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Production of Quality Jute Fibre through Accelerated Retting

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ABSTRACT

Among the lignocellulosic fibres jute has been conspired as the golden fibre for its inherent colour and lustre. Jute is one of the cheapest natural fibers and is second only to cotton in amount produced and variety of uses. Jute fibres are composed primarily of cellulose and lignin. The fibres are separated from the woody core of the stem by steeping the bundles of the harvested and the defoliated plants in water of various sources. The process employs the joint action of microbes and moisture to dissolve the cellular tissues and pectin surrounding the bast fibre bundle facilitating fibre separation from the stem. Water retting produces more uniform and high quality fibre, but it requires both labour and capital. Large volume of clean water is needed for this purpose. Due to unavailability of sufficient water, quality of fibre produced becomes inferior. To avoid scarcity of water, the barks of decorticated jute plants are separated prior to retting in green condition. This is called ribbon retting. The process of retting is further accelerated by the application of a chemical accelerator formulated by National Institute of Research on Jute and Allied Fibre Technology, Kolkata. In this process the defoliated jute bundles (50kg) are immersed in a tank or confined water bodies with ratio of plant to water is 1:2. The bundles are stacked in reverse direction and at a place around 30-40 bundles can be placed. The retting in this process takes little longer, i.e., 10-12 days. Fibre quality in this process was found to enhance around two grades. This may bring economic benefit to the farmers to the tune of ₹ 500-600 per quintal of jute fibre yield.

Keywords: Jute retting, fibre, accelerated retting, quality fibre, microbial retting

Jute, also known as Golden fiber, is an internationally traded major commodity originating primarily from two developing countries-Bangladesh and India. It's easily and widely popularized due to property that it can be spun into coarse, strong threads. It is produced from plants in the genus *Corchorus*, family Malvaceae. Jute is one of the cheapest natural fibers and is second only to cotton in amount produced and variety of uses. Jute fibres are composed primarily of the plant materials, cellulose (major component of plant fibre) and lignin (major components wood fibre). It is thus a lignocellulosic fibre that is partially a textile fibre and partially wood. It falls into the bast fibre category (fibre collected from bast or skin of the plant) along with kenaf, industrial hemp, flax (linen), ramie, etc. The industrial term for jute fibre is *raw jute*. The fibres are off-white to brown, and 1-4 meters (3–12 feet) long. Jute fibre is often called hessian, jute fabrics are also called hessian cloth and jute sacks are called gunny bags in some European countries. The fabric made from jute is popularly known as burlap in North America. The suitable climate for growing jute (warm and wet climate) is offered by the monsoon climate during the monsoon season. Temperatures ranging 20°C to 40°C and relative humidity of 70%–80% are favourable for successful cultivation. Jute requires 5-8 cm of rainfall weekly with extra needed during the sowing period. Due to its good spinnable characteristics, it is a good textile fiber. It is well known as a golden fiber.

The main constituent of the fibre is α-cellulose, hemicelluloses including uronic acid derivatives and lignin. Bioconversion of cellulosic materials into many useful products like cellulase, alcohols, organic acids etc. have considerable importance.

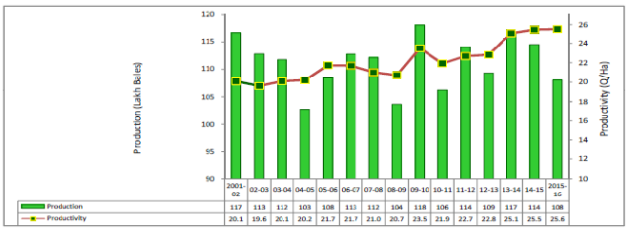
The fibres are separated from the woody core of the stem by steeping the bundles of the harvested

