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Van Sangyan

Note to Authors:

We welcome the readers of Van Sangyan to write to us about their views and issues in forestry. Those who wish to share their knowledge and experiences can send them:

by e-mail to vansangyan_tfri@icfre.org

or, through post to The Editor, Van Sangyan,
Tropical Forest Research Institute,
PO-RFRC, Mandla Road,
Jabalpur (M.P.) - 482021.

The articles can be in English, Hindi, Marathi, Chhattisgarhi and Oriya, and should contain the writers name, designation and full postal address, including e-mail id and contact number. TFRI, Jabalpur houses experts from all fields of forestry who would be happy to answer reader's queries on various scientific issues. Your queries may be sent to The Editor, and the expert's reply to the same will be published in the next issue of Van Sangyan.

Cover Photo: Panoramic view of Achanakmar-Amarkantak Biosphere Reserve
Photo credit: Dr. N. Roychoudhury and Dr. Rajesh Kumar Mishra, TFRI, Jabalpur (M.P.)

From the Editor's desk

Since prehistoric times, humans have used natural products, such as plants, animals, microorganisms, and marine organisms, in medicines to alleviate and treat diseases. According to fossil records, the human use of plants as medicines may be traced back at least 60,000 year s. The use of natural products as medicines must, of course, have presented a tremendous challenge to early humans. It is highly probable that when seeking food, early humans often consumed poisonous plants, which led to vomiting, diarrhea, coma, or other toxic reactions—perhaps even death. However, in this way, early humans were able to develop knowledge about edible materials and natural medicines . Subsequently, humans invented fire, learned how to make alcohol, developed religions, and made technological breakthroughs, and they learned how to develop new drugs. Traditional medicines (TMs) make use of natural products and are of great importance. Such forms of medicine as traditional Chinese medicine, Ayurveda, Kampo, traditional Korean medicine, and Unani employ natural products and have been practiced all over the world for hundreds or even thousands of years, and they have blossomed into orderly-regulated systems of medicine. In their various forms, they may have certain defects, but they are still a valuable repository of human knowledge.

Medicinal plants provide major source of molecules with medicinal properties due to presence of natural compounds. In these components, antioxidant substances are of particular interest. The oxidative stress that leads to progression of disorders such as: cardiovascular diseases, degenerative conditions, rheumatic disorders, metabolic syndrome, and in aging can be reduced with the help of antioxidant properties of medicinal plants and act as key-feature of modern multi-potent remedies. During ancient as well as in modern culture, medicinal plants play very important role in protection of human health. It has been reported that two-thirds of the world's plant species contain medicinal property.These medicinal plants contain several components of therapeutic value so they can be used as drugs or formulations to treat various human diseases. Due to more availability, cost affectivity and non-toxic nature, these drugs are good source of therapeutic agents.

Various medicinal plants have antioxidant activity, high phenolic content and a large amount of flavonoids and flavonols. They are used around the world as therapeutic agents. The present informative note suggests that medicinal plants that possess antioxidant potential are the best supplements for the diseases associated with oxidative stress. However, in vivo studies of the all the medicinal plants are required. Before they are applied in the food processing industry or used as preventive medicine, their systematic investigation should be done to identify their antioxidant potential.

In line with the above this issue of Van Sangyan contains an article on Stereospermum chelonoides: Prospective of a lesser known and medicinal tree. There are other useful articles viz. Dragon fruit: a fruit crop for future, Coix - An underutilized crop of economic importance, Emergence of sal borer in Madhya Pradesh and Chhattisgarh, मार्किंग नट- भिलवा, Forests, water and rivers .

I hope that readers would find maximum information in this issue relevant and valuable to the sustainable management of forests. Van Sangyan welcomes articles, views and queries on various such issues in the field of forest science.

Looking forward to meet you all through forthcoming issues

Dr. R. K. Verma
Scientist 'G' & Chief Editor

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Stereospermum chelonoides: Prospective of a lesser known and medicinal tree

L.K. Behera, R.P. Gunaga, S.K. Sinha, Madhuri Sukhadiya, C. A. Dholariya and V.M. Prajapati

College of Forestry, Navsari Agricultural University, Navsari- 396 450

Email- chintanforestry@gmail.com

Introduction

Stereospermum chelonoides (L.f.) DC. synonymously known as *Stereospermum suaveolens* (Roxb.) DC. It is commonly called as 'Padiala or Paral' in Hindi whereas 'Patala' in Sanskrit and belongs to 'Bignoniaceae' family. It is a large sized indigenous tree and distributed in sub Himalayan tract, central parts of India. Rajasthan, Chota Nagpur, Deccan plateau and Peninsula, in Tamilnadu distributed in Salem. Further in Assam, Meghalaya and in moist deciduous forests of Western Ghats (Troup, 1986; Masoumeh & Deokule, 2013). *Stereospermum chelonoides* is globally distributed in East Asia - India, Sri Lanka, Nepal, Bangladesh, Myanmar, Thailand, Cambodia, Laos, Malaysia.

Destructive methods of harvesting seriously reduced seed production and ultimately caused the gradual reduction of population in natural conditions. The species is normally propagated by seeds and collection of seeds is also a laborious process as winged pericarps dispersed by wind after mature. Further, poor germination rate creates difficulty for the species and hence propagation by seeds in the wild is limited in natural habitats (Baul, 2006).

Taxonomy and morphology

Taxonomically Patala is under Kingdom- Plantae, Phylum- Mangoliophyta, Class- Mangoliatae, Order Scrophulariales, Family Bignoniaceae. Tree is a large deciduous tree, 10-20m tall with dark brown bark. Leaves are compound imparipinnate, 30-60cm long. Leaflets 3-4 pairs, 7.5- 15×5-7.5cm, broadly elliptic, usually acuminate, often serrulate, rough above, pubescent beneath, base usually rounded and unequal sided. Main nerves 6-8 pairs with reticulate venation. Flowers dull purple, yellow within, and fragrant in large lax trichotomous viscidly-hairy panicle. Calyx 1cm long, campanulate, viscidly hairy, lobes 3-5, short and broad, Corolla 2.5-3.8cm long, dull purple, infundibuliform, pubescent outside, bearded inside on the lower, glabrous on the upper side, limb oblique, 2-lipped, lobes rounded, crisped crenate, capsules straight, cylindric, slightly ribbed, 30-60cm × 1.7cm, somewhat rough with elevated whitish specks, valves thick and hard. Seeds 3.2 × 1.3 cm with large membranous wings at each end. Root is dark brown, cylindrical, fissures; transversely extended lenticels are seen (Anon., 1992; Kritikar & Basu 1999).

Climate and soil

A plant of the moist subtropics and tropics and found at elevations up to 1,300 meters. It grows best in areas where annual daytime temperature is within the range of 24-32°C (tolerate in the range of 5- 47°C). Further at

dormant stage, the plant can survive temperature down to about -5°C, however young growth can be severely damaged at -1°C. It prefers a mean annual rainfall in the range of 1,200- 2,500mm (tolerates in the range of 750-3,800mm). Grows well in full sunlight condition though it can tolerate partial shade. Succeeds in a wide range of well drained soils and prefers a pH in the range 6- 7 (tolerate 5.5- 7.5 pH). The tree produces suckers profusely. Trees can survive forest fires. It is one of the commonest trees to be seen in the savannah lands of India and able to produce and develop shoot annually in spite of regular fire incidence. The plant is generally propagated by seeds and sometime by cuttings and air layering.

Utilization of *Stereospermum chelonoides*

Common uses

Tender young fruit and flowers are cooked and eaten as a vegetable. The grey wood is hard, elastic, moderately durable, and easy to work. It is used for making furniture, construction, tea boxes, canoes etc. An excellent fuel and the wood also make a good charcoal.

