmers who wish to make use of the flower and/or fruit production of the plant. Variety A is encouraged for people who need the purple dye for beautifying faces.

Keywords: Phenology, Hibiscus, flowering, fruiting, foliage, girth.

1. Introduction

The Genus, *Hibiscus* belongs to the family Malvaceae and consists of up to 300 species. The genus includes both annual and perennial herbaceous plants, including woody shrubs and small trees. Hibiscus which is certainly the most variable genus in the family with respect to its vegetative and floral expressions is composed mostly of tropical herbs, shrubs, and trees (Copley, L.S, 1975). They can be found growing in the admixture of humus and sandy soils. The plants are erect, procumbent or decumbent in habit. They are found on farmlands, rocky ground, and coastal regions, along roadsides and in the gardens as horticultural plants (Lebler, 1973).

Regarding its vegetative character, the leaves are alternate, simple, and ovate to lanceolate, often with a toothed or lobed margin. Stipulates are present; the stem contains mucous canals and often also mucous cavities. Hairs are common and are not most typically stellate. The flowers are large, conspicuous, trumpet-shaped, with five or more petal, ranging from white to pink, red, purple or yellow in colour, and form 4-15cm broad. Flowers are commonly borne in definite axillary inflorescences, which are often reduced to single flowers. The flowers often bear supernumerary bracts. They can be unisexual or bisexual and are generally actinomorphic, often associated with conspicuous bracts, forming an epicalyx. The fruit of Malvaceae is a dry five lobed capsule, a schizocarp or nut containing several seeds in each lobe, which are released when the capsule splits open at maturity. The seeds may be hairy as in *Gossypium* cotton, rounded as in *Hibiscus*, flat or even a berry as in *Malvaviscus* sp. (Schippers R.R., 2000).

Hibiscus cannabinus is a plant with a straight, slender stem to nearly 3m high (Schippers R.R., 2000). In Nigeria, it comes only second to the baobab (*Adansonia digitata* Linn, Bombacaceae) in the provision of cordage and raw materials for beautifying faces. The species is very variable and a number of cultivars are recognized in the colour (black, red or green), height and thickness of the stem, on leaf form, flower colour, vigour of growth and time to maturation, and adaptability to edaphic and climatic factor. Green stem forms are said to be best. Crop maturation period is variable; normally it is 4-5 months. In Sierra Leone one cultivar is grown as a 7-8 months crop with upland rice. Different period are reflected in Nigeria in cultivar names some being ready during the hot season, another being the last and final crop to harvest. Sowing of seed is usually close so that the plant grow straight upright without branching. Harvesting is normally carried out when the plant is in bud. Quality of the fibres is affected if the plant is delayed but even this, one cannot be emphatic and the optimum date needs to be determined by trial. The stems are cut at the base and the tops lopped off. The bark is then peeled. Barks from 50 plants constitute a unit of merchandise in market trade in northern part of Nigeria having a special Hausa name. Stems are retted in either running or stagnant water, the length of time being variable within 5-22 days according to crop maturity. Temperature and the sort of microorganism active in the retting process but it has to be correctly gauged as underretting result in difficulty in removing fibres from the bark, and overretting weakens the fibres. A satisfactory procedure in Sierra Leone appears to be sun drying the stem, then soaking for 2-3 days in water after the fibre peels. Good quality fibre is coarse and less supple than jute but it has more tenacity and luster and is more resistant. In some respect it is more suitable for cordage than for textile, but if well grown it

can substitute jute for any purpose (Mann et al., 2003).

Species of *Hibiscus* are very useful economically. The outstanding economic importance of this genus is the fibres which they yield; hence some species are cultivated for their fibres. Notable species are *H. abelmoschus* Linn. and *H. sabdariffa* Linn. whose fibre is known as java jute, has come into prominence in the world as a substitute for jute (Mahadevan N., 2009). *H. cannabinus* Linn. is the most cultivated fibre plant in the open country from Senegal to Nigeria (Mohta et al, 2000). Some of its usual application is for tying the rafters used for roof binding, plaited ropes for drawing water; hobble ropes, fishing lines and women's hairstyle (Cheng, 2001). Also yielding fibres of good strength for various local purposes are *H. lunarifolius* (wild), *H. rotellatus*, *H. scitellii* (Bak f), *H. sterculifolius* (Stend), *H. surattensis* Linn and *H. vitifolius*.