and the defoliated plants in water of various sources (Saha and Banerjee, 1955). The fibre cells are cemented together by pectin and gummy substances (Deb, 1954; Mian *et al.*, 1996). The process of separating and extracting fibres from non-fibrous tissues and woody part of the stem by dissolution and decomposition of pectins, gums and other mucilaginous substances is called retting (Gupta *et al.*, 1976; Majumdar and Day, 1977). The process employs the joint action of microbes and moisture to dissolve the cellular tissues and pectin surrounding the bast fibre bundle facilitating fibre separation from the stem. The two traditional types of retting are field retting or dew retting and water retting. Water retting produces more uniform and high quality fibre, but it requires both labour and capital. Large volume of clean water is needed for this purpose. Due to unavailability of sufficient water, quality of fibre produced becomes inferior. It is necessary to determine optimum amount of water required for proper retting for production of quality fibre. To avoid scarcity of water, the barks of decorticated jute plants are separated prior to retting in green condition. This is called ribbon retting. The process of retting is further accelerated by the application of a chemical accelerator formulated by National Institute of Research on Jute and Allied Fibre Technology, Kolkata. It not only reduces the time of retting and quantity of water, but also improved the quality of fibre by using this chemical formulation.

Production, Area and Yield of Jute Fibre

Production of jute and allied fibres in the country as well as its area coverage and yield levels has been featured by fluctuations during last one and half decades. During the period 2001-02 to 2010-11, production has remained in the range of 102.72 to 118.17 lakh bales of 180 kg each, with the peak of 118.17 lakh bales registered in the year 2009-10. In 2010-11, the production was reduced to 106.20 lakh bales. Whereas the production of jute fibre in 2013-14 slightly increased to 1.14 as per the 4th Advance Estimates of the Directorate of Economics & Statistics (DES), Ministry of Agriculture. The area coverage during this period has delivered the peak of 10.47 lakh ha. (2001-02) and trough of 8.98 lakh ha. (2005-06). During 2013-14, the area under jute cultivation was increased to 9.01 lakh ha. The levels of yield attained under jute cultivation were also marked by ups and downs. During this time-frame, the yield fluctuated within the levels of 1960 kg/ha. (2002-03) and 2372 kg/ha. (2013-14). The year 2010-11 witnessed a considerable decrease of fibre yield to 1722 kg/ha. The position indicates the stagnant levels of jute production; the growth rate in production between triennium ending 2000-01 and 2010-11 has been (-) 0.10%. Fluctuating movements in the three dimensions of area, production and yield levels of jute have been mainly attributed to the shift of area to other crops by farmers prompted by better earnings expectations, and factors such as prevalent weather conditions at the time of sowing, price levels of raw jute, and price and availability of seeds. The increasing use of polythene and synthetic fibres as cheaper and convenient substitutes for jute products, is also reportedly depressing the prospects for jute production. The area coverage and production during the period indicate that as against the earlier years, the area reductions have not correspondingly impacted production during the later years, because of relatively better yield levels. But the substantial determinant of production still remains the extent of area under jute cultivation. The trends in production, area coverage and yield under jute and allied fibres over these years are given in the chart below:

All India Production and Productivity of Jute and Mesta, 2001-02 to 2015-16



Source: *CACP using DES data*

Jute Retting: Key factor for quality fibre production

The quality of the jute fibre is genetically controlled and it varies among varieties on the basis of anatomical features of the fibre cells and their orientation. Coarser and light-body fibre is obtained from sandy soils whereas clay-loam soils with silt give fibre of superior quality. Climate and the

nutrition pattern also affect the fibre. But the most important single factor is 'retting' which, if faulty, spoils the positive contributions of the variety, soil, climate etc. Under-retting gives coarse and over-retting dazed and weak fibre. The bundles are kept standing in water, 30 cm deep, and later placed side by side in retting water, usually in 2 to 3 layers and are tied together. They are covered with water-hyacinth or any weed that does not release tannin and iron.

The float is then weighed down with seasoned logs or with concrete blocks or are kept submerged (at least 10 cm below the surface of the water) with bamboo-crating. Clods of earth used as a covering material or as weighing agent produce dark (*shyamla*) fibre of low value. Gently flowing, fairly deep, clear and soft water is ideal for retting. The optimum temperature is around 34°C; ditches, tanks and pools are also used for retting. Incomplete submergence produces 'croppy' fibre of extremely low value. Most of the defects in fibre are due to faulty retting. Over–retting results in 'dazed' weak fibre. Retting is a microbiological process and, therefore, the end-point is determined by inspecting a few plants each day from the tenth day onwards. If fibre slips out easily from the wood on pressure from the thumb and fingers, retting is considered complete.