Ethnobotanical uses

An infusion of the pleasant tasting root, as well as the fragrant flowers, is used as a cooling drink in the treatment of fevers. The juice of the bark is used to treat indigestion. The decoction of the root is antipyretic and is useful in asthma, cough and excessive thirst. The bark and all parts contain a napthaquinone and lepachol (Sandermann & Dietrichs, 1957; Joshi *et al*., 1977). Flowers are used in bleeding disease, sore throat and diarrhea; fruits are useful in blood diseases. The root bark is an ingredient of Dashmoola (Tomar *et al*., 2013) and Chywanprash (Yashoda *et al*., 2004). It is regarded as cooling, astringent cardio tonic, bitter, diuretic and generally used in combination with other medicine; the ashes of the plant are used in the preparation of alkaline water and caustic pastes. Fruits are useful in hiccough and blood diseases (Negi, 2000).

Pharmacological uses

Different parts of the tree are used for pharmacological purposes. Root is used for the activity against Ranikhet disease, hypoglycaemic and anticancer activity (Dhar *et al.*, 1968). Stem bark is used for diuretic effect, antihyperglycemic, antioxidant (Balasubramanian *et al.*, 2012) hepatoprotective and free radical scavenging activity (Chandrashekhar *et al.*, 2010), analgesic, antipyretic, antiinflammatory (Balasubramanian et al. 2010), antimicrobial and cytotoxic activities (Mohammed *et al.*, 2006), antiulcer and gastroprotective potential (Ashok *et al.*, 2011), *In vivo* immunomodulatory activity (Amal *et al*., 2013)

Conclusion

Stereospermum chelonoides an indigenous, medicinally important and lesser known tree species distributed few lregions of India having maximum utility in the pharmacology and due problem in seed germination, can be given importance for research and management for greater prospective in India to get multiple benefits.

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Photographs of *Stereospermum chelonoides*

Tree

Leaves

Flowers

Fruits

Seeds

Bark

Dragon fruit: *a fruit crop for future*

Tamanna Perween[1] and Abdul Majid Ansari[2,*]

[1]Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal-741252, India
[2]Zonal Research Station (Birsa Agricultural University, Ranchi), Chianki, Palamau-822102, Jharkhand, India
*Corresponding author email: majid.gbp@gmail.com

Introduction

Dragon fruit *Hylocereus costaricensis* (Haw. Britton and Rose) is a climbing vine cactus species which has received worldwide recognition first, as an ornamental plant and then as a fruit crop. This species is native to Costa Rica and Nicaragua, although its natural range is hard to determine because it has been cultivated so widely. It occurs in dry or deciduous coastal forests, at elevations of 0 - 1,400 m (0 - 4,593 ft) above mean sea level. Its fruit is the most beautiful in the family cactaceae with a bright skin studded with green scales and white or red flesh with tiny black seeds. The flower is so beautiful that it is nick named as "Nobel women" or "Queen of the night" the juicy flesh of fruit is delicious in taste it is well established as new crop in Australia, China, Israel, Malaysia, Nicaragua, Taiwan, Vietnam and Bangladesh. Thus

underutilised dragon fruit is considered as fruit crop for future in the world as well as in the Indian sub continent.

Fig. 1: Dragon fruit plant at flowering stage

Health benefits of Dragon fruit

- Helps in controlling diabetes
- Lowering of cholesterol level
- High in fat and protein
- Excellent source of antioxidant
- Preventing arthritis
- Improving heart health
- Helps in weight management
- Fight against ageing
- Preventing asthma
- High in vitamin and mineral content

USES

Fig. 2: Dragon fruits at maturity

Dragon fruit can be processed into a range of products as juice, sherbet, jam, syrup, ice cream, yoghurt, jelly, preserve, candy and pastries, sometime also in pizzas. In Malaysia dragon fruit wine industry is popular. The red colour fruit pulp is used as colouring agent in many food industries. Flower buds are used in soup, salad and as vegetables.

Origin

Mexico and Central America (Costa Rica and Nicaragua) and South America.

Botanical description

- Botanical name: *Hylocereus*
- Dicotyledonous family: Cactaceae
- Chromosome number.: 2*n* =22
- Genus: 120 - 200
- Species: 1500 - 2000

Horticultural important genera are *Stenocereus* Britton & Rose, *Cereus* Mill. *Selenicereus* (A. Berger) Riccob and *Hylocereus* Britton & Rose.

Vegetative morphology

Plant is perennial, fast growing, climber with triangular or rarely four or five sided stems. The stems are fleshy, vine like with many branched segments. Each segmnt has three wavy wings or ribs with corneous margins and 1 - 5 spines. These form aerial roots that adhere and climb and keep errect. These roots enable the vine to climb over rocks, treees or cling to walls and forms dense masses. The stem may reach upto 6 meter or more depending on the growing condition.

Propagation and planting density

H. undatus and *H. costaricensis* can be multiplied naturally and very easily by cutting off the stem *as soon as* it touches the ground. The sowing of seeds and the *in vitro* multiplication of young shoots of mature plants are also possible but the fruiting stages reached more rapidly with cuttings, less than one year after planting, as opposed to three years for plants grown from seed. Finally, the robustness of these species enables cuttings to be taken directly in the field; provided cuttings are at least 50 - 70 cm in length and are regularly watered in order to ensure satisfactory rooting. Given these conditions and the plant's characteristics, around 90% of the cuttings will take place. The distance between plants depends on the type of support/staking used. With a vertical support 2 - 3 m distance between planting lines is required. 2000 and 3750 cuttings /ha, @ of three cuttings per support is ideal for planting. The congenial height for vertical supports is 1.40 - 1.60 m.

Mineral nutrition and irrigation

Yields vary as a function of the nutritive elements supplied. Dragon fruit's root system is superficial and can rapidly assimilate even the smallest quantity of nutrients. Mineral and organic nutrition is particularly advantageous and when they are combined, their effect is even more beneficial. Even if dragon fruit can survive with very low rainfall, even many months of drought, when good quality fruits are required, a regular water supply is needed. Regular irrigation is important, because it enables the plant to build sufficient reserves not only to flower at the most favourable time, but also to ensure the development of the fruits. Localized micro-irrigation is recommended for better crop. In addition to the efficiency of the water supplied by this system, micro-irrigation avoids uneven and excess watering that can result in the flowers and the young fruits falling off also prevent insect-pest attack.

Following fertiliser doses may be suggested for Gangetic Alluvial planes:

450 g N+ 350 g P2O5+ 300 g K2O along with 20 kg FYM/plant/year.

Time of application of nutrients:

Growth stage	Per cent (%) nutrient application		
	N	P_2O_5	K_2O
Before flowering	10	10	30
At fruit set	20	40	25
At harvest	30	20	30
2 month after harvest	40	30	15

Flowering and pollination

Few studies have been published on the floral biology of *H. undatus* and *H. costaricensis*, which are the most widely cultivated *Hylocereus* species in the world. The flowers of these two species appear under the areoles; they are large (more or less 30 cm), in the shape of a funnel and nocturnal. The ovary is located at the base of a long tube carrying the foliaceous scales to the exterior. There are numerous stamens on a slender anther stalk. The unusually large, tubular style is 20 cm in length and 0.5 cm in diameter; the stigmas have 24 slender lobes, creamy green in colour. Floral growth does not depend on water availability, but on day length. The floral buds can remain in the latent stage for many weeks, and the beginning of flowering generally occurs after the rainy season. In the southern hemisphere, *H. undatus* and *H. costaricensis* flower from November to April and, in the northern hemisphere, from May to October. Flowering episodes are cyclic and spread out over the whole period. The number of flowering episodes or flushes depends on the species: seven to eight for *H. costaricensis* and five to six for *H. undatus*. There is a period of three to four weeks between flowering flushes which makes it possible to see floral buds, flowers, young fruits and mature fruits on the same plant at the same time. The periods between the appearances of floral buds (lifting of the areole) and flowering (stage1), and between flower anthesis and fruit harvest (stage 2) are very short: around 15 - 20 days for the first stage and 30 days for the second stage.

