Effect of Some Cultural Treatments on Retting of Some field Crops

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C O N T E N T S

<u>INTRODUCTION</u>

Vegetable fiber could be classified according to the part of the plant from which they are obtained into many classes among which bast fiber group is one of the most important. These fibers are contained in the inner bast tissue or bark of the stem. In this group are some of the commercially most important fibers in Egypt, e.g. flax and kenaf.

The bast fibers which are often given the designation of soft fibers to distinguish them from the hard fibers are obtained from the stems of various plants.

Flax *Linum usitatissimum*, L. is the most important bast fiber crop grown in Egypt, whereas kenaf, *Hibiscus cannabinus*, L. ranks second after flax with regard to acreage and tonnage produced every year.

The acreage of flax fluctuated considerably during the last five decades. The annual acreage of flax amounted to 46040 faddans.(1)

As soon as growers expect that the war will break-out they increase the acreage of flax.

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(1) Extracted from annually Review of the Department of Agricultural Economy, Ministry of Agriculture, ART, 1975.

Some of flax fibers produced in Egypt is exported to European markets. In Egypt, the flax fiber is used in some industries especially textile.

Egypt imports about 25000 tons of jute fiber every year costing approximately 5,000,000 pounds for manufacturing bags, sacks and other important products. Kenaf which is characterized with heavy yielding compared to jute, could be used in a wide variation of conditions. In addition, spinning and weaving of kenaf fibers could be carried out on jute machinery.

The annual acreage of kenaf in Egypt amounts to about 10000 faddans.

The rising demand for both flax and kenaf fibers necessitates studying of some cultural treatments on fiber production.

This work was designed to investigate the following:

1. The effect of soil moisture deficit (SMD) induced at different periods of flax growth on the yield of flax and its components and retting.

2. The effect of mineral fertilizers on the yield of flax fibers and fiber quality.

3. The effect of some cultural treatments on the counts of bacteria during retting process.

4. The effect of plant density and nitrogen fertilizer on the fiber yield of kenaf and loss during retting process.

REVIEW OF LITERATURE

Flax and kenaf are the most important bast fiber crops grown in Egypt. In connection with their rising importance in Egypt, the government is pressing hard to increase the production and improve the fiber quality of the fiber crops. Both yield and quality could be improved by cultural treatments. For the diversity of this subject, this work was reviewed under two main parts namely Flax and Kenaf and each part was divided into many sub-parts.

Flax

Flax, *Linum usitatissimum*, L. is the most importent bast fiber crop grown in Egypt. The literature concerning tne relation between cultural treatments with yield and quality of flax crop is greater than any other bast fiber crop in Egypt.

Effect of soil moisture deficit:

1. On growth and yield:

The plant responses to water stress has been given due consideration during the last few decades. Writing of a review nature has been voluminous in symposium proceeding and books (Slavik 1965, Hagan et al. 1967, Eastin et al 1969, Kozlowski 1968, 1968a, 1972, Kramer 1969, Pierre et al. 1969, Slatyer 1972, UNESCO 1973 and Hsio 1973).

The rising demand for knowledge in this field has been stimulated mainly by awareness of the importance of water in food production in developing areas and by progress in understanding the physical aspects of plant-water relations.

Agronomists are interested in the studies concerning the effect of water deficit on growth and yield of field crops. Recently, the effect of water stress on growth, morphology and ontogeny of plants has been reviewed. (Kriedemann et al 1972, Slatyer and Goode 1967).

In Egypt, the literature dealing with the relationship between soil moisture deficit and flax yield and its components is scarce. As reported by The Central Agency for Public Mobilisation and Statistics the water requirement of flax amounted to 1200, 1610 and 1610 m^3 of water in lower, middle and upper Egypt respectively.

Effect of nitrogen fertilizer:

In Egypt the effect of nitrogen fertilizer on the growth, yield and fiber quality of flax has been more considerably investigated than any other cultural treatment.

1. On plant height:

An extensive work has been performed on the effect of nitrogen fertilizer on height of flax plants (Caner 1961-1962, Mansour 1965 and Moursi et al. 1969). These investigators showed that nitrogen increased the height and thickness of flax stems. In Egypt, Moursi et al. 1969, found a linear and a pronounced increase in plant height with increasing the amount of calcium nitrate added to flax plants up to the highest level, i.e. 200 kg. per faddan.