Various fungi, aerobic and anaerobic bacteria involved in retting. The aerobic organisms grow first and consume most of the dissolved oxygen, ultimately creating an environment favourable for the growth of anaerobes. It has been observed that the greater part of decomposition is carried out by anaerobic species. Various factors responsible for proper retting viz., nature and volume of water, temperature and pH of water and weighting down material etc.

Retting of jute: Chemistry behind

Anaerobic bacteria and aerobic microorganisms mostly mediate conventional retting of jute. Complete removal of pectin and polysaccharide gummy materials are necessary to obtain good quality fibre keeping the natural strength of cellulose. For conventional retting of jute, water requirement is 1:20 to get good quality fibre (Ray *et al.*, 2015a). The crisis of water becomes more severe due to drought situation or late onset of monsoon. Retting means partial rotting of any living materials. Retting can be defined as a process by which the fibre bundles get separated from non-fibrous tissues and woody parts of stem. Production of good quality jute is primarily dependent on retting. The quality, quantity, nature and temperature of water during retting, presence of micro-organisms etc. are the controlling factors of jute retting. Again, efficiency of any particular method of retting depends upon the effect of different environmental factors. NIRJAFT has worked exhaustively on these aspects of retting phenomena and recommended several measures to improve the fibre quality at farmer's level (Ray *et al.,* 2015b).

Through our study, it was found that jute plants, irrespective of species, jute harvested at 120 days produce fibres of better strength than 140 fays old plants. It was also observed that microbial action in retting water is maximum at a depth of 15 cm from the surface of water and retting is quicker and better at this depth. Some microbial action is evidenced even up to depth of 35 cm, but below this practically no effect has been observed.

From our study, it has been observed that the bacterial count in retting water increased up to seventh day when it reached maximum and then there was sharp fall in the number. As the actual process of separation of fibres takes after this period, it can be inferred that either that either facultative or strict anaerobic microbes are the causative agents carrying out actual retting.

During retting process, a series of biochemical reaction takes place as a result of which chemical composition, pH, Eh and BOD of retting water change continuously. It was observed that release of total sugars increased gradually during retting process up to thirteenth day and beyond this period the increase was significant indicating a condition of over retting, when decomposition of cellulosic components takes place. Galactouronic acid, the main degraded product of pectin, reaches the peak on the thirteenth day, when retting is completed. Pectin is the major binding material between the jute fibres. The maximum galactouronic acid release may be regarded as an indication of completion of retting and over retting starts beyond this period, when decomposition of cellulosic fibre occurs as indicated by excess release of soluble sugars in the retting liquor.

It was also observed that BOD of retting water steadily increased with progress of retting and reached the peak between twelve and fifteen days. The pH of retting water during this period became acidic and then gradually reached neutral values at the completion stage. The redox potential of the water similarly decreased during progress of retting and remained constant during progress of retting and remained constant during twelfth and fifteenth day. The results clearly indicate that the dissolved oxygen was quickly exhausted due to microbial activity and biochemical oxygen demand (BOD) in water increased due to increase of dissolved and particulate organic matter in water. Drop in pH with progress of retting is due to release of acidic components especially galactouronic acid. Drop in Eh values clearly indicates that anaerobic environment was established in water during the progress of retting.

Since the retting process is normally slow, several workers have attempted to hasten the retting processes and improve the quality of fibres by various methods. These methods include addition of chemicals, pure culture of bacteria, pectinolytic enzymes derived from certain bacteria and fungi. NIRJAFT has developed a farmer friendly technology for faster retting of jute through extraction of jute ribbon followed by chemical retting.

Types of retting

The most widely practiced method of retting is water retting. Bundles of stalks are submerged in water. The water penetrates to the central stalk portion, swells the inner cells and bursts the outermost layer, thus increasing absorption of both moisture and decay-producing bacteria. Retting time must be carefully judged; under-retting makes separation difficult and over-retting weakens the fibre. The plants were harvested at 120 days maturity and defoliated. The green stems were immersed in retting tank and covered with polythene sheets. After three weeks the retting was completed. It is a time consuming process and needs a huge quantity of water for retting.