Hibiscus is also a primary ingredient in many herbal teas. One species of *Hibiscus*, known as kenaf (*Hibiscus cannabinus*), is extensively used in paper making (Mohta et al., 2000). Another, roselle (*Hibiscus sabdariffa*) is used as a vegetable and to make herbal tea and jams (especially in the Caribbean), it is highly medicinal, dieters or persons with kidney problem often take it without sugar for its beneficial purposes and as a natural diuretic (Odigie, J.P., Etttarh, R.R. and Adigun, S, 2003). It is made by boiling the dried flowers in water, once it is boiled, it is meant to cool, ice and be drunk. The petals of roselle are used to make tea (Cheng Z., 2001). *H. abelmoschus* juice is used as stomach tonic. *H. asper* is mucilaginous in water; the juice which is slightly acidic is used in northern Nigeria as remedy for tertiary syphilis. The powdered leaves of *H. cannabinus* are used as local application for guinea worm sores. An acid jelly extracted from the edible calyx of *H. sabdariffa* is used in Sudan for curing bronchitis and cough (Abdallah, M.A., 2011). The leaves of *H. sabdariffa* are also cooked for nearly circumcised boys. The leaves of *H. cannabinus* are the pot-herb, sometimes called in Hausa, 'dinkin rama' and used in soap. The seeds of *H. abelmoschus* are used in perfumery; they are also strong as scented necklaces girdles. The seeds of *H. cannabinus* and *H. sabdariffa* yield oil (Mohammed R., 2007). European uses the calyx of *H. sabdariffa* for making jelly, chutney, wine or syrup (Mahadevan N., 2009).

Hibiscus species are used as food plants by the larvae of some *Lepidoptera* species including *Chionodes hibiscella*, *Hypercompe hambletoni*, the nutmeg moth, and the turnip moth. Red hibiscus (*Hibiscus rosa-sinensis*) serves for hair care purposes. The red flower and leaves extracts of which can be applied on hair to tackle hair-fall and dandruff on the scalp. It is used to make hair-protective oils. A simple application involves soaking the leaves and flowers in water and using a wet grinder to make a thick paste, and used as natural shampoo. Its petals are used to cure fever while its roots are used to cure cough. *Hibiscus* can also be used by children as part of bubble-making pastime. The flowers and leaves are crushed until the sticky juice comes out. Hollow papaya stalks are then dipped into this and used as straws for blowing bubbles. Dried hibiscus is edible, and is often a delicacy. To the Niger fisher-folk, the plant is very important source of fish lines and nets, cordage for Hippotamus during hunting, twine for sewing canoe hides together, caulking being carried out using old tow treated with baobab flour and karate butter. The debarked stem can be used as fuel. They have found suitable for match-splint (Cheng Z., 2001).

In Nigeria, the stem is sometimes used as a base in fire drill, and soot from the scorched stem is applied as a pigment in wall decoration (Webber III C.L. et al, 2002). A little alkaloid is found in the stem. The leaves are edible and are eaten throughout as sorrel spinach in soup and as a vegetable. The Nnakanni of Northern Ghana dries them quickly in the sun for storage and consumption in dry season. In Nigeria, they are added to locust beans pulp and condiments to make a foodstuff called 'kwado' (Cheng Z., 2001). Nutritionally, they are good. In India, the leafy tops are fed to milk-cattle. In Nigeria, the powdered leaves are applied to guinea-worm sores, and the leaves and peeled stems both have superstitious medicinal and occult uses (Brotherton, 1969). The Yorubas of Southern Nigeria invoke the plant under the name of 'Ida orisa', Sword of orisha, to help find a thief (Veger, 1967). In Gambia, a leaf-infusion is taken for cough and in Sierra Leone the roasted ground leaf is rubbed vigorously over boils (Duke, J.A., 1993). Tested for molluscicidal activity, the leaves are reported inert (Adewumi and Sofowora, 1980).

