NOTES ON KENAF "HIBISCUS CANNABINUS" PRODUCTION IN CUBA AND FLORIDA

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Kenaf as grown in Cuba and Florida originated from Java via El Salvador. As far as can be ascertained, the original sowings on a large commercial scale in El Salvador were carried out in the years 1943-1944. The original commercial sowings were destined for fibre production. The idea of growing the crop in Cuba arose due to the high export tariff placed on jute by Pakistan in recent years and the resulting activity of the United States Government in promoting the crop. At the same time the crop fits in well with the agricultural system of Cuba whose economy relies solely on the production of sugar. The Kenaf being a summer-grown crop lends itself to rotation with sugar-cane and the utilization of labour which is left idle after the cane cutting season in summer months.

The crop grown originally for fibre in El Salvador was bought up by Cuban interests and was allowed to grow for seed only. The El Salvador producer after this crop has never re-entered the field of Kenaf production. Verbal reports to hand state that the crop is now being produced on a small peasant scale in that country in order to supply local needs only.

The seed sold to the Cuban interests contained the so-called "viridis" and "vulgaris" types. No attempt had been made to separate these fundamental types besides known strains of such a heterozygous material.

With Pakistan still maintaining the export tariff on Jute and at the same time adding an extra loading on the fibre being sold to the United States, the United States Government, through the agency of its Commodity Credit Corporation, in 1950 contracted for Kenaf fibre to be delivered at Philadelphia at the following guaranteed prices up to 1st May, 1953; 12, 18, 24 and 32 cents. (U.S.) per pound. These contracts were made with interests in Cuba, South Florida and Mexico. Seed for fibre production in South Florida and Mexico coming from Cuba, the seed in the case of the Cuban-New Guinea importation being of the basic heterogeneous stock.

Up to this period in late 1951, the production of Kenaf in Cuba had been biased towards the production of seed only, little thought in comparison from the commercial side being given to the production of fibre. The season 1952 saw production in all three countries aimed at fibre production only, the price of seed dropping from a $(U.S.).1 to 6 cents (U.S.) per pound.

In Florida and Cuba, due to the cost factor, the emphasis during the 1952 season had been placed on the mechanical production of fibre in lieu of hand labour methods as in the case of Mexico.

The young industry in Cuba and South Florida has ended for the present, the 1953 sowings being in the neighbourhood of 50 acres by a commercial undertaking which is still persevering with the crop. The collapse of the industry during the 1952 season was due to lack of forethought and lack of suitable processing machinery coupled with the advent of Anthracnose disease (*Colletotrichum hibisci*) which became manifest in commercial plantings in the 1952 season.

At the present time of writing there is no commercial production of the crop either in Cuba or Florida, except the small acreage mentioned before, being grown at Bayamo by the North Atlantic Fiber Corporation. However, the future holds much promise for the crop and active research now being carried out from the agronomic and engineering fields points to a sound future.

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The research work in Cuba is being carried out by the Co-operative Fiber Commission. The U.S. and Cuban Governments both supply technicians and funds on an equal basis. The work in Florida is being carried out by the U.S.D.A., Division of Plant Industry, Soils and Agriculture Engineering in co-operation with Florida State University.

Soils.

The soils utilized for Kenaf in Cuba have been generally run down cane land of the red earth group. Initial plantings on these lands have given satisfactory crops but second plantings have been generally poor. The use of these low fertility soil areas has been manifestly due to their availability and lower rental charges. The work done in experimental fertilizer trials has shown that on this class of soil the crop quickly responds to nitrogen and phosphate applications.

In the case of Florida Kenaf—the crop is being grown on organic muck soil containing no mineral matter, the crop responding to phosphate and potash applications. Owing to unique genealogy of the muck soil, the whole area is more or less trace element deficient and Kenaf as well as all other commercial crops in the area responds to copper, zinc, manganese and boron applications.

The only sign of trace element deficiency in the crop appears to occur in Cuba on a mineral soil. The symptoms of chlorosis only occur in small localized spots. As yet, nothing definite is known about it conclusively.

Agronomy.

As stated previously, in Cuba the Kenaf crop lends itself to the agricultural practices of the country. It is the same story in the South Florida region. In South Florida on the muck soils of the everglade area, the main crop is winter grown vegetables, the land for the greater part of the summer months lying idle. In both countries the crop is an essential one from the standpoint of a self-sufficient economy, besides its export trade possibilities.