If the retting is not conducted properly the fibres of the basal parts of plant remain hard. The hard basal parts of the fibre are called cuttings (Saha and Banerjee, 1955). The less is the percentage of cuttings, more is the fibre quality.

In double retting, a gentle process for producing excellent fibre, the stalks is removed from the water before retting is completed, dried for several months and then retted again.

Microbial or dry retting

Retting can be also carried out by using a large variety of micro-organisms. This type of retting often requires a minimum amount of water and may be referred as dry retting. Different types of fungi, aerobic and anaerobic bacteria are involved in retting. Micro-organisms attack cambium and secondary phloem as they have no effect on hard wood. The microbes secrete specific enzymes to decompose parenchymatous tissues. Pectisinase, pectase and pectinase enzymes are mainly used to hydrolyze the pectic substances which cement the vascular tissues of jute plant. The enzyme pectisinase converts pectic substances into soluble pectin which is then activated by pectase to produce pectic acid (Bhuiyan *et al.*, 1979). At the initial stage of retting, due to high pH value, the growth of bacteria is vigorous and the enzymatic reaction increases. As the reaction proceeds, slowly the bacterial growth decreases due to decrease in pH value (Haque *et al.*, 2001).

Ahmad *et al.* (2008) isolated aerobic and anaerobic bacteria from retted jute stems. They have been found to comprising three genera, *Bacillus*, *Micrococcus*, and *Pseudomonas* and thirteen species. Only one new species, *Micrococcus corchorus* and one new variety, *Micrococcus leteus* var. *liquefaciens*, are reported. Among the aerobes and facultative anaerobes, *Bacillus subtilis* has been found to be most common and *B.* macerans, *B. polymyxa*, *Micrococcus corchorus* and *Pseudomonas aeruginosa* the most active retting agents.

If the retting is continued beyond the optimum period of time, micro organisms begin to degrade the cellulose of the fibre. Such a condition is known as over retting.

Ribbon Retting of Jute Fibres

Among the various factors that influence the fibre quality starting from seedling to fibre extraction, the retting and extraction have been identified to be the most significant in yielding quality fibre. But the issues associated in conventional stem retting are manifold, requiring abundant water in the ratio

of 1:20 for plant: water besides other factors which lead to imperfect retting and yielding fibres of low grade. In view of the scarcity of suitable retting water it has become imperative to concentrate our thoughts on alternative methodologies for extraction of jute vis-a-vis the conventional method of stem retting. As conceived now-a-days the ribbon retting is considered to have relative advantages over traditional systems in handling the biomass and subsequent retting in water.

With this background in view, alternative method has been evolved such as ribboning of green stems by mechanical devices and retting the ribbons in a small volume of water instead of stem retting. In ribbon retting the volume of biomass to be retted comes down to about 40% only. The retting time is also reduced. The release of organic matter into water is less than one third that of stem retting. Such factors enable the ribbon retting to be conducted in almost one-fourth the water used in stem retting and more number of rettings can be done in the same water.

Jute retting by application of chemical accelerator

Traditional retting of jute takes 15 to 20 days and requires large quantity of water which should be preferably slow-flowing water. Ponds in villages are not allowed for jute retting in general as the water turns dark and foul-smelling making it unfit for domestic use and pisciculture, breeds mosquitoes and creates environmental problem. Erratic rainfall also creates water scarcity for retting of jute. In the absence of adequate retting facilities, jute is mostly retted by immersion in stagnant and insufficient water in ditches repeatedly in batches by which the colour and quality of fibre degrades to grade 4, 5 or even 6 and the farmers are deprived of their earning of hard labour. Moreover, farmers may suffer from health related problems due to working in waist-deep dirty and stagnant water for long hours. The young generation of farmers is losing interest in jute cultivation for the occupational hazard and un-remunerative price of their hard labour.