The flowers, large, yellow, with a reddish-purple centre contain a pigment, 'cannabistrin', and a flavanol (Walt and Breyer-Brandwijk, 1962). In Kenya, children squeeze out the purple dye from the eye of the flower in marking faces. The flowers are sometimes cooked and eaten in Malawi.

The seeds are edible, commonly sold in Northern part of Ghana markets for use in sauces and are readily eaten by poultry. Records of oil content are variable. It is non-drying and the principal fatty acid are linoleic, oleic, palmitic, and stearic. It is used in India as a lubricant and for lighting. It is suitable for soap manufacture especially hand soaps, and for linoleum, paint and varnishes. Refined oil is suitable for human consumption (Bouquet and Debray, 1974; Walt and Breyer-Brandwijk, 1962). The presence of an unnamed alkaloid in the seed is recorded. If a seed crop is required, it is usual to sow rather less thickly than for a fibre crop and to let the plant run its full course, the resultant fibre may thus be of a lesser quality than obtained by earlier harvesting (Mohta et al, 2000). The pressed cake after extraction of the oil resembled linseed and rapeseed cakes. Protein about 33/100, oil 6/100, fibre 17.4/100, ash 6.0/100, and nitrogen-free extract 37.6/100. It may be used as

fertilizers (Webber III, 2002).

The dearth of phenological studies in tropical plants had been pointed out by various authors (Frankie et al, 1974). Phenology is defined as a branch of science dealing with the relationship between climate and periodic biological phenomena; it is the study of the response of living organisms to seasonal and climatic changes in the environment in which they live; seasonality exposes plant to regular, periodic changes in the quality and abundance of resources (Fretwell, 1972). Almost all tropical environments vary seasonally in temperature, humidity, rainfall, wind speed and day length, although the amplitude of the variation may be small. All of these factors are known to play a role, alone or in combination, in triggering phenological changes in tropical plants (Longman and Jenik, 1974).

Given the available information, there has not been any report on the phenology of *H. cannabinus* in Nigeria. The aim of this work is therefore to study the phenology of flowering, fruiting, foliage, and girth changes in the two varieties of *H. cannabinus* and relate this to their different morphological characters.

2. Materials and Method

For the purpose of this study, two varieties of *Hibiscus cannabinus* were collected from Iloko Ijesa, Osun State, with the geographical co-ordinate of 7° 38' 0" North, 4° 49' 0" South. Identification of the plant was confirmed in The IFE Herbarium, O.A.U, Ile-Ife, Nigeria where voucher specimens were deposited. The plants were also locally identified by the Yoruba market women; Variety A as 'oja-ikoko (yemoro)' and Variety B as 'ida orisa (yewuru)'. The Five replicate seeds of *Hibiscus cannabinus* of both VARIETY A and VARIETY B were planted in different petri dishes (10cm in diameter). The date of planting and germination were recorded for the two varieties. They were finally planted in medium sized buckets. Careful watering of the plants in the morning of everyday was ensured. The following phenological events in the two varieties were tracked weekly throughout the germination periods until maturity namely: time, duration and frequency of leafing, flowering, and fruiting. Changes in girth were measured at the base of the stem with the aid of thread whose length was read on a metre rule. Morphological characters such as heights of plants, number of leaves, length of leaves, width of leaves, area of leaves, petiole length, at a particular period of time were also noted. Number of sepals and episepals and length of sepals and episepals were also recorded in the two varieties.