Experience in these countries with the crop, has been most interesting, especially in the factor that the crop is being cultured in the temperate and sub-tropical zones as against its cultivation in New Guinea, which is well within the tropics. This fundamental factor, besides showing the crop's versatility, also governs every aspect of its cultivation and cultural habits.

The length of day has a deciding influence on the time of sowing and the utilization of the crop. Sowing early in the spring means that the crop is utilized for fibre whilst sowing in the autumn-late summer period in shortening day length results in the crop being grown for seed only. The same material in long days grows to a height of 8-12 feet as against 3 feet 6 inches to 5 feet during short days.

The foregoing factor controls sowing rates and sowing distances. At the same time, varietal characteristics have a governing influence also. As yet figures for these factors have not yet been proved conclusively for the crop for the best results.

The basic criteria which is used as a rule of thumb so far is that for fibre production, sowing should be heavy in the order of 20-30 pounds per acre, with a spacing distance of 7-12 inches, for seed production the sowing rates being lighter in the order of 8-15 pounds per acre and spacing being in the order of 10-24 inches.

In Cuba under certain conditions of high rainfall, it has been observed to be possible to grow a fibre crop, cut it and allow it to ratoon and harvest as a seed crop. This may have big possibilities where irrigation facilities exist.

The main problem with the crop from an agronomic and economic point of view, is to produce a fibre crop over an extended harvesting period, in order to obtain maximum utilization of harvesting and processing equipment and at the same time preventing marked fluctuations in the number of labour required through the year. It is stated that for the crop to be economic in considering the capital investment for equipment, the crop must be in production for a minimum of six months, that is six months continual harvesting for fibre. An optimum harvesting period for large scale commercial undertakings being given as eight months. So far in Cuba using the present existing varieties, production can only be maintained for a four and a-half to five month period.

This question is of great importance to New Guinea wherein day length and temperature factors are more or less confined to a narrow diurnal and seasonal range.

There is little difficulty in weed competition, once the crop becomes established after the seedling stage. All weed control investigation work has been aimed at preplanting control. This can either be done by the use of general cultivation implements in the case of nearly all weeds. An exception is in the case of Morning Glory (*Convolvulus upsi*) which will persist and finally may smother the crop. A big danger with this weed is that its seed and the seed of Kenaf are difficult to mechanically separate. In some instances in Cuba and Florida, plantings of the crop have been abandoned due to sowing of a Kenaf-Convolvulus seed mixture.

The use of hormone weedicides have shown promise for weed control for commercial practices, one-quarter pound 2-4D ester per acre, two to three weeks prior to planting, has been recommended.

As yet, nothing definite is known about Kenaf's place in a crop rotation. Cuba is the only place where some thought has been given to this problem. A crop rotation experiment has been started but it will be a few years hence before any definite information comes to hand.

Both in the case of Cuban and Florida soils, a big danger to Kenaf production is nematode infection. The nematode affecting Kenaf in Florida has been classified as *Meloidogyne incognita.*

The question of nematode control revolves about the question of crop hygiene and crop rotation, so far maize being the only feasible crop to grow in a rotation.

Chemical sterilization of the soil for nematode control has been undertaken in Cuba during the 1952 season. The following chemicals have been used in experimentation—D-D, C.B.P. 55, Chloropicrin, Ethylene Dibromide (100 per cent. pure) —in conjunction with the following solvents —Kerosene, Alcohol and Xylol.

The nemacides were applied to the soil six weeks prior to planting. It was observed that the nemacides may have a possible effect as a weedicide.

Chloropicrin appeared to be the best nemacide but in considering the cost factor and results, the use of ethylene dibromide is to be further investigated as well as the effect of Xylol as a solvent.

As yet, no serious insect pest has shown up in the Kenaf crop. Though it has been reported from Texas that Kenaf introductions were badly infected with Pink Boll Worm (*Pectinophora gossypiella*) and that it is unlikely that Kenaf will ever be grown in the U.S. cotton belt for this reason, as the Kenaf, growing out of season to cotton would serve as a harbour for the pest.

Physiology.