Ribbon retting with retting accelerator

NIRJAFT has developed a post-harvest technology for accelerated retting of jute which involves ribboning of green jute plant by a manual ribboner or a power ribboner designed and fabricated by NIRJAFT and accelerated retting of the ribbons with an aqueous solution of a chemical formulated by NIRJAFT in minimum quantity of water just sufficient for wetting the ribbons which yields good quality of fibre in higher yield.

Fig. 1: Jute fibre obtained through ribbon retting of jute vis a vis jute from conventional retting

The new jute retting technology will benefit the farmers in various ways. Jute is harvested in 100-120 days in traditional cultivation. In the new retting process, 90-100 days old jute can be harvested and ribboned in the new ribboner machine taking 10-12 green plants at a time. Jute ribbons are made into small bundles and retted with the aqueous chemical solution of 0.5 - 0.7 per cent concentration in a kuchha retting tank made with polythene sheet or in a cemented pucca retting tank. Retting is completed within 8 days and golden lustrous high quality fibre between grade 2 and 3 is obtained on washing of retted ribbon in water. At least 1% higher yield of fibre is obtained in NIRJAFT retting technology due to minimum loss of fibre during ribboning and washing of retted ribbons. The plant to water ratio in the NIRJAFT retting technology is greatly reduced to 1:1 only while traditional retting practice requires 1:20 to 25 ratio of plant and water.

Moreover, whole jute stick of better strength and quality is obtained without breaking through ribboning of green plants compared to the stick obtained after 2 to 3 weeks immersion in water in traditional retting. Jute stick is an important by-product to farmers for fuel, fencing, betel leaf

cultivation, etc. The technology has been successfully demonstrated in the fields in blocks of different districts of West Bengal in which the farmers, State agriculture officers and NGOs participated.

Recipe for Retting of Jute Ribbon

Ribbon extracted from 100 kg of green plant	40 kg
Amount of water required for one quintal of green plant	100 litre
Chemical formulation required per litre of water	0.7 gram
Average retting time	7-10 days

Retting of whole jute plant with retting accelerator

Despite the several advantages of ribbon retting, it is found to be difficult to execute the work as the process require plenty of time for ribboning of jute plants. The most recently developed and available Ribboner takes minimum 3-4 days to ribbon the jute obtained from 1 bigha of land. Moreover, it requires more number of labourers. Therefore, farmers are losing their interest to use this technology. Rather they are keen to use the conventional technology with some modifications. Retting of whole jute plant with the retting accelerator was therefore a better achievement towards this direction.

The Institute has modified the retting technology which do not requires much time for extraction and requires low volume of water. In this process the defoliated jute bundles (50kg) are immersed in a tank or confined water bodies with ratio of plant to water is 1:2. The bundles are stacked in reverse direction and at a place around 30-40 bundles can be placed. The retting accelerator is diluted in the water and uniformly poured in the tank. A few packets were also dusted on the plant heaps and finally the plants were covered with waste jute hessian.

Weights were placed above the hessian to dip the plants just below the water. The bundles were periodically turned to get uniform retting environment. The retting in this process takes little longer, i.e., 10-12 days. Fibre quality in this process was found to enhance around two grades. This may

FLD Programme on Accelerated Retting of Jute Conducted by ICAR-NIRJAFT during 2015-16

Sl. No.	Performed with the help of	Retting Technology	Name of DPC
1.	Krishnanagar Region, West Bengal	Accelerated retting of Jute	Farmers field at Krishanagar
2.	Barasat, North 24 Parganas	Accelerated retting of Jute	Farmers field at Barasat, North 24 Parganas
3.	KVK, Hooghly	Accelerated retting of Jute	Dhobapara, Hooghly
4..	KVK, Hooghly	Accelerated retting of Jute	Dyamargachha, Hooghly
5.	Sheoraphuli DPC	Accelerated retting of Jute	Kulia, Howrah
6.	Sheoraphuli DPC	Accelerated retting of Jute	Bakshi, Howrah
7.	Bethuadahari Regional office	Accelerated retting of Jute	Jompukur, Nadia
	Debagram DPC	Accelerated retting of Jute	Dingel, Nadia
8.			
9.	Cuttack Region, Odisha	Accelerated retting of Jute	Marshaghai
10.		Accelerated retting of Jute	Kendupatna
11.		Accelerated retting of Jute	Danpur
		Accelerated retting of Jute	Dhanmandal
12.			
13.	Purnea Region, Bihar	Accelerated retting of Jute	Kishanganj
14.		Accelerated retting of Jute	Simulbari
15.		Accelerated retting of Jute	Bahadurganj
		Accelerated retting of Jute	Thakurganj
16.			
17.	Agartala Region, Tripura	Accelerated retting of Jute	Udaipur
18.		Accelerated retting of Jute	Jamjuri
19.		Accelerated retting of Jute	Ranirbazar
20.		Accelerated retting of Jute	Taidu-Ompi