3. Results

The two varieties of *H. cannabinus* germinated 2.8 ± 0.45 days after planting. In VARIETY A, purple colour pigmentation occurs at the nodal ring of the leaf base. In VARIETY B, there was no colour pigmentation at the nodal ring of the leaf base. In each of the plants, two different kinds of leaves were seen to be growing on them; unifoliate and multifoliate. Unifoliate are at the lower part while the multifoliate are at the upper part of the plant. Number of leaves increases with time but at a faster rate in VARIETY B. Changes in number of leaves in VARIETY A and VARIETY B are not significantly different (NSD) in week 3, 5, 9, 11, 12 AND 14 but are significantly different (SD) in week 4, 6, 7, 8, 10, 13 and no difference at all in week 1 and 2 (Fig. 1).

The height difference between VARIETY A and VARIETY B is not highly significant, though there is little difference. The significant difference was within week 7 and week 12 where VARIETY B grew higher than VARIETY A, (Fig. 3). Height changes of variety A and variety B were not significantly different throughout the weeks except for weeks 2, 4, 5, 8, 11, 12. The leaves of variety B were broader than leaves of variety A, (Fig. 2). In weeks 1, 5, 7 and 10, diversity of width changes in the leaves of variety A and variety B are not significantly different but in week 2, 3, 4, 6, 8, 9, they are significantly different.

The surface area of leaves in variety B is larger than that of variety A except for week 3 and week 10, (Fig. 4). The leaf petiole was longer in variety B throughout the week except for week 10 in which variety A was longer, (Fig. 5). Variety A and variety B have significant different levels of petiole length diversity for the weeks except weeks 8, 9, 11 and 12.

The girth size of the two varieties is significantly different. Variety B grew faster in girth size than Variety A throughout the weeks (Fig. 6). Girth changes for both varieties are significantly different throughout the weeks except for week 12 (Fig. 6).

Initiation of flowers began in variety A 46.5 ± 4 days after germination. Variety B initiates flower 45.4 ± 5 days after germination. Flowers open in variety A 27.7 ± 5.8 days after the initiation and opened in variety B 36 ± 4.0 days after the initiation. Flowering takes place in variety B almost every day in a week while flowering was once or twice in a week in variety A. The number of flowers produced per day per plant in variety A was not more than one while that of variety B ranges from 1 – 2. The flowers in variety A has cream coloured petals which were fully splitted and interior basal portion of the flower is purple in colour, the anther is brown in colour. Flowers in variety B also had cream coloured petals which were partially splitted, the anther is yellow in colour without any colour pigmentation at the interior basal portion. Flowers are solitary in the leaf axils. Seed dispersal in both varieties was by explosive mechanism and the undispersed seeds were observed germinating on the plant of both varieties.

Flowers drops in both varieties a day after it has opened. The number and length of sepals and episepals possessed by the flowers on variety A is lesser and shorter than those of variety B's flowers respectively, (Fig. 7). Fruits development commenced in variety A, 2 days after flower opened. Fruiting began in variety B, 3 days after flower opened. The multiplication of fruits in variety B was rather faster because after sixteen weeks of germination, the number of fruits on variety B exceeded that of variety A, (Fig. 7). The fruits produced by variety B were longer and wider respectively than those produced by variety A. larger number of seed and seed compartments within the fruit were always found in variety B, (Fig. 7).

4. Discussion

It has been observed that in many ways the species *Hibiscus cannabinus* are variable as seen in the two varieties. The production of leaves in variety B is more rapid than in variety A. Longton, 1979 reported that vegetative growth may be partly under endogenous control; this might inform the variation and leaf production. For purpose of vegetative use, both varieties are suitable based on the timing and the type of leaves needed, if numerous young leaves are needed, variety A should be planted and harvested after 7 weeks of planting because the number of leaves of variety B exceeded that of variety A at 7th week of planting and beyond. If numerous, broad and matured leaves are needed, then variety B is encouraged for cultivation and must not be harvested before 7-9th week of planting.