As yet, little is understood about the physiology of the plant. This lack of knowledge has been a great stumbling point for a sound plant breeding programme. This is especially manifest in the case of the so-called early, mid and late maturity types. The factors of maturity, photoperiodicity and temperature response being as yet unknown variables as listed :—

1.—*Photoperiodicity.*—

(*a*) Effect on various stages of growth which may be correlated back to effective planting time.

(*b*) Factors effecting floral inception.

(*c*) Length of the vegetative period.

(*d*) The breaking of the short day period, and the use of artificial illumination.

2.—*Thermoperiodicity.*—

(*a*) Vernalization—the effect of cold storage of seed in relation to photoperiodicity.

(*b*) Effect on internodal length.

(*c*) Diurnal fluctuation of temperature in relation to plant metabolism.

3.—*Substrate Requirement.*—

(*a*) Varying response to pH.

(*b*) Tolerance to basic ions—calcium and magnesium.

(*c*) Oxygen level and redox potential.

(*d*) Calcium toxicity.

Breeding Programme.

Active plant breeding programmes have been under way in Cuba for the last eight years and for the last three years in Florida. The main factor which governs all breeding work at present is anthracnose (*C. hibisici*) resistance. In Florida the factors for resistance are claimed to be of a simple 3:1 segregation factor, whereas work in Cuba has tended towards a multiple factor theory.

Other factors which are considered in the breeding programme are as follows :—

1.—*Seedling Characters.*—

(*a*) Rapid emergence—related to seed size and hardness of seed coat.

(*b*) Rapid early growth—shade weeds.

(*c*) Resistance to disease and insect attack in the seedling stage.

2.—*Mature Plant Characters.*—

(*a*) Resistance to disease and insects.

(*b*) High yield of dry fibre per given area.

(*c*) Uniformity of plants for better machine efficiency—harvesting and processing.

(*d*) Strong fibre for better field handling, spinning and better finished product.

(*e*) Medium to fine stem for higher yield and better machine efficiency.

(*f*) Faster retting types.

(*g*) Types reacting better to mechanical and chemical extraction.

(*h*) Types of varying sensitivity to length of day for more efficient use of production and extraction equipment.

(*i*) Types of varying sensitivity to rainfall and temperature patterns.

3.—*Seed Characters in the Mature Plant.*—

(*a*) High yield of viable seed.

(*b*) Medium hard seed coat. (Soft enough for rapid emergence and hard enough for longevity under storage.)

(*c*) High oil content—a type for the oil market.

(*d*) High protein content—foodstuffs.

(*e*) Non-shattering types.

(*f*) Reduction of spines in the capsule.

Pathology.

Prior to May, 1952, there was no organized pathological work on Kenaf being carried out.

The onset of Anthracnose disease during the 1952 season was the principal reason for workers turning their attention to the disease of this crop. The bulk of all this work has been carried on in Cuba and considerable knowledge has been accumulated, especially with Anthracnose. In the case of this disease, the casual organism has been isolated from stem tissue, leaf spots and stem cankers; its pathogenecity proven and finally represented by 32 strains all virulent. These strains have been used in the hand inoculation work of all of the 48,000 individual Kenaf plants in the Cuban breeding plots.

Diseases of Kenaf in Cuba.—

(*a*) Root and Collar Rots—

(1) Collar Rot—*Sclerotium rolfsii.*

(2) Charcoal Rot—*S. bataticola.*

(3) Root Rot—*Phytophthera parasitica.*

(4) Seedling Root Rot—*Rhizoctonia solani.*

(5) Physiological Root Rot.

(*b*) Stem and Leaf Diseases—

(1) Black Stem Spot—*Nectria* spp.

(2) (*a*) White Stem Spot—*Pellicularia filamentosa.*

(*b*) Zonate Leaf Spot.

(3) Anthracnose — *Colletotrichum hibisci.*

(4) Mildew, powdery—*Leveillula taurica.*

(5) Deficiencies.

(6) Mosaic—Virus.

Harvesting and Processing.

The harvesting and processing of Kenaf is still more or less an open book. No method has been proved conclusively to be the best and the most practical one.

The first object in the growth of Kenaf is to maintain a seed supply and in doing so, if possible, to recoup fibre from the seed producing plants.