In their native countries, pollination of these two allogamous species is carried out by bats at night or by a butterfly belonging to the *Sphingideae* family of the genus *Maduca*. Dehiscence takes place a few hours before the complete opening of the flower. Pollen is very abundant, heavy and powdery. Flowers open at between 8:00 P.M. and 8:30 P.M.; the stigma dominates the stamens (the position of the stigma at this stage encourages allogamy). Flowers bloom only for a day and then close (whether fertilizedor not) in the morning of the day after anthesis. The following day, petals become soft and then slowly dry. The lower part of a non fertilized flower becomes yellowish and the whole flower falls off four to six days later, while the lower part of a fertilized flower remains greenish and increases enormously in volume, indicating that the fruit has set.

Manual pollination is simple and this operation is facilitated by the floral characteristics of *Hylocereus*, as the different floral parts are huge. Manual pollination may be carried out from before anthesis of the flower from 4:30 P.M. until 11:00 A.M. the next day. Pollination is accomplished by opening the flower by pinching the bulging part. This reveals the stigmata, which are then covered with pollen with a brush. Alternatively, the anthers can be directly deposited (with minimal pressure) on the stigmata with the fingers.

Harvesting

The fruit skin colours very late in the maturation stage, changing from green to red or rosy-pink (25 - 27) days (depending on the species) after anthesis. Four or five days later, the fruits reach their maximal coloration. After this stage, the fruits of *H. Costaricensis* burst without spoiling. The first harvest begins from the 18th month after the cuttings were planted; the time period between flowering and harvest is short and from 27 - 33 days depending on the ecology .The yield depends on planting density and is around 10 - 30 t/ha. The absence of a peduncle makes picking difficult. The present harvesting technique of simply twisting the fruit very often injures the skin and secateurs should consequently be used.

The fruits are not very fragile, but to ensure a good quality product certain precautions should be taken; for example, careful handling during processing and storage, especially for *H. costaricensis* whose foliated scales is brittle.

Post-harvest management

Major post-harvest problems include water loss and shrivelling, decay, bract yellowing and chilling injury of dragon fruit. It needs Adoption of appropriate packaging and coating, delaying bract senescence and chilling injury alleviation.

Marketing Channels

Dragon fruit is primarily grown for the fresh market and is often sold through specialty stores and farmers' markets. In West Bengal demands are exceeding the supply for planting materials as the fruit growers are getting aware to the importance and economics of the fruit crop. It also supports agro tourism.

Economic return

One pole normally yields approx 15 - 25 kg of fruits. Yield of 60 - 80 kg per pole has been reported in India. These fruits are sold in the market at Rs 300 - 400 per kg, but the general Farm rate is approx between Rs. 125 - 200 per kg. An average yield of 8 - 12 t/acre is to be expected in better management condition with full package of practices.

Future thrust

Dragon fruit is a high value fruit crop, the farmers can earn about Rs 4 - 5 lakhs per acre annually. The productive age of the dragon fruit is also very long i.e. 20 - 30 years. A full-grown plant on an average yields 25 - 30 t/ha. Dragon fruit has no tendency of irregular bearing. It gives continuous and steady fruiting throughout the season. It bears heavily every year with no crop failure. Fortunately, in dragon fruit no serious pests and diseases attack has been observed, thus it has a better scope to become commercial eco-friendly fruit crop of the country and most suitable for the organic farming promotion. The dragon fruit can be grown from humid to sub humid to arid region where the climate is warm and humid. Dragon fruit can be stored for one month in open conditions at room temperature and for 4 - 6 months in cold storage.

Conclusion

The fruit is well adapted to the agro-climatic condition of India. Being highly remunerative, the innovative fruit growers are showing keen interest in growing dragon fruit. The reasons behind the growing popularity of the fruit are due to high market price, rich in antioxidant and nutraceutical properties, short juvenile phase, precocious bearing and attractive fruit colour. Cultivation of dragon fruit will take a new way along with vision of export of the crop and improving the livelihood of the small and marginal farmers.

Coix - An underutilized crop of economic importance

V C Tyagi, Maneet Rana, Rahul Gajghate, Nitish Rattan Bhardwaj, S S Bhat and R V Kumar

ICAR-Indian Grassland and Fodder Research Institute
Jhansi-284003
Email: tyagiv54@yahoo.in

Introduction

Grasses (family Poaceae) form one of the largest plant communities and serve multipurpose functions in sustenance and maintenance of the ecological balance of different ecosystems. The family consists of about 780 genera and around 12,000 species, due to which it has become the fifth-largest plant family, after the Asteraceae, Orchidaceae, Fabaceae and Rubiaceae. Genus *Coix* (*Coix lacryma-jobi* L.), a native to Southeast Asia, belongs to the grass family (Poaceae) and is a close relative of maize, thus considered to be a valuable genetic resource for maize improvement. It has different vernacular names in different states such as adlay, giral, golugu, gurgur, kara, koa sangti, kesai, kasi, etc and is widely known as Job's tear due to its large, shining, pear shaped fruits showing fanciful resemblance to tears.

Distribution in India

Coix can grow in a variety of environments including forest margins and swamps from the tropical to the temperate zones. However, In India, it mostly found in Rajasthan, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, West Bengal, Orissa and Assam. However, the main centre of distribution appears to be the North Eastern Hilly states like Assam, Meghalaya, Nagaland, Mizoram, Arunachal Pradesh etc. Because of its limited cultivation on a very small scale, *Coix* has been categorized as a minor cereal.

Botanical description

Coix grows up to 3-6 ft tall, erect, annual, many branched, monoecious plant, with brace-roots from the lower nodes. Nodes are glabrous, leaf blade is broad, linear to ovate-lanceolate, 10-60 cm × 1.0 -2.5 cm, base rounded to almost cordate, apex acuminate, margins rough, smooth or scabrid above. Inflorescences numerous, terminal and axillary, each consisting of separate pistillate and staminate racemes, cupules borne on long stout peduncles from axis of upper leaves, white or bluish, bony, lustrous, globose-ovoid, 5–15 mm long; upper pistillate floret fertile, lemma scale-like, 3–5-nerved; palea reduced to a small scale; staminodia 3; staminate raceme 3–5 cm long, the spikelets 7–10 mm long, glumes equal to the spikelet in length, coriaceous-membranous, broadly lanceolate, glabrous, smooth, lemma membranous, lanceolate, 3-nerved, glabrous, palea similar in shape and texture to lemma, 2-nerved. Caryopsis broadly ellipsoid to subglobose, 2.5–5 mm long, chromosome number (2n) is 20.

Cultivation practices

Job's tear is often propagated by seed (caryopsis). However, propagation by cuttings is recommended for fodder production. The crop can be sown either by broadcast or dribbled in a well prepared soil with a seed rate of 10–15 kg/ha. Seed is dibbled at 2.5 cm depth, at spacing of 60 x 60 cm. Sufficient rains during early stage of growth and a dry period at the time of grain setting are necessary for getting good yields. Weeding is recommended up to 60 days after sowing or until Job's tears has attained a plant height of 40 cm. The crop has been reported to respond well to the application of organic manures. However, a fertilizer dose of N:P:K @ 40:20:20 kg/ha is recommended to get good yields. Crop harvested in 4-5 months after sowing. It is reported that Job's tears yields of 2-4 tons of

husked grain per hectare, with a hulling percentage of 30-50 %. Plants are cut off at base and grain separated by threshing. Seeds are dried in sun prior to milling.

There are 4 varieties accepted by the World Checklist of Selected Plant Families of the Royal Botanic Gardens, Kew, UK. They are:

- *Coix lacryma-jobi* var. ma-yuen (Rom.Caill.) Stapf
- *Coix lacryma-jobi* L.
- *Coix puellarum* Balansa
- *Coix lacryma-jobi* var. *stenocarpa* Oliv.