I suggest that the cultivation of variety that flowers almost every day in a week (VARIETY B) should be encouraged for farmers who wishes to make use of the flower or/and fruit production of the plant which at the end of the cultivation will be more abundant than the variety that flowers once a week (i.e. Variety A). It can be said that the flowering in variety B is continual while that of variety A is periodic. Continual flowering however may be constrained by fruit development and maturation. If seeds and fruits mature over a long period of time, repeated flowering would not be possible. Continual flowering variety that is variety B, which necessarily accompanies continual fruiting, requires special conditions to ensure resource acquisitions (Opler et al., 1980). The flower of variety A has a reddish-purple centre; this is due to the fact that it contains a pigment named *cannabiscitrin*, and a flavanol (Watt and Breyer-Brandwijk, 1962). For Kenya children who squeeze out the purple dye from the flower for marking their faces and other uses, the cultivation of variety A is encouraged. The rate of stem elongation declined as the plant initiated flower.

Since variety B produces more seeds than variety A, it is recommended for people who use the seeds for consumption, lubricant, lightning. Especially to the Northern Ghanaians who use the seeds in making sauces and for other purposes. The production of seeds is directly proportional to the production of fruits and flowers.

The pattern of the girth changes throughout the period of cultivation is similar between the two varieties. Girth of variety A was smaller than that of variety B, this may be due to internal correlative pattern which are important in the timing of growth processes as seen in the relationship between girth changes and foliage phenology. To the Niger fisher-folk where the plant stem is very important for the manufacture of fish lines and net, cordage for hippopotamus-hunting harpoons, twine for sewing canoe hides together and to Nigerians where the plant stem is sometimes used as a base in a fire drill, and the soot from the stem which is used in the pigment of wall decoration, and for other uses, variety B which has bigger and higher stem is the suitable variety for cultivation. The ease of removal of the bark from the stem for man's use is higher in variety B than variety A because the bigger the stem, the easier the removal of the bark from the stem and vice versa.

Conclusively, variation exists among the species of *H. cannabinus* as seen in the two varieties investigated. The two varieties are different in phenology and can be cultivated for different purposes; variety 'B' exceeds variety 'A' in height of plant, numbers of leaves, length of leaves, number of fruits and seeds.

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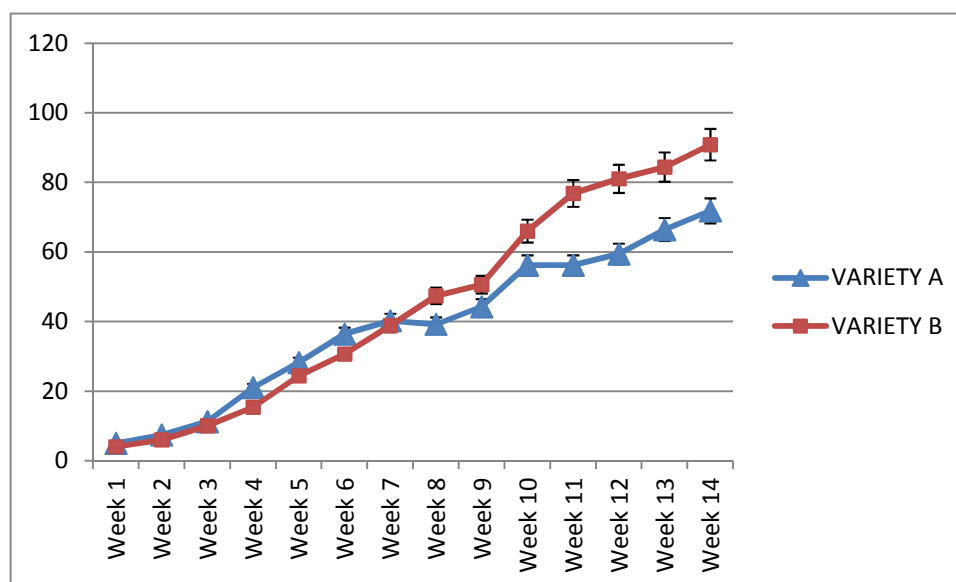