2. On technical length:

Nitrogen fertilizer exerts a marked influence on the plant height as well as the technical length of flax plants. Moursi et al. 1969 found a linear increase in the technical length of flax plants with increase in calcium nitrate up to the highest level, i.e. 200 kg. of calcium nitrate per faddan. They showed that calcium nitrate at a rate of 200 kg. per faddan increased the fiber length over the control by 18.53%. They suggested that these results might be attributed to the increase in the length of fiber cells and/or the increase in the number of cells tied together at their tapering end to form the fiber.

3. On length of flowering region:

In Egypt, Moursi et al. 1969 found a linear increase in flowering region length of flax plants with adding calcium nitrate.

4. On yield:

In Egypt, Moursi et al. 1969 showed that calcium nitrate had a marked effect on the yield of straw before and after retting. The effect was linear. The increase in yield amounted to about 29 and 27 kg. per faddan for flax straw before retting and about 24 and 19 kg. per faddan of straw after retting for the first and the second cwt of calcium nitrate per faddan respectively.

Similarily, calcium nitrate has a paramount influence on the fiber yield of flax. It caused an increase in fiber yield (Moursi et al. 1969). They attributed the favourable effect of calcium nitrate on fiber yield to the increase in technical length of the plant, the increase in the cross sectional area of the phloem and the amount of cellulose precipitated in the secondary wall of the fiber cell.

Frederiksen 1958 in Denmark on scutched fiber, Larsen 1960 in Denmark on scutched tow and Mansour 1965 in Egypt came to similar conclusion. They found increase in fiber yield with adding nitrogen fertilizer.

5. On fiber quality:

Moursi et al 1969 b showed that the total area of the cross section, the cortex, phloem, xylem, phloem + xylem and pith area became great with adding calcium nitrate. Calcium nitrate increased the percentage area distribution of phloem, xylem, phloem + xylem and reduced the percentage area distribution of pith. The percentage area distribution of cortex was not influenced by calcium nitrate. In addition, they found a progressive increase in total area of the individual fiber cell, the wall area, the lumen area, the lumen thickness and the percentage of wall area to total fiber area with adding calcium nitrate. The lumen area to total area percentage followed opposite response.

Grashchenko 1958 indicated that the greatest fiber strength of flax was observed at full mineral fertilization. In 1959, Aukema and Friendrich showed increase in stem fiber content but no effect on fiber quality by adding nitrogen fertilizer within the range from 23 to 41 kg/ha.

In Egypt, Moursi et al (1969 a) found that calcium nitrate increased fiber length and strength but did not affect fiber fineness. They showed a marked improvement in the general grade and tabulated grade of fibers determined according to the mutual experience of the technicians.

Moursi et al (1969 a) concluded that both length and strength of flax fibers were more responsive to the application of calcium nitrate than fiber fineness.

6. On chemical contents:

The main constituents of the vegetable fiber cell is cellulose. Cotton, for example contains 82.7% of cellulose, hemp 67%, jute 64.4% (Urquhart and Howitt 1953, flax 85.14% (Salem et al 1969) and kenaf 79.69% (El-Sonbaty 1974). A part from cellulose, vegetable fibers also contain significant amount of other chemicals such as lignin, hemicellulose, pectic substances, resins, mineral matter, fats and waxes.

The commercial stem fibers such as flax, jute and hemp contain about 12 to 16% of hemicellulose (Urquhart and Howitt 1953 pp 55 - 113).

Lignin is found mainly in the woody core of the stem, and also in the walls of the cells of the ultimate fibers. Lignin is not removed in the retting process to which the plant are subjected for the extraction of the fiber. Jute contains a high percentage of lignin namely 11.8% compared with the other stem fibers such as flax and hemp. Flax for example contains 2.0% of lignin and kenaf 3.3 percent (Urquhart and Howitt 1953 p 106) and kenaf contains 5.73% (El-Sonbaty 1974).

Pectin is found in the walls of the cells which surround the fiber cells as well as in walls of the fiber cells themselves. The pectin contents of the more important fibers are unretted flax, 3.8%; retted flax 1.8% jute, 0.2% (Urquhart and Howitt 1953 p 106) and kenaf 8.53% (El-Sonbaty 1974).

7. Retting:

Retting is the most important operation in the production of both flax and kenaf plants. If retting is not performed properly, the fiber may be ruined or the quality lowered.

Retting cannot improve the fiber quality, but proper retting can ensure maintenance of original properties of the fiber.

