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Jute: A Multipurpose Bast Fibre Crop Can Reduce the Risk of Climate Change

Kanti Meena

ICAR- Central Research Institute for Jute & Allied Fibres, Barrackpore, Kolkata, West Bengal (700 120), India

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Corresponding Author

Kanti Meena

e-mail: kantimeena@gmail.com

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Abstract

At the interface of global climatic change, green technologies are most compatible to mitigate, prevent the quantum jump of predominant environment parameters and impart adaptive capacity to face the calamities of climate change, which is a global issue. It demands utilization of biodegradable or eco-friendly products for better survival and perpetuation. Jute and jute based products offers best option as those are biodegradable and non-toxic in nature. India and Bangladesh produce about 95% of world total jute and these two countries are comparatively low CO_2 emitting countries.

Introduction

Jute, (*Corchorus* L.) regarded as "Golden fibre", is one of the most important natural lingo-cellulosic bast fibre crop, next to cotton globally and has been reported to originate from Indo-Burma and Africa (Kundu, 1951). It is a predominant coarse fibre crop grown for commercial purposes, particularly in India and Bangladesh. Traditionally classified within the family Tiliaceae, later shifted to Malvaceae based on certain molecular evidences and presently placed in family Sparrmanniaceae. It is an annual or short-lived perennial distributed in tropical, sub-tropical and warm temperate regions of the world. The genus is endowed with about 215 species, subspecies, cultivars, land races and varieties, among which 50-60 species are considered to be important (Mahapatra and Saha, 2008; Benor *et al.,* 2010). Unfortunately, only two jute species are cultivated *viz*., *C. capsularis* L. (white jute) and *C. olitorius* L. (tossa jute) with haploid number of seven (n = 14) chromosome.

It is a cash crop with marketable significance for generation of diversified value-added industrial products, in addition to its immense potential as packaging material. It provides the raw inputs for textile, paper pulp, geotextile, packing decorative and many other ancillary industries. Beside it is also used as a green leafy vegetable, and is a rich source of antioxidants, endowed with diverse fatty acid compounds with antioxidative properties and also contain ionone glycoside, cyclooxygenase 2 and possess anti-inflammatory properties.

Jute cultivation could be considered for afforestation and reforestation with an intense relationship with the environment. Jute inertly cleans the air and has low carbon footprint, which enriches the soil. It is reported that during the 100 to 120 days of jute growing period, 1 hectare of jute plants consumes about 15 MT CO_2 and releases 11 MT of O_2, the life supporting gas. Whereas, the tropical tree plantations of pine and eucalyptus can sequest an average of 33 MT of CO_2 per hectare per year. The total amount of CO_2 consumed per year

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E-mail: *bioticapublications@gmail.com*

is about 22.5 million tons, which is equivalent to 22.5 million CER. However, small amount of CH_4 is emitted at the time of jute retting, which can be diverted for biogas production (at commercial level) as a source of heat and light in rural areas.

Jute as Biofuel

The green biofuel offers most potential substitute for petrol and diesel and constitutes an important source of energy. They play crucial role in combating climatic change and mitigation of carbon emissions and release less GHG compared to fossil fuels. Biofuel production is well evident from crops like sugar cane, jatropha, sorghum, corn *etc*. Jute is a biodegradable and environmentally safe, non-grain fibre crop, with high cellulose and hemicellulose content in biomass compared to non-tree species. Potential of jute for CO_2 credit/ sequestration, water conservation, easy biodegrability, low cost for biofuel due to soft biomass makes jute a candidate species for biofuel. The hemicellulose component of this crop possess high energy output and biofuel conversion rate, thus offer tremendous option for mitigating climatic change. Its low input requirement and easy growing nature makes it a good source of biomass for biofuel production in marginal areas. It is also used for combustion in the household kitchens especially in Eastern India and Bangladesh, where jute is grown. The burn rate of jute stick (1.1 kg/h) is comparatively lower than the straw and the emission of fine particulates (1.7 g/kg) is estimated to be lowest among many wood and non-wood fuel sources. Biomass generated by jute is comparable with other biofuel producing crops and it adds huge amount of organic matter to the soil and left over roots increases soil organic content. In India about 3-4 MT of jute stick is produced, which can be efficiently used for biofuel production.

Jute for Plastic Products and Polybags

Plastic bags are made up of polypropylene, which involves release of huge amount of CO_2 during their manufacture. However being 100% biodegradable and eco-friendly in nature, jute based products do not pollute the environment like plastic and poly bags, thus utilization of jute and jute products needs to be encouraged to save the environment for smooth livelihood of all beings on planet earth. Cultivating jute in nearby area of plastic and polybag industries would help in sequestration of CO_2 emitted during the manufacturing process. Jute plants deemed to clean the air, when the plants are in vegetation and assimilate three times more CO_2 than the average tree, converting the CO_2 into oxygen.

Impact of shelf life of Jute fibre on the environment is appreciably superior in comparison to polypropylene (PP) used in our daily life (non-degradable). Production of polypropylene fibre requires 10 to 20 times more energy than jute fibre. Production of 1 ton of polypropylene produces 3.7-7.5 tons of CO_2 whereas jute production has a negative impact on CO_2 production. 1 MT of PP releases 7 MT of CO_2 in the nature whereas 1 MT of jute fibre removes 2 MT of CO_2 from nature. 1 MT of PP generates five times more waste along with NO_2, SO_2, H_2S, CO_2 and CH_4 on complete combustion than that of 1 MT of jute. Jute and jute products are also photodegradable, thermo-degradable, non-toxic, and possess UV absorbing capacity. Jute production requires more water, but jute waste water does not contain heavy metal like in PP wastewater.