Fig. 1: Production of Leaves in *Hibiscus cannabinus* varieties

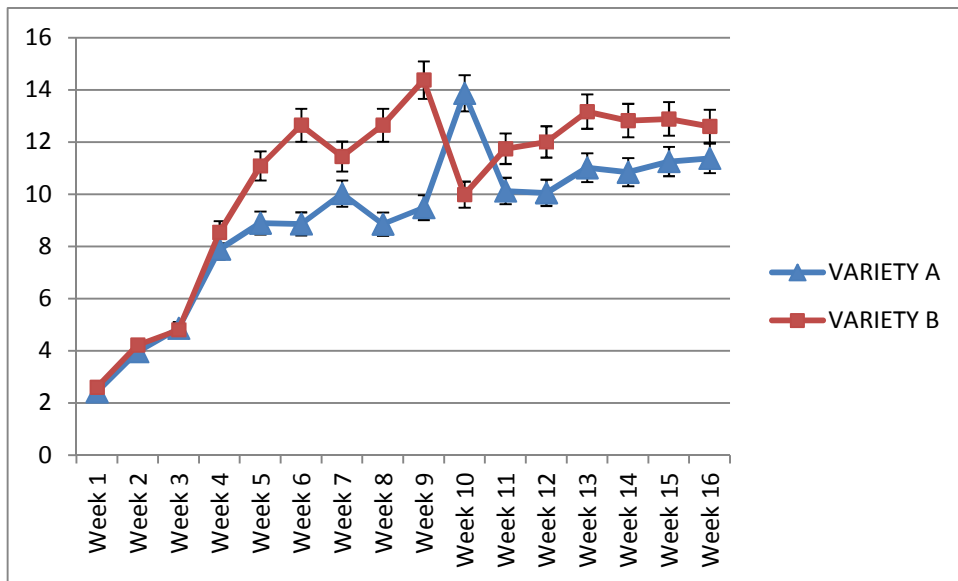


Fig. 2: Width (cm) of leaves in *Hibiscus cannabinus* varieties

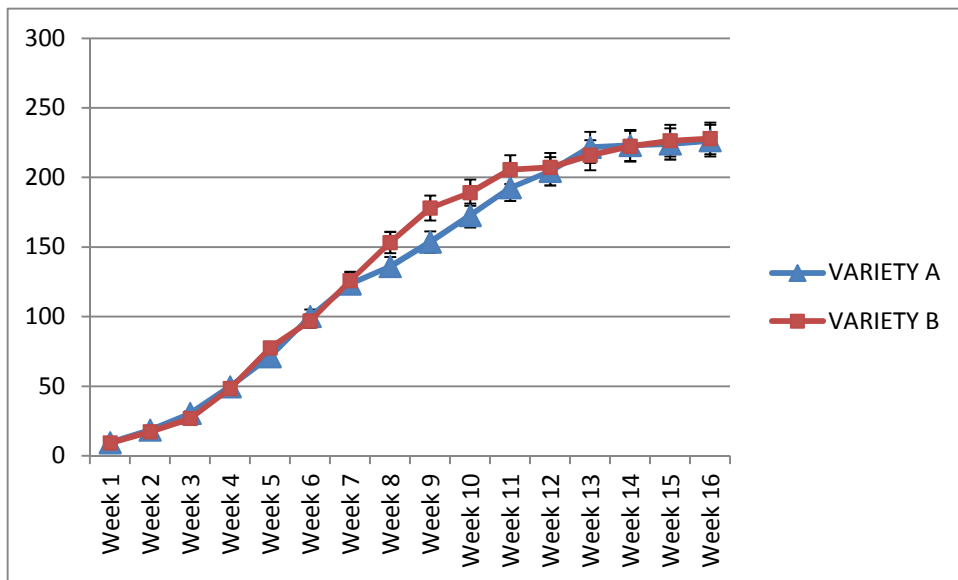


Fig. 3: Rate of increase in height (cm) of *Hibiscus cannabinus* varieties