The common wild variety is *C. lacryma-jobi* L. which is hard shelled and has been used as beads for making necklaces and rosaries. Soft-shelled varieties (*Coix lacryma-jobi* var. ma-yuen (Rom.Caill.) Stapf) are eaten.

Nutritional value of seed

Despite its minor crop status, Job's tear is a nutritious grain. It is found that *Coix* contains more fat and protein than rice and wheat. It is reported that per 100 g seed contains nearly 380 calories, 11.2 g H_2O, 15.4 g protein, 6.2 g fat, 65.3 g total carbohydrate, 0.8 g fiber, 1.9 g ash, 25 mg Ca, 435 mg P, 5.0 mg Fe, 0.28 mg thiamine, 0.19 mg riboflavin, 4.3 mg niacin, and 0 mg ascorbic acid. Starch is found to be a major component of *Coix* seeds which ranged up to ~70% of the dry weight. It is a good source of certain minerals like P, K, Mg, and Se. Seed oil found to contain triglyceride like palmitic, stearic, oleic, and linoleic acid. NIR results showed that seed has 1.3-3% dietary fibre. *Coix* is gluten free so good for people suffering from celiac disease.

Uses

Job's tear is a very useful and productive grass consumed in various ways, including soups, beverages, and desserts, and steamed like rice, as forage, as well as an important medicinal herb. *etc.*

As food

Before corn (*Zea mays*) became popular in Southern Asia, Job's tear was rather widely cultivated as a cereal in India. It has higher protein to carbohydrate ratio than any other cereal. The pounded flour is sometimes mixed with water like barley for barley water. It can be ground into flour and used to make bread or used in any of the ways that rice is used. The pounded kernel is also made into a sweet dish by frying and coating with sugar. It is also husked and eaten out of hand like a peanut. Both alcoholic and non-alcoholic drinks are prepared from it. Beers and wines are made from the fermented grain. The seeds are used in soups, porridges, and drinks, and are also brewed and fermented for tea, beer and other alcoholic beverages. A coffee is made from the roasted seed.

As fodder

In India, Coix is mainly grown as a fodder crop in low-lying areas. However, the grain is also used as a feed for poultry. It is reported as an excellent alternate feed resource for goats. Normally the seed production is 1500 kg/ha. At early vegetative stage it is quite nutritious; contains 29.9 % dry matter, 8.5-10 % crude protein, 27.9 % crude fiber, 8.96 % ash, 2.7 % ether extract and 51.9 % nitrogen-free extract. Its average green forage yield is about 13.9 t/ha. The green material is very palatable and is utilized as fodder. The foliage can be turned into ensilage. The bran is used as substitute for wheat bran in feeding the poultry. The Indian Grassland and Fodder Research Institute, Jhansi, offers a few forage varieties of Job's tears, including *Bidhan Coix 1*. This variety is reported suitable for cultivation in West Bengal, Orissa, Assam and north Bihar with an average green fodder yield of 34.6 t/ha (15.22 non-metric tons/acre) and a dry matter yield of 6.9 t/ha (3.04 non-metric tons/acre). Several cuts of Job's tears fodder per year are possible.

As medicine

The dehusked coix seeds are used to treat ailments of the lungs, spleen, large intestines and stomach. It is pertinent to mention that the grain contains kanglaite, a neutral lipid extract

from the endosperm, which has been even endorsed as a treatment for lung, liver, stomach and breast cancers. The seeds are also known to be antispasmodic, control blood sugar levels and serve as a mild natural sedative. The fruits also have anti-inflammatory, antipyretic, antiseptic, anodyne, hypoglycaemic, hypotensive, sedative and vermifuge properties and are used in folk remedies for abdominal tumours, gastrointestinal, oesophageal, and lung cancers, various tumours, as well as excrescences, warts, and whitlows. In addition, for the treatment of menstrual disorders roots are being used. A decoction of the root is also used for the anthelmintic disorder.

Other uses

The hard, inedible seeds of the non-grain varieties (*Coix lacryma-jobi* var. Stenocarpa and var. monilifer) are often employed as beads that are sewn onto garments. The seeds are used as decorative beads. This crop is grown as an ornamental plant in tropical to temperate areas. At some places, the stem is used to make matting. However, the mature straw and leaves are used for thatching purpose.

Pest and diseases

Job's tear is relatively little affected by diseases and pests. The most serious disease of Job's tears is smut caused by *Ustilago coicis,* which destroys the ovaries. Smut can severely damage crops and therefore seed treatment with fungicide or hot water (60-70C) for at least 10 minutes before sowing is recommended. Another important disease is leaf blight caused by *Bipolaris coicis.* It can be controlled by adopting measures like burning of crop residues, spraying fungicides, and the use of more resistant cultivars. Besides this, tar leaf spot (*Phyllachora coicis*), rust (*Puccinia operata*) and *Ustilago lachrymae-jobiare* are some other diseases known to attack this crop. Rats, birds and sometimes grasshoppers and termites may cause little to a considerable loss.

Limitations

The problem in using coix as food is probably the lack of suitable machinery for hulling. Another problem is usually a great reluctance and resistance in accepting any unconventional cereal in the diet. The major bottle necks of production and processing technology need to be resolved by taking research on priority areas viz., yield enhancement by increasing harvest index, synchronous maturity, lodging resistant etc. The demand for Job's tears is increasing rapidly with its medicinal use, but knowledge on genetic diversity and quality evaluation of Job's tears is still limited.

Future prospects

Coix has high potential as food, forage and medicine. There appears to be a tremendous potential for its cultivation in the north eastern region and the adjoining parts of the country. Job's tear can also be cultivated on uncultivated and marginal lands. Special effort should be made to introduce coix cultivation to uncultivated marginal and degraded lands in the hills. Another advantage of Job's tears is the crop's resilience, as it is affected by very few diseases and pests so requires little care. Besides this, the crop is also productive in waterlogged, acidic and lateritic soils, and on degraded, sloping land. This will not only generate income for poor farmers but also improve the structure of these lands to sustain agriculture for future generation.

Plant close up

Seed close up

Emergence of sal borer in Madhya Pradesh and Chhattisgarh

N. Roychoudhury, P.B. Meshram, Ram Bhajan Singh and Rajesh Kumar Mishra

Tropical Forest Research Institute
(Indian Council of Forestry Research and Education, Ministry of Environment, Forests and Climate Change, Govt. of India)
Jabalpur – 482021 (M.P.)
E-mail : choudhury_nr@yahoo.com, meshrampb@icfre.org, mishrark@icfre.org

Abstract

This article presents the recent emergence of heartwood borer, *Hoplocerambyx spinicornis* Newman (Coleoptera: Cerambycidae) in sal forests of different Forest Divisions including Tiger reserves of Madhya Pradesh and Chhattisgarh during 2012-2015. Further, the article has highlighted the work carried out by the scientists of this Institute on sal borer and its management in Madhya Pradesh and Chhattisgarh.

Key words: Sal borer, *Hoplocerambyx spinicornis*, emergence, Madhya Pradesh, Chhattisgarh

Introduction

The sal heartwood borer is prevalent in the sal growing areas of Madhya Pradesh, Chhattisgarh and Odisha. *Hoplocerambyx spinicornis* Newman (Coleoptera: Cerambycidae), commonly known as sal borer is the most devastating insect pest responsible for catastrophic damage of sal forests of the country (Fig. 1). This insect was first recorded as a destructive pest of sal in 1897. It causes extensive damage to sal trees both in standing as well as freshly felled timbers (Fig. 2).

The less vigorous, weak, unhealthy trees or those with reduced vitality are easily attacked or killed due to borer. Different abiotic and biotic factors have been the major cause for the recurring epidemics. The borer kills trees of all age groups above the girth of 20 cm, however, the trees between the girth classes 91-150 cm are the most preferred with maximum mortality recorded in the girth class of 121-150 cm. The attack of sal borer is considered epidemic when the trees affected by the insects are above economic threshold level (ETL), more than 1% of the total number of trees.