bring economic benefit to the farmers to the tune of ₹ 500-600 per quintal of jute fibre yield.

Fig. 2: Demonstration of Accelerated Retting Technology with whole jute plant

Important Information about accelerated retting of jute at a glance

A standard chemical recipe of the chemical retting agent with the standardized parameters is given below. For 100 kg of green jute plant the parameters are presented hereunder.

Physical and physico-chemical parameters

Initial pH of retting water	10.5-11.5
pH at which final retting occurs	3.5-4.5
Average water temperature	25-35°C
Average atmospheric relative humidity (RH)	85-90 %
Completion period retting	7-10 days

Physical Progress in FLD trials

State/ District	Village	Target (No. of trainees)				Achievements (No. of trainees)				Total
		SC	ST	Women	Others	SC	ST	Women	Others	
West Bengal	Krishnanagar Region, West Bengal	15	5	5	30	30	6	16	34	70
	Barasat, North 24 Parganas	15	5	5	30	10	5	5	25	40
	Balagarh, KVK, Hooghly	15	5	5	30	20	9	7	21	50
	Inchhura, KVK, Hooghly	15	5	5	30	13	5	5	27	45
	Kulia, Sheoraphuli DPC	15	5	5	30	20	8	4	15	43
	Bakshi Sheoraphuli DPC	15	5	5	30	10	5	6	23	48
	Bethuadahari Regional office	15	5	5	30	14	8	10	27	49
	Debagram DPC	15	5	5	30	17	6	12	27	50
Odisha	Marshaghai	15	5	5	30	28	9	16	35	72
	Kendupatna	15	5	5	30	22	6	12	40	68
	Danpur	15	5	5	30	21	4	8	42	67
	Dhanmandal	15	5	5	30	24	17	16	34	70
Bihar	Kishanganj	15	5	5	30	15	5	10	40	60
	Simulbari	15	5	5	30	20	8	6	12	40
	Bahadurganj	15	5	5	30	10	2	12	38	50
	Thakurganj	15	5	5	30	9	5	4	30	44
Tripura	Udaipur	15	5	5	30	15	27	18	58	100
	Jamjuri	15	5	5	30	15	5	9	30	50
	Ranirbazar	15	5	5	30	25	5	10	30	60
	Taidu-Ompi	10	30	5	10	20	57	24	8	85
									Total	1161

Yarn parameter values of chemically retted jute fibre

Fibre characteristics	
Fibre strength	22.5 - 26.3 g/tex
Fibre fineness	2.6 - 3.2 tex
Average root content	< 5%
Average fibre grade	TD- 4
Yarn properties of chemically retted jute (8 lb)	
Average tenacity	23.24 cN/tex
Work of rupture	2.7 mN/tex M
True density	1.48 g/cm^3
Fibre bundle tenacity	g/tex

Monitoring of FLD and further reports

The FLDs were monitored regularly by our team as well the local surveillance group deputed for day to day activities. Intermediately operations were conducted by the semiskilled workers associated with jute retting process at JCI DPC level. On completion of the retting process the fibre was properly by a semiskilled worker and dried in shade/ sun. The final weight of the jute bundles was taken on competition of drying and morah were prepared and labelled properly for final testing. Testing was carried out by the NABL accredited fibre testing laboratory situated at NIRJAFT (Table below).

Nearly all the FLDs were attended by the enthusiastic farmers and local people. Many of them were very keen to accept our retting accelerator development programme. All the programes were covered by the local and national Newspapers and television reporters. Many of the newspaper cuttings were collected and have been documented.