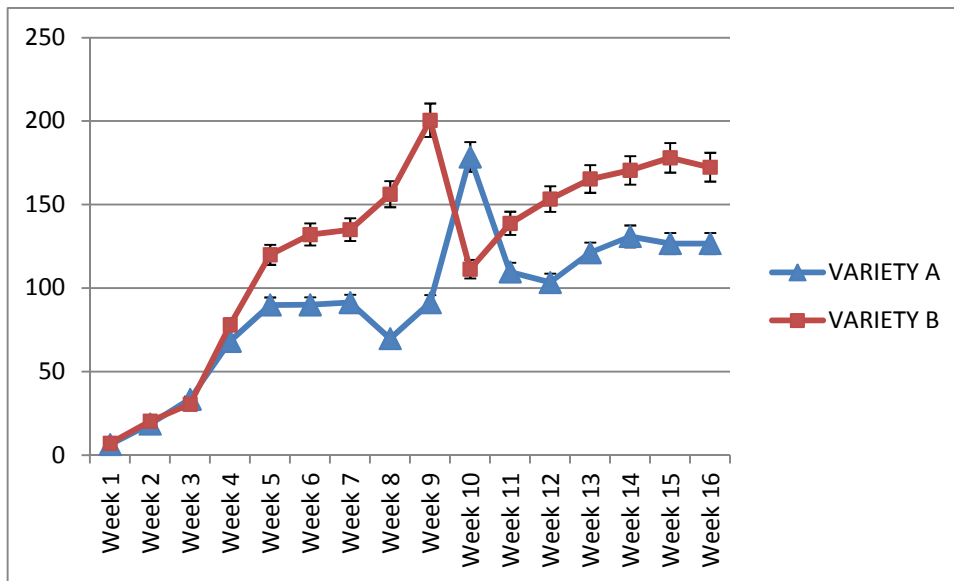


Fig. 4: Rate of increase in Area (cm²) of leaf for *Hibiscus cannabinus* varieties

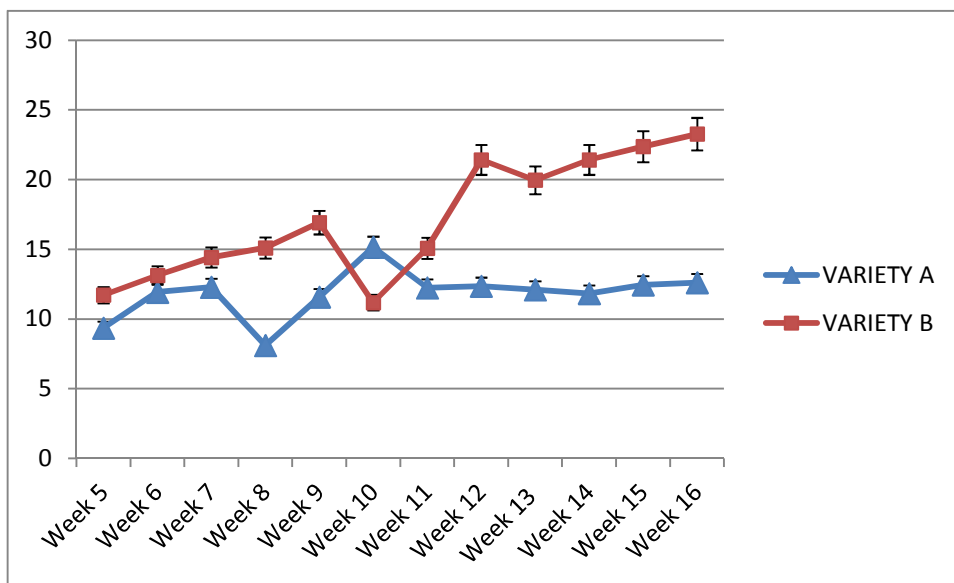


Fig. 5: Rate of increase in the height of petiole for *Hibiscus cannabinus* varieties