Till date, over 21 epidemics of this borer have been recorded in sal forests of different states of the country (Table 1). Sal borer epidemic has occurred in Madhya Pradesh and Chhattisgarh during the year 1997-2000. Out of 16.84 lakh ha. of sal forests, about 3 lakh ha. got affected by the borer in the recent epidemic and the worst affected district was Mandla where about 8 lakh trees were damaged. Recently, occurrence of sal heartwood borer and its considerable damage has been reported in sal forests of Madhya Pradesh (Tables 2-5) and Chhattisgarh (Table 6).

Recent research on sal borer at TFRI

In recent past, Forest Entomology Division of Tropical Forest Research Institute, Jabalpur (M.P.) has carried out substantial work on sal borer and its management in Madhya Pradesh and Chhattisgarh, viz.,

- Categorization and enumeration of borer infested sal trees (Fig. 3)
- Natural enemies of sal borer (Figs. 4-8).
- Efficacy of trap trees operation followed by collection of beetles to minimise the multiplication of the borer (Fig. 9).
- Pesticidal (bio- and chemical pesticides) mode of killing borer beetles on tree traps in sal forests (Figs. 10-12).
- Role of climatic factors for borer emergence in sal forests (Figs. 13 and 14).
- Trainings (Figs. 15 and 16).
- Publication of research papers and bulletins (Roychoudhury, 1997, 2008, 2015a, b, 2016, 2018a,b; Roychoudhury

and Soni, 2009; Roychoudhury et al., 2004, 2013, 2017a,b; 2018a,b, 2019; Joshi et al. 2006a,b; Kulkarni et al., 2015; Prakasham et al., 2017).

Fig.1. Eggs, grubs and adults of sal borer.

Fig.2. Borer damaged sal tree, Type-T3.

Table 1. Outbreak of heartwood borer in sal forests of India

State	Forest Division/ Range	Infested area (km^2)	Year	Number of affected trees
Assam	Goalpara	-	1906, 1961	-
	Amosi, Nowgong	-	1961	-
Himachal Pradesh	Nahan	85	1948, 1954	6,955
Jharkhand	Palamau	491	1961	29,46,000
	Singhbhum	-	1899, 1906	-
Madhya Pradesh and Chhattisgarh	Balaghat	-	1905	-
	Balaghat	-	1997-2000	68,641
	Supkhar and Baihar	122	1927-1928	4,500
	Supkhar and Mukki	-	1948-1952	2,963
	Mandla	-	1923-1928	70,00,000
	Mandla	-	1950-1955	56,500
	Mandla	324	1959-1962	3,50,000
	Mandla	-	1997-2000	26,20,157*
	Chada	-	1997-2000	8,23,997
	Sarguja	-	1997-2000	13,163
	Shahdol	-	1997-1998	97,824
	Bilaspur	-	1997-1998	1,53,856
	Rajnandgaon	52	1997-1998	2,05,692
	Pachmarhi	-	1979-1982	8,085
Uttarakhand	Dehra Dun	18	1916-1924	80,000
	Timli	-	1958-1960	1,760
	Lachhiwala	-	1961	-
	Thano	-	1964	8,475
	Thano	5	1965	2,379
	Kalagarh	-	1924-1925	-
	Kalagarh	-	1934-1937, 1994	-
	Phandowala	30	1994	-
West Bengal	Sevok, Kuresong	7	1931-34	3,177
	Raja Bhatkhawa	14	1974	23,120

- Not known. *Including Kanha.

Table 2. Data on sal borer incidence in Mawai Forest Range, East Mandla Forest Division, M.P., during the years 2014 and 2015

Year	No. of compts.	Area (ha)	Total no. of borer affected trees	No. of borer affected sal trees/ha
2014	100	23910	22583	0.94
2015	103	23999	5932	0.25

Table 3. Sal borer incidence in Dindori Forest Division, Dindori, MP, during 2012-14

Range	Sal forest area (ha)			No. of sal borer affected tree	Sal borer affected tree/ha	No. of sal borer affected tree	Sal borer affected tree /ha	No. of sal borer affected tree	Sal borer affected tree/ha
	2012	2013	2014	2012		2013		2014	
Bajag	12247.42	16267.01	20574.37	167	0.01	1664	0.10	6435	0.31
East Karanjia	6265.13	13844.59	14476.11	345	0.06	2039	0.15	5291	0.37
West Karanjia	-	15104.25	14810.48	-	-	1365	0.09	3991	0.27
South Samnapur	10041.77	11900.46	14715.67	187	0.02	1071	0.09	13571	0.92
North Samnapur	-	-	327.02	-	-	-	-	94	0.29
Total	**28554.32**	**57116.31**	**64903.65**	**699**	**0.02**	**6139**	**0.11**	**29382**	**0.45**

Table 4. Data on incidence of *H. spinicornis* in sal forests of Satpura Tiger Reserve, M.P., during the year 2013-14

Range	Forest area (ha.)	Sal forests (ha.)	No. of borer affected sal trees	No. of borer affected sal trees/ha
West Pachmarhi	17805.79	5715.69	3922	0.69
East Pachmarhi	24901.74	8521.20	4191	0.49
Denwa buffer	12958.41	3835.99	1931	0.50
Total	**55665.94**	**18072.88**	**10044**	**0.56**

Table 5. Sal borer incidence in different ranges of core and buffer zones of Kanha Tiger Reserve, Mandla, M.P.

Range	Sal area (ha)	No. of sal borer affected tree	Sal borer affected tree/ha	No. of sal borer affected tree	Sal borer affected tree/ha	No. of sal borer affected tree	Sal borer affected tree/ha	No. of sal borer affected tree	Sal borer affected tree/ha
		2012		2013		2014		2015	
Core zone									
Kisli	4022.16	278	0.07	809	0.20	1441	0.36	1503	0.37
Kanha	4495.65	139	0.03	2900	0.65	4902	1.09	5453	1.21
Sarhi	1952.55	65	0.03	931	0.48	2061	1.06	2619	1.34
Bhesangha t	3228.21	411	0.13	5828	1.81	8227	2.55	5342	1.66
Supkhar	11866.71	440	0.04	3104	0.26	5801	0.49	2160	0.18
Mukki	7304.16	810	0.11	6957	0.95	8721	1.19	5758	0.79

Fen Sanctuary	6306.72	411	0.07	1081	0.17	1165	0.19	813	0.13
Total	**39176.16**	**2554**	**0.07**	**21610**	**0.55**	**32318**	**0.82**	**23648**	**0.60**
Buffer zone									
Khapa	2888.00	29	0.01	211	0.07	443	0.15	15	0.03
Motinala	6525.43	0	0.00	576	0.09	816	0.13	62	0.84
Ghadi	4065.87	175	0.04	197	0.05	558	0.14	348	0.05
Sijhora	73.67	0	0.00	0	0.00	56	0.76	197	0.05
Khatiya	571.95	0	0.00	7	0.01	4	0.01	1420	0.80
Samnapur	1771.87	307	0.17	396	0.22	1267	0.72	577	0.20
Total	**15896.79**	**511**	**0.03**	**1387**	**0.09**	**3144**	**0.20**	**2619**	**0.16**
Grand total	**55072.95**	**3065**	**0.06**	**22997**	**0.41**	**35462**	**0.64**	**26267**	**0.48**

Table 6. Extent of sal borer infestation recorded in Chhattisgarh during 2012-2015

Forest Division	Sal forest cover (ha)	Forest Range	Year of infestation	Affected area (ha)	Number of affected trees
Bhanupratappur	24163.370	Amabeda	2012-2015	493.925	565
Kabirdham	25584.175	Chilpi (Bhoramdev sanctuary)	2013-2014	7452.00	9925
			2014-2015		22874
		Kabirdham	2013-2015	2069.74	2692
		Taregaun	2013-2015	-	2284
			2014-2015		5047
Korba	109765.280	Korakchar	2015	39.636	2757
		Basin	2015	639.061	1314
		Pasarkhet	2015	40.00	1268
Total					**48726**