Frontline demonstration on Accelerated Retting of Jute/ Mesta during 2015-16

Sl. No.	FLD Location	Area	Age of plant	Yield enhancement over control	Improvement on Grading
1	Krishnanagar Region, West Bengal	Around 0.1ha or 15 k	150 days	1.5%	Control – TD 4+45% Treated –TD 3+60%
2	Barasat, North 24 Parganas	Around 0.1ha or 15 k	150 days	1.5%	Control – TD 5 Treated –TD 3+60%
3	Balagarh, KVK, Hooghly	Around 0.1ha or 15 k	120 days	2.0%	Control – TD 5+90% Treated –TD 3
4	Inchhura, KVK, Hooghly	Around 0.1ha or 15 k	125 days	2.6%	Control – TD 5+85% Treated –TD 4+60%
5	Kulia, Sheoraphuli DPC	Around 0.1ha or 15 k	130 days	2.5%	Control – TD 5 Treated – TD 3
6	Bakshi Sheoraphuli DPC	Around 0.1ha or 15 k	140 days	2.0%	Control –TD 4+45% Treated – TD 3+60%
7	Bethuadahari Regional office	Around 0.1ha or 15 k	125 days	2.8%	Control – TD 5 Treated – TD 3
8	Debagram DPC	Around 0.1ha or 15 k	130 days	2.7%	Control – TD 5 Treated – TD 3
9	Marshaghai	Around 0.1ha or 15 k	125 days	2.2%	Control – TD 6 Treated – TD 4+30%
10	Kendupatna	Around 0.1ha or 15 k	150 days	1.5%	Control – TD-5 Treated – TD-4+60%
11	Danpur	Around 0.1ha or 15 k	150 days	2.0%	Control – W5+40% up Treated – W-4+70%
12	Dhanmandal	Around 0.1ha or 15 k	140 days	2.5%	Control – TD-5 Treated – TD-3+30%
13	Kishanganj	Around 0.1ha or 15 k	150 days	1.5%	Control – TD-6 Treated – TD-4+50%

14	Simulbari	Around 0.1ha or 15 k	140 days	1.5%	Control – TD-5 Treated – TD-3+30%
15	Bahadurganj	Around 0.1ha or 15 k	145 days	1.5%	Control – TD-5+30% Treated – TD-4+80%
16	Thakurganj	Around 0.1ha or 15 k	140 days	2.05%	Control – TD-5 Treated – TD-3+30%
17	Udaipur	Around 0.1ha or 15 k	145 days	1.5%	Control – TD-6 Treated – TD-4+30%
18	Jamjuri	Around 0.1ha or 15 k	140 days	2.0%	Control – TD-5+20% Treated – TD-3+30%
19	Ranirbazar	Around 0.1ha or 15 k	150 days	2.5%	Control – TD-5+60% Treated – TD-3+30%
20.	Taidu-Ompi	Around 0.1ha or 15 k	140 days	2.0%	Control – TD-5 Treated – TD-3+60%

CONCLUSION

The improved process has several advantages over the conventional retting process. The accelerated retting by NIRJAFT technology takes 8-12 days using chemical formulation for completion of retting (Ray *et al*., 2013) while conventional retting of plants takes 18-22 days. The conventional retting of plants requires 20 to 25 times of water while in accelerated retting process reduces the requirement to 50%. NIRJAFT retting process yields fibre of better qualities in colour, strength, fineness and graded between 3 and 4 grades as per BIS standard while conventional retting yields mostly fibre in the grades 6 or lower due to improper retting conditions (Ray *et al*., 2014). Conventional retting yields about 6% fibre on green plant weight while accelerated retting technology records at 1-2 per cent higher yield due to efficient extraction from the sticks. The improved accelerated retting is environment-friendly as it remains shorter period in water emanating lesser foul smell and relieves farmers of the occupational hazard and health risk for working in polluted water during fibre extraction. The accelerators used are not hazardous. The improved retting yields fibre of better grade in higher yield which would fetch higher market price to the farmers of their produce.

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