The harvesting of Kenaf seed revolves around the use of two principal methods. First, the harvesting of the seed in the standing crop by the use of an all-crop harvesting machine and then cutting the standing "stubble" by the use of hand labour or binders followed by the use of some processing operation.

The other method used in some cases is to cut the seed crop by using a binder and to stook the cut sheaves and allow the seed to dry on the plant. The material then being passed through a stationary thresher for the recovery of seed and then the resulting stem material being processed for fibre.

The governing factors which control either method which have been tried on a rather limited scale is first, the weather. In high rainfall areas the use of the all-crop harvester is the most practical as the seed can be harvested on the green side and finally be dried in artificial dryers. The main difficulty in this practice, which in turn favours the stook method, is that the height of the crop makes harvesting operations difficult and the seed yield is much lower owing to the restricted period of time the crop is harvested in regard to the floral habit of the plant.

The use of the binder and stooking method does not require a high capital investment for equipment (harvester and drier) as the machine is used for fibre production also. Again, seed yield recovery is ten to twenty per cent. greater, and at the same time the crop residue is in a state which makes for easier transport, handling and processing. It has been stated that yield of tow fibre may be 200 to 300 per cent. greater than that of a combine harvested crop.

Unfortunately, no serious experimental work has been done in this field in order to obtain more explicit information. The question will undoubtedly rest upon the economics of cost of seed and tow recovered per acre, and the most economic proportion of each.

One of the big problems in seed production is the purity of the seed. As yet, no mechanical device has been manufactured to give 100 per cent. separation of Kenaf and its major weed pest, *convolvulus*.

The question of the best harvesting methods of Kenaf for fibre is as yet unanswered specifically.

The main factor which hinders production of the crop is that the producer whilst being an agriculturalist in growing Kenaf has also to be a semi-manufacturer in processing the crop. This processing factor immediately governs the type of producer, either a large commercial establishment with capital to install costly processing machinery, or again a peasant producer turning out small quantities produced laboriously by hand. As yet, there is not much opening for the middle class producer which is the bulk of rural producers, as seen in a European country. There is some hope of the middle class section producing the crop if the industry, say, should follow the pattern of the sugar-cane industry, in produce being supplied for processing to a central plant owned either by the Government, private interests or a co-operative of the producers themselves.

Ideally, though, since the crop is in the non-perishable category, it is that the spinners, as in the wool trade, buy the raw fibre such as in the form of dry ribbon, which is easily produced by any of the agricultural classes, and processed into finished fibre as required for the looms during a twelve to twenty-four month period.

This concept of the spinner taking a more active interest in the crop is most important from the long range point of view as well as the short term view, in the development of the crop, and the position of Jute or any other short bast fibre crop in the world to-day.

The present problem is that with the high price of Jute products and its probable lack of production in the East in future due to unsettled conditions, there will be a greater use of bulk handling and kraft papers and other substitutes resulting in low demand for fibre packaging materials. This getting away from Jute and allied fibres is clearly witnessed in the U.S.A. at the present time. This state of affairs arising during the War when users of Jute products were forced to find substitutes due to its lack of supply. Substitutes were found mainly in the form of kraft papers; this industry has now built up its markets to such a proportion that Jute and its allied fibres are in a precarious position.

Jute and allied fibres such as Kenaf can quite easily recapture these lost markets, if it is produced at a competitive price. If this price is to be realized, the spinning manufacturer must take more interest in the crop and especially in Kenaf if it is to flourish as a major fibre crop. It is obviously in his interests to do so, if he is to compete with substitute packaging materials.

The cutting of the crop has been carried out in the greatest extent by converted John Deere rice binders fitted with a McCormick binder head. These machines have given fair results only. The main problem being that the machines were redesigned first to cut hemp and then put on to Kenaf work. The machines are too lightly constructed for the Kenaf crop. Cuba and Florida interests have persevered with them and strengthened the machines as breakdowns occurred. In the case of Mexico producers, they reverted to hand labour and matchets for cutting the crop. Unfortunately, the machinery manufacturers are not interested in producing a more suitable binder at present, due to the small demand.

Inventive interests and small machinery firms are turning their efforts towards field decorticators and ribboners. Results so far tend to show that success will first be met in the field of ribboners, the field produced ribbons then being processed for fibre, either by retting, chemical or mechanical decortication.