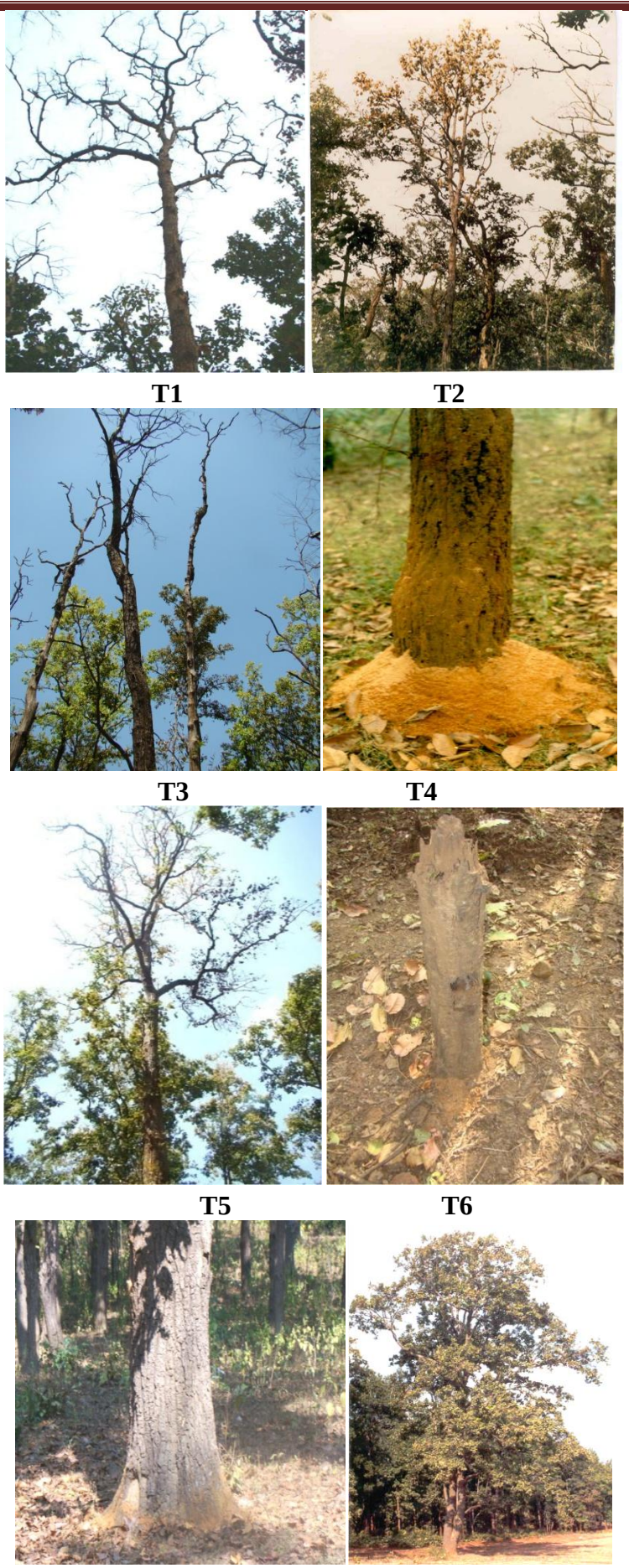

Fig.3: Types/categorization of borer affected trees in sal forests

Fig. 4. Parasitoid of sal borer recorded in timber depot, Shahpur, Dindori.

Fig. 5: Grub and adult beetles of predator, *Alaus sordidus*, recorded in timber depot, Shahpur, Dindori.

Fig. 6: Predator ants of sal borer recorded in tree traps in sal forests, Chilpi, Kabirdham

Fig. 7: Feeding holes of woodpecker bird in borer affected tree trunk of sal, Baihar.

Fig. 8: Mole predator damaged sal borer beetle in tree traps in sal forests, Chilpi, Kabirdham.

Fig. 9. Steps involved in Trap tree operation for collection of borer beetles in sal forests.

Fig.10. Pesticidal experiment against borer beetles in captivity at Chilpi, Kawardha Forest Division, CG.

Fig. 11. Pesticidal experiment against borer beetles released after spraying in tree traps in sal forests at Chilpi, Kawardha Forest Division, CG.

Fig. 12. Pesticidal experiment in tree traps in sal forest at Jampani, Kawardha Forest Range (compartment No. RF-47), Kabirdham Forest Division, CG.

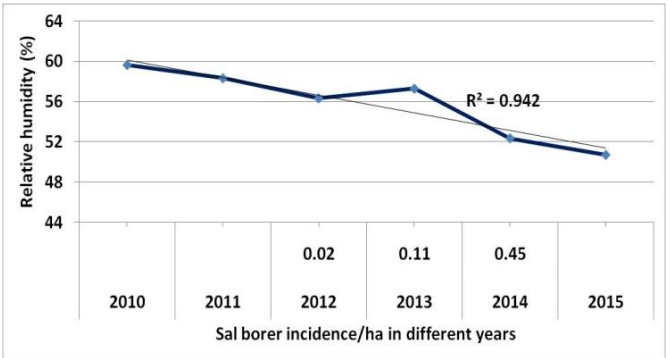

Fig. 13: Correlation coefficients between sal borer incidence with relative humidity in Dindori Forest Division during 2012-2015.

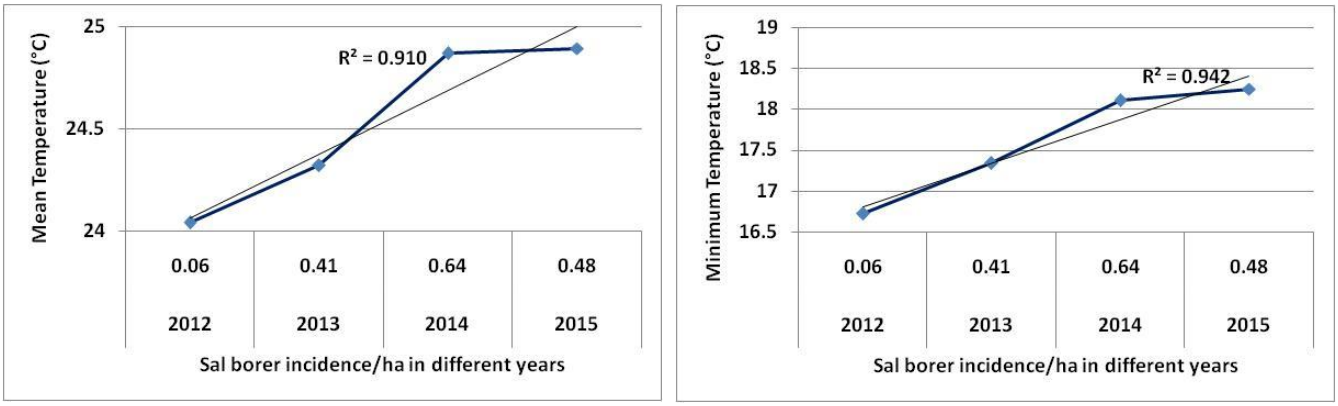

Fig. 14: Correlation coefficients between sal borer incidence with (A) minimum temperature and (B) mean temperature in Kanha Tiger Reserve during 2012-2015.

Fig. 15. Training on sal borer and its management at Mawai and Chada, MP.

Fig. 16. Training on sal borer and its management at Chilpi and Bhanupratappur, CG.