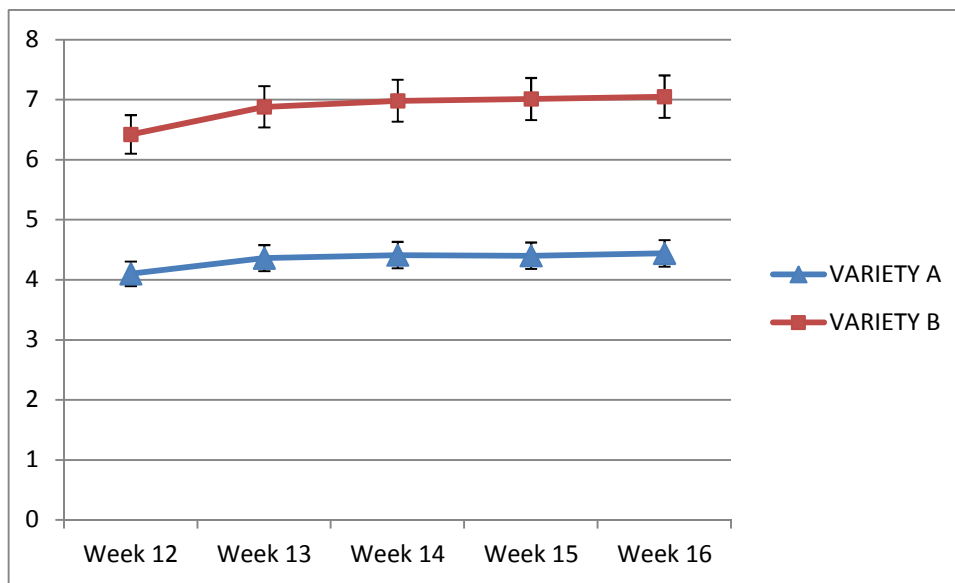


Fig. 6: Girth size (cm) in *Hibiscus cannabinus* varieties

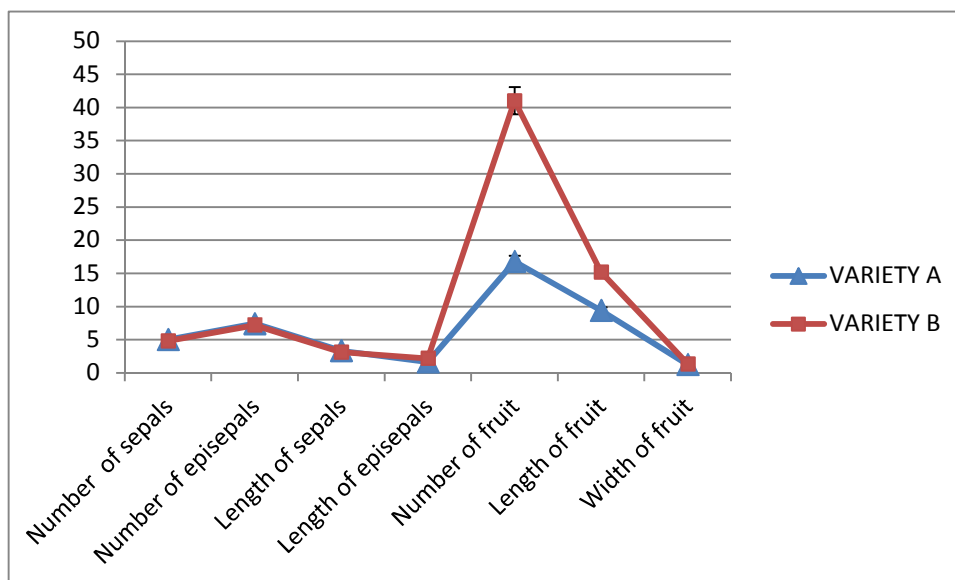


Fig. 7: Quantitative and qualitative characteristics of episepals, sepals, seeds and fruits in *Hibiscus cannabinus* varieties

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