The age-old method of retting, either the stalks or ribbons, has as yet not been superseded for a method of production. An interesting point which may prove a deciding factor in any processing method is experimental trials carried out by the U.S. Navy in 1952 on Kenaf sandbags. These bags, which were produced from fibre by mechanical decortication only lasted one handling due to rotting of the bag as against no rotting of retted fibre-produced bags. This fact has led the U.S. Military Authorities to purchase onlv retted fibre material.

Rot-proofing of mechanically decorticated fibre can be incorporated by giving such produced material a small final retting process, this process removing all free microbial substrate carbohydrate material. In future, it may be carried out by a quick-acting chemical treatment.

Machines which have been utilized for the production of ribbons are as follows :—

Meister Ribboner, Kiser No. 5 Test Kenaf Ribboner, Marti Ribboner, Alfab Kenaf Ribboner, Short Kenaf and Ramie Ribboner, Proctor and Schwartz Ribboner, Cary Harvester Ribboner, USDA Harvester Ribboner.

Machines for decorticating :—

Japanese Decorticator, Hubert Defibring Machine, Vencedora Decorticator, Krupp Stella Decorticator, Mohegan Decorticator.

Chemical Extraction.

Active research is now being taken in this field. It has been shown in the laboratory that the method has possibilities in the production of finished fibre.

The production of fibre from stalks or ribbons depends upon the breakdown or digestion of pectins—the main cementing material followed by the breakdown of the parenchyma cells consisting mainly of cellulose in order to free the independent fibres.

Sodium hydroxide has been found to be the cheapest substance for the extraction of pectin substances. The only trouble is that the concentration and temperature of the digesting media must be controlled in regards to the age and condition of the material to be treated. Digestion of the hemi celluloses of the fibre can easily take place, leading to fibre harshness and loss of spinning quality.

Soft soap and sodium carbonate (20 to 22 per cent.) solution gives satisfactory results in the digestion of the parenchyma material, the soap molecule attaching itself to the fibre and protecting it from the action of the sodium carbonate. Ammonium oxalate solutions have been extremely successful in producing fibre, but is prohibitive due to the cost factor.

Attempts are being made to use cheap sodium phosphate and borate salts as a digesting media.

The process appears to be impractical for quite a considerable length of time as yet. The disadvantages are the costs of the chemicals, especially soap, and the engineering problems of designing suitable equipment.

Research in Cuba is mainly centred on the problems of soap and chemical recovery. If whole or part of the soap could be recovered with more efficient use of digesting chemicals, the system would have something for it.

Proctor and Schwartz did design, build and install a continuous processing plant for Des Fibradores de Kenaf of Cuba.

The plant was a failure. This failure was due to the high cost of chemical for the process and the failure of the machine to transfer the processing material through the various tank compartments. The latter difficulty being due to the failure of a suitable conveying system. When the material was partly digested, it lost its original form and the separating fibre wound around the conveyors, resulting in stoppages.

Retting.

Experimental work in Cuba and Florida has shown that retting may be divided into two stages. First, the respiration of simple carbohydrates within the plant cell followed by the removal of the pectinized bark, which may take a further 24 to 56 hours to take place.

This bi-phase of the retting process must be fully understood if the process is to be mechanized. The quick retting which occurs in the first stage may mask the second stage of retting and lead to the production of a poor grade of fibre. This has occurred with commercial retted fibre, both in Cuba and Mexico.

The second stage of retting of the bark pectins is receiving the greatest attention from the mechanization angle. The aim has been in all experimental and commercial work to reduce the time of retting in order to save on capital outlay in regards to the number of retting tanks, etc.

The aim of mechanization principles after the retting process has been to produce a satisfactory washer-burnisher machine. This is a machine which will remove shives and other foreign material, and at the same time leave the fibre in line for easier spinning. This operation of washing and preparing the finished fibre has been stated to be one of the greatest cost factors in the retting method, being costly in time, labour and water.

One interesting fact is that colour is no criteria of quality of fibre, but buyers are always influenced by colour. A buyer being biased personally towards a silky, white fibre every time. This colour of the fibre can easily be imparted by frequent washing in water, it being stated that three good washings will impart a most attractive appearance to an unattractive sample. This washing for appearance fits in best with the retting method, as washing is a normal procedure in the process.