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मार्किंग नट- भिलवा

ममता पुरोहित एवं राजेश कुमार मिश्रा

उष्णकटिबंधीय वन अनुसंधान संस्थान
(भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय, भारत सरकार)
जबलपुर

भिलवा अनाकार्डेसी कुल का पतझड़ी वृक्ष है जो मुख्यतया उष्णकटिबंधीय वनों में पाया जाता है। नम भूमि की अपेक्षा शुष्क भूमि में ज्यादा पाया जानेवाला भिलवा बड़े आकार की पत्तियों और लाल रंग के राल के रिसाव से आसानी से पहचाना जाता है। मध्यप्रदेश के साल एवं मिश्रित वनों में यह बहुतायत में पाया जाता है। खेतों की मेड़ों पर इसके फैले हुए वितान वाले वृक्ष प्रायः देखने को मिल जाते हैं। खुले क्षेत्रों में इसकी बहुत अच्छी वृद्धी होती है। इसका प्राकृतिक पुनरुत्पादन बीजों द्वारा होता है। इसका वानस्पतिक नाम सेमीकारपस अनाकारडियम है। अंग्रेजी में इसे द मार्किंग नट ट्री कहते हैं तथा हिन्दी में भिला व भिलवा के नाम से जाना जाता है। एक क्विंटल भिलवा फलों से लगभग 10 किलो बीज प्राप्त होते हैं। प्रायः इसके फलों का एकत्रीकरण तेल की अपेक्षा बीजों के लिए अधिक किया जाता है। बीज रुपये 800 से रुपये 1400 प्रति क्विंटल के हिसाब से बिकते हैं। महाराष्ट्र एवं इसके आस-पास के क्षेत्रों में भिलवा के बीजों को बड़े चाव से खाया जाता है। मध्यप्रदेश में छिन्दवाड़ा जिले का भिलवा फलों के एकत्रीकरण में प्रथम स्थान है क्योंकि पूरे राज्य के कुल एकत्रीकरण का 50 प्रतिशत भाग छिन्दवाड़ा और इसके आस-पास के क्षेत्रों से एकत्रित होता है। द्वितीय स्थान पर सिवनी और इसके आस-पास के क्षेत्र हैं जहाँ से लगभग 30 प्रतिशत भिलवा फल एकत्रित किये जाते हैं।

आकारकीय

भिलवा वृक्ष लघु या मध्यम ऊँचाई का होता है जो 12 से 15 मी. तक ऊँचा होता है। तना का व्यास 1.25 से.मी. तक होता है। छाल खुरदरी तथा गहरे रंग की होती है। पत्तियाँ बड़ी-बड़ी माप की, सामान्य, एकान्तर क्रम में शाखा के सिरे पर गुच्छा बनाती हैं। पत्तियों की ऊपरी सतह चिकनी तथा निचली सतह रोमयुक्त होती है। पत्तियों का अग्रभाग एवं आधार गोलाकार होता है तथा पर्णवृन्त 1.5 से.मी. तक लम्बा होता है।

फूल

फूल छोटे, हरे-पीले रंग के, एकलिंगाश्रयी (डायोसियस) तथा शीर्ष पुष्प गुच्छ (टर्मिनल पेनिकल) में लगे रहते हैं तथा मई-जून में नई पत्तियों के साथ वृक्ष पर लगते हैं।

फल

भिलवा का फल ड्रूप प्रकार का होता है जो दिसम्बर से मार्च के दौरान पकता है। फल 2.5 से 3.8 से.मी. तक लम्बे, चपटे व आयताकृति होते हैं। पकने पर यह काले चमकीले रंग के हो जाते हैं तथा नारंगी रंग की रिसेप्टीकल/कप पर रखे होते हैं।

बीज

- बीज दिसम्बर-जनवरी के दौरान एकत्रित किये जाते हैं। बीजों में उत्तरजीविता (वाएबिलिटी)

बहुत कम होती है इसलिए एकत्रीकरण के तुरन्त बाद बुआई कर देना चाहिए। प्रायः एक किलो में 450 से 875 तक बीज पाये जाते हैं।

पौध तैयार करना

- बुआई पूर्व बीजों को 48 घंटे ठंडे पानी में डुबाना चाहिए। बीज उपचार के बाद मिट्टी, रेत और गोबर की पकी खाद से बने (1:1:1) मृदा मिश्रण में माह दिसम्बर-जनवरी के दौरान पॉलीथिन की थैलियों में बोना चाहिए। मृदा मिश्रण से भरी पॉलीथिन थैलियों को सूखे चारे से ढक देना चाहिए जिससे एक सी गर्मी बनी रहे। रोपणी में पौध तैयार करने के लिए पहले से अंकुरित बीजों का उपयोग करना उत्तम है। बीजों की अंकुरण अवधि 28 दिन होती है। बीजों का अंकुरण प्रतिशत 50 से 55 तथा पौध प्रतिशत 55 से 60 तक होता है। पौधे पाला के प्रति संवेदनशील होते हैं।

उपयोग

वृक्ष

- यह पोषक के रूप में लाख के कीड़ों (कुसुमी स्ट्रेन) को आश्रय देता है।

लकड़ी

- लकड़ी सस्ते एवं हल्के फर्नीचर बनाने के लिए उपयोग की जाती है।
- यह माचिस की डिब्बियों और कमठी बनाने के लिए उपयोग की जाती है।
- पैकिंग बाक्स बनाये जाते हैं।
- यह खांचा/टोकरा (क्रेटिंग) बनाने के काम आती है।
- मध्यप्रदेश में इसकी लकड़ी से नाव का डांड़ा बनाया जाता है।
- यह मध्यम प्रकार की जलाउ लकड़ी है।

गोंद/रॉल

- वृक्ष से निकलने वाली गोंद/रॉल कुष्ठ रोग तथा नाड़ी/तंत्रिका तंत्र संबंधित दुर्बलता के उपचार में काम आती है।

फल

- फल का उपयोग गठिया, श्वांस रोग एवं दमा, नाड़ी संबंधी विकार, मिर्गी, मस्सा, गिल्टी/गुल्म आदि के उपचार में उपयोग किया जाता है।
- फल का नारंगी रंग का मॉसल रिसेप्टिकल/कप (हाइपोकार्प) पकने पर सुखाकर, भूनकर या बिना भुना खाया जाता है।
- हाइपोकार्प महत्वपूर्ण कशाय (एस्ट्रिन्जेन्ट) है।
- यदि फल पकने के पहले टूट जाते हैं तो इनसे तेल प्राप्त नहीं होता है। केवल पके हुए फलों के खोल से ही तेल प्राप्त होता है। अच्छी तरह पके हुए फलों में 16 प्रतिशत तक तेल पाया जाता है।

रस

- पैरिकार्प में बहुतायत में पाया जानेवाला काला, तैलीय, कड़वा एवं गाढ़ा तथा अत्यधिक फफोलाकारी (वेसीकेन्ट) रस परम्परागत रूप से सन और उससे बने कपड़े रंगने के काम आता है।
- यह के. एस. मार्किंग का घटक है। मार्किंग स्याही बनाने के काम आता है।
- पैरिकार्प में पाया जानेवाला गाढ़ा फफोलाकारी (वेसीकेन्ट) रस फीनॉल का बहुमूल्य स्रोत है इसे व्यापारिक जगत में भिलवा शेल लिक्विड (BSL) के नाम से जाना जाता है।
- भिलवा शेल लिक्विड (BSL) से बना अर्ध ठोस या ठोस रॉल वार्निश, पेंट, जलरोधी (वाटर प्रूफिंग), विद्युतरोधी पदार्थ (इन्सुलेटिंग

इलेक्ट्रिकल सामग्री), मोल्डिंग कम्पोजिशन तथा इनेमल्स का आधार है।

- यह टोकरियों, नाव के तख्ता/पटिया तथा लकड़ी के अन्य सामान की विलेपन (कोटिंग) करने के काम आता है।
- इसमें एन्टीबैक्टीरियल गुण होते हैं।
- यह रस हाथ, पैर, कोहनी आदि पर गोदना (टेटू) बनाने के काम आता है।

करनल

- करनल खाये जाते हैं।
- करनल से प्राप्त होनेवाला अंश शुष्कन तेल (सेमीड्राइंग आइल) लकड़ी के परिरक्षक तथा गाड़ी में लकड़ी से बनी धुरि के स्नेहक के रूप में उपयोग किया जाता है।