The outermost layer of the stem is the cuticle which envelops the next layer, the epidermis. The epidermis has about 40 stomata per square millimetre; through these the bacteria enter the stem at the beginning of the retting process. (Anon. 1953). Beneath this epidermis in the cortex and inside the cortex are the bast fibers which are the flax fibers of the commerce. The fibers occur in bundles in pericycle; each contains about 10 to 40 individual fibers. In one stem, there are about 30 fiber bundles forming a ring around the stem inside the cortex. Within the pericycle and the phloem is the cambium which envelops the inner woody part of the stem. The woody part envelops the pith which is located in the center.

In Egypt, flax and kenaf stalks are spread out in thin layers on the ground and turned once or twice in the field before retting. During this period, stalks are exposed to the attack of aerobic micro-organisms. This retting is referred to as dew retting.

Before the main retting process starts, [redacted] the straw is washed, the air in the straw is driven out and the water soluble constituents are extracted. These materials include carbohydrates, glucosides, tannins, nitrogenous compounds and various colouring matter.

After the straw has been put into the tank, water is let in. The water is drained after the straw has been left for some hours. The straw loses about 8 to 10 percent of its weight owing to the loss in water soluble constituents in the first two hours of leaching process. At the end of leaching process, the water will become dark in colour and there will be a light froth around the edges of the tank.

Once the leaching is finished, the tank is emptied of the leaching water and filled with warm water at a temperature of 80 to 86°F.

Once the fresh warm water has been let into the tank, the retting proper begins. The retting process is divided into two stages, the first of which is known as the development stage, and the second as the actual retting stage or main biological phase.

In the development stage, aerobic bacteria attack the easily broken down substances in the straw. This uses up the air in the water and results in evolution of carbon dioxide and hydrogen. Consequently, aerobic bacteria die off with exhaustion of oxygen in the water and a slimy scum on the surface which is composed of bacteria and fungi appears. During the development stage, the tank should be left undisturbed, otherwise bacteria which are developing rapidly would be lost (Dujardin 1948).

Once the development stage has been completed, the anaerolic bacteria multiply. The pectic materials in the straw is broken down with the decomposition of the primary soft tissues of epidermis first ~~and~~ then the bast ring of the stem.

Retting in Egypt:

Flax and kenaf retting had been well known in Egypt since a long time. Egyptians have for hundreds of years retted flax in the soft warm water of the River Nile (Proscott and Dunn 1949).

In Egypt, flax retting is mainly performed in stagnant water. In Egypt, three companies namely Eastern Co. for linen and cotton, Tanta Co. for Linen and Oils and Cairo Oils and Soaps Co. are concerned with retting in the factories of the two latter companies located at Karatien and Tanta is performed in tanks (8 x 6 x 4 m) using stagnant water method. (Carbon retting process).

Organisms performed in retting:

The organisms concerned in dew retting are numerous. *Rhizopus nigricans*, *Mucor plumbens* and *Cladosporium herberum* (Ruschmann 1923), *Alternaria tenus* and few yeasts and an aerobic spore forming bacteria (Ruschmann and Bartram 1940); the fungi *Denatium pullulans*, *Cladosporium bacterum* and *Alternaria sp.* (Jensen 1941) species belonging to the fungi genera *Alternaria*, *Hormodendrum*, *Fusarium*, *Phoma* and cepholosporium (Fullar and Norman 1944) Rhodotorula macerans ((Frederiksen 1956), the mold Cladosporium herberum, the yeasts Cryptococcus albidus, Rhodotorula glutinis and R. macerans, the mold Pullularia pullulans and some bacteria such as Ps. fluorescens (Wieringa 1951) play a part in dew retting.

A large number of micro-organisms are found in the retting liquor, e.g. aerobic and anaerobic bacteria, yeasts, moulds, Streptococci coliform bacteria many of these organisms seem to take no part in the retting itself.

Several organisms are concerned with anaerobic retting. Clostridium pectinovorum a plectridial anaerobe was the first bacterium to be considered a retting agent in cold water process (Krais 1920, Omelyansky and Konova 1926).

The main retting agents of bast fibers was found to be C. pectinovorum (Markova 1940 a), C. felsineum (Ogle-Jensen and Klyver 1939), Bacillus felsineus (Markova 1940 b). On the other hand, Allen 1946 did not find C. felsineum in retting in England. In Germany, Ruschmann and Bavendamm 1925 found that C. felsineum did not play an important role in the fermentation of pectin. Other anaerobes had been shown as retting agents; some of which are Bacillus humanii (Soriano 1930), C. haumanii (Thiemann and Maravahes 1951) and Plectridium pectinovorum desulfuricans (Seliber and Alekseev 1957) and some other organisms.