Jute for Paper and Pulp

Tremendous use of paper in our daily life at different levels is creating havoc to the environment as wood is the major source. Expansion of cultivable agriculture land and huge usage of paper are major bottlenecks facilitating deforestation at an alarming rate. The demand for pulp and paper is increasing, which in turn enhancing deforestation in both developed and developing countries and restoration of the forest resources is difficult due to relatively long life cycle of trees. However, drastic reduction in the supply of wood/ bamboo pulp is a serious concern and reduction of forest resources have enforced many countries to search for alternatives for making paper from "Tree free" pulp. The pulp and paper industry is under constant pressure to reduce emission of hazardous components in air and water leading to environmental threat. In order to keep up with the increasing demand for pulp and paper and to mitigate increasing environment disorders, the industry needs to look forward towards improved techniques and alternative resources.

In future use of non-wood fibers on large scale would be a hard reality and about 15-20% of world pulp production comes from non-wood fibrous raw material (jute, kenaf, hemp, sisal, straw, bamboo, bagasse, cotton and sugarcane). Most non-wood pulp is produced in China and India and account maximum contribution of the total non-wood pulp production. Jute contains cellulose like any other raw materials used for paper pulp, it has been found to be an excellent raw material for making good quality pulp and paper to produce diversified products for packaging industries. It is a renewable energy source, takes only 120 days for its growth and to attain harvestable stage. Jute sticks (by-product) are used as fuel apart from other household uses by the rural farmers. Jute sticks annually save 5.06 million tons of forest wood and bamboo in India and Bangladesh and help in preserving ecological balance.

Jute as a Soil Enricher

The plant possesses unique capacity to enrich the soil with micronutrients and maintain the soil fertility with leaves and other left over parts after harvesting. Its roots are capable of breaking the plough pan. They enrich the microbial population and improve drainage system and contribute good

percentage of the dry weight as organic matter through leaves, roots and bark and add 10 times more organic matter into the soil. The leaves are good source of manure for increasing fertility of land. Jute is used in geotextile industries, which reverts the nutrients back into the soil when it is decomposed. Jute crops incorporate 5.43 million tons of dry leaves per year to the soil during defoliation stage prior to retting. By this process soil is enriched by an equivalent amount of 1,68,750 tons of N_2, 56,250 tons of phosphorous (P), thus minimizing the use of chemical fertilizers. About 4.88 tons of CO_2 get sequestered per ton of raw jute fibre production. Jute plantation acts as a sink for carbon. The CO_2 emission from jute is carbon-neutral in nature since the product is from plant-source and can be considered as biomass. GHG emissions from jute are negative on account of large carbon sequestration in Phase I (vegetative). All man-made geo-synthetics exhibit positive GHG emissions.

Mitigation of Soil Erosion using Jute

Soil, the important matrix on planet earth, provides the medium for plant growth and water retention, and thus maintains life line of all biota. Top soil is highly vulnerable to erosion due to man-made adverse activities, thus the issue needs to be addressed by a sustainable, eco-friendly and aesthetic solution. Jute is one of the strongest natural fibres with high tensile strength and low extensibility. It is also enriched with cellulose and hemicellulose that facilitates absorption and retention of water. The biodegradable nature of jute is generating importance in variable agricultural sectors to control soil erosion, seed protection, weed control and in maintain soil fertility.

Jute products are used extensively in geotextiles in India since 1980's to control soil erosion. Its fibre is used to develop soil erosion control blanket (jute mesh and mat), which conserve moisture, allow water and light infiltration, encourage growth for germination of seed and natural vegetation and soil to breath, minimize water requirement and reduces evaporation. JGT acts as mulch on biodegradation, adds micro-nutrients to the soil and creates a congenial humid micro-climate conducive for well growth of vegetation. Upon bio-degradation jute enhances the hydraulic conductivity of soil, besides the mulching effects. Jute possess highest water-absorbing capacity (up to about 5 times its dry weight), and ground storage capacity, helps in reduction of the velocity of surface run-offs, mitigation of extremes of temperature, bio-degradation with addition of useful fibres to the soil, creation of congenial humidity with sufficient open structure supporting plant-growth and is eco-friendly.

Conclusion

Climate change is one of the most complex global issues facing by the world today. This serious concern is leading to a great change on planet earth, in turn affecting our lives. India is the fourth largest country in the world contributing for CO_2 emission. It's a man-made greenhouse gas, which acts like a blanket trapping heat near the surface of the earth, which mainly comes from the burning of fossil fuels as well as by deforestation, thus release of carbon stored in them to the atmosphere as CO_2. Use of jute as soil enricher minimizes fertilizer application in the farmer's field with minimum/ no chemical fertilizer manageable with only farm yard manure (FYM). It helps in reduction of emission of GHG to atmosphere and nourish by absorbing CO_2 and releasing O_2. Only the retting process involves some negative impact to environment by releasing CH_4, H_2S that can be minimized by ribbon retting and by utilizing retting residual water as fertilizer and CH_4 for biogas production. All agricultural byproducts of jute, bear positive impact on soil, water and atmosphere, hence it can be a potent crop for mitigating climate change. Jute can be a potential source for "green technology" as it acts as sink to mitigate greenhouse effect.

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