बीज

- बीजों का स्वाद काजू की तरह होता है।
- बीज मार्किंग नट की तरह उपयोग किये जाते हैं।
- बीज आयुर्वेदिक औषधियाँ बनाने में उपयोग किये जाते हैं।

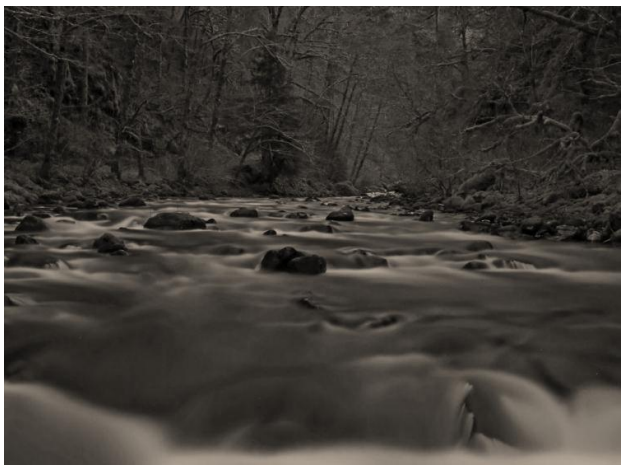
विपणन व्यवस्था

मध्यप्रदेश में छिन्दवाड़ा भिलवा के क्रय-विक्रय का महत्वपूर्ण विपणन केन्द्र है। इसके बाद कटनी के विपणन केन्द्र का द्वितीय स्थान है। मध्यप्रदेश के जबलपुर, मंडला, सिवनी, शहडोल आदि जिलों से आदिवासी एवं ग्रामीण समुदाय द्वारा भरपूर मात्रा में भिलवा के फल/बीज एकत्रित किये जाते हैं। ग्रामीणों एवं आदिवासियों द्वारा एकत्रित फल/बीज समीप के स्थानीय हाट-बाजार में बेचे जाते हैं जहाँ से ये बड़ी-बड़ी मंडियों में भेजे जाते हैं। इन मंडियों में व्यापारियों द्वारा पके व बिना पके बीजों की मात्रा के आधार पर मूल्य तय किया जाता है। श्रमिक दर अधिक होने से भिलवा बीजों का भंडारण नहीं किया जाता है।

Forests, water and rivers

Rekha Agarwal
Government Science College
Old Robertson College, Estd.-1836
Jabalpur (MP)

There are few resources, if any, more vital to life than water. Whether it be drinking water, or water in our homes for bathing and cleaning



dishes, not one day goes by that we don't need and use water. The average American uses an estimated 80-100 gallons of water per day. For many of us, having access to clean drinking water and running water in our homes is a necessity that we often take for granted. According the United Nations, 85 percent of the world's population lives in the driest half of the planet, and 783 million people do not have access to clean water.

Trees and vegetation absorb rainwater, increase evapotranspiration and draw water from the ground. Although these natural process are an important part of the water cycle, this means that forests can also restrict water supply to dry areas.

Forests are undeniably valuable for water quality and quantity. This infographic highlights why it is essential that restoration projects are implemented carefully and strategically to maximize benefits and avoid any unintended impacts.

But, people aren't the only ones who need water — animals need clean water too, and for many species, such as different species of frogs which have highly permeable skin, water pollution can mean extinction. The loss of access to clean water, and the pollution of water sources, is partially due to deforestation.

Water availability has a direct impact on the health of forests and their inhabitants, which shows the importance of the relationship between forests and water. Trees are made up of more than 50 percent water and need a steady source of it in order to grow and stay healthy. A healthy 100-foot-tall tree can take 11,000 gallons of water from the soil and release it into the air again, as oxygen and water vapor, in a single growing season. They "drink" in the water using their small, hair-like roots. Water from the soil enters their roots and is carried up the tree's trunk all the way to the leaves.

Trees serve as natural sponges, collecting and filtering rainfall and releasing it slowly into streams and rivers, and are the most effective land cover for maintenance of water quality. The ability of forests to aid in the filtration of water doesn't only provide benefits to our health and the health of an ecosystem, but also to our pocketbooks. Forest cover has been directly linked to drinking water treatment costs, so the more forest in a source water watershed, the lower the cost to treat that water. Forests provide these benefits by filtering sediments and other pollutants from the water in the soil before it reaches a water source, such as a stream, lake or river.

eople will always find a way to support themselves and their families. For those who live in rural, heavily forested regions with few

options for lucrative employment, this often means turning to forests to provide food for their tables, supplement their incomes and preserve their traditional ways of life.

For the policymakers who govern these regions, the diverse needs of rural people must be considered when making policies about local forest resources. These forest-dependent populations are the main target of locally-controlled forest management, a concept that allows local families and communities to make decisions on forest and land use, with secure tenure rights, freedom of association and access to markets and technology.

As our landscape changes, it begins to have an impact on stream health. What we do on or to the land affects both the quantity (volume) and quality (pollutant levels) of the water in our streams and lakes. The land area through which any water moves, or drains, to reach a stream is called a watershed.

As we begin to remove forest canopy and replace it with roads, parking lots, driveways, homes, patios, pools (impervious surfaces) and even grass, we immediately have impact on watersheds and receiving streams (or lakes). With the increased amount of impervious surfaces, water runs off the land, traveling on the surface towards the streams. As this 'storm water runoff' travels to the streams it collects pollutants and increases speed. The changes to the landscape, not only increase the volume of water that goes to the stream, it also shortens the amount of time it takes the water to get to the stream. These increased or peak flows cause water to move quickly to the streams. This leads to flooding, stream bank erosion, widening of streams, sediment deposited in streams, a loss of fish habitat, and decline in water quality.

Forests filter and regulate the flow of water, in large part due to their leafy canopy that intercepts rainfall, slowing its fall to the ground and the forest floor, which acts like an enormous sponge, typically absorbing up to 18 inches of precipitation (depending on soil composition) before gradually releasing it to natural channels and recharging ground water. In a North Carolina Watershed study the mean soil infiltration rate went from 12.4 in/hr to 4.4 in/hr when a site was converted from forest (duff layer on soils) to suburban turf. Other studies have found similar results when comparing hourly infiltration rates and soil bulk density of forested areas with crops and grazed pasture.

Average interception of rainfall by a forest canopy ranges from 10-40% depending on species, time of year, and precipitation rates per storm event. In urban and suburban settings a single deciduous tree can intercept from 500 to 760 gallons per year; and a mature evergreen can intercept more than 4,000 gallons per year. Even young, small trees help. In a recent Forest Service study a single small tree that was only 9 years old, was able to intercept 58 gallons of storm water from a ½ inch rain event (67% of the rain that fell within the canopy).

A study in the 1980's of Dayton, Ohio's existing tree canopy found that storm water runoff was reduced by 7% and could be increased to 12% through planting more trees. In a more recent UFORE Hydro study conducted by the USDA Forest Service of the Toby Creek Watershed (a suburban area of Wilkes-Barre), 54% tree canopy cover was able to reduce storm water runoff by 11%. One Forest Service Researcher has stated that planting large canopy trees over impervious surfaces, such as a parking lot or street has much greater impact on reducing storm water (up to 8 times greater) because it works to reduce peak flows in urban settings.

Forests are the most beneficial land use for protecting water quality, due to their ability to capture, filter, and retain water, as well as air pollution from the air. Forests are also essential to the provision of clean drinking water to over 10 million residents of the watershed and provide valuable ecological services and economic benefits including carbon

sequestration, flood control, wildlife habitat, and forest products

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P.O. RFRC, Mandla Road
Jabalpur – 482021, M.P. India
Phone: 91-761-2840484
Fax: 91-761-2840484
E-mail: vansangyan_tfri@icfre.org, vansangyan@gmail.com
Visit us at: http://tfri.icfre.org or http://tfri.icfre.org