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HI-TECH KIWI FRUIT PRODUCTION TECHNIQUES IN NORTH WEST AND NORTH EAST HIMALAYAN STATES – POTENTIAL FOR TRANSFORMATION FROM SUBSISTENCE FARMING TO SUSTAINABLE HORTICULTURE TOWARDS IMPROVING LIVELIHOODS OF FARMERS

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Abstract: Kiwifruit is recent crop introduction to horticulture practices in Mid-Himalayan states in India such as, Himachal Pradesh and J&K in the North-West and Sikkim, Arunachal Pradesh and Nagaland in the North-Eastern Himalayas. Over past few years this fruit has attained immense popularity and among consumers due to its nutritional value, while also it has gained appeal among small and marginal farmers owing to its high benefit-cost ratio, particularly through Hi-Tech cultivation techniques.

Kiwifruit, also known as Chinese gooseberry (Actinidia chinensis Patch) is believed to have originated in China, although it gained popularity in New Zealand. In India, Kiwi was first introduced in Lal Bagh at Bengaluru, however, it was soon observed that the fruit could be cultivated well only in the semi-temperate climate of Himachal Pradesh, around1963. Thereupon, it was broadly introduced in this North-West Himalayan state of Himachal Pradesh and also to some extent in J&K and Uttrakhand. In course of time, it has been extensively cultivated in the North-Eastern Himalayan states viz. Arunachal Pradesh, Sikkim and recently in Nagaland, Meghalaya, Mizoram and Manipur. Kiwi Fruit production holds great scope for expansion in almost all states of North East barring Tripura and Assam, owing to their warmer and tropical climate.

Through the author's field awareness initiatives along with encouragement from the State Department of Horticulture of Sikkim, the idea was conceptualized for inter-cropping of Kiwifruit with Large Cardamom, a widely grown spice crop in the state. Given that Large Cardamom is a shade-loving plant, this requirement can be met when grown under the canopy belt of Kiwi vines. This, along with the suitable soil and climate conditions particular to Sikkim and Arunachal Pradesh, lends great credibility to the beneficial intent of introducing this concept and eventually it is hoped to standardize this as a cultural practice in the suitable regions. This Inter-cropping practice of Large Cardamom with Kiwi Fruit is greatly on the rise in Sikkim, adding to the farm income of the growing community in the state. This technique also ensures income security in the form that if one crops fails in a season the other would provide necessary sustenance. This model of inter-cropping has lately also been expanded to other Kiwi growing states of the region.

The Kiwi fruit of North-Eastern area in India has managed to attain its commercial identity in national as well as international markets. Sikkim and Arunachal have established themselves as largest producers of Kiwifruit nation-wide, along with production of Large Cardamom. Of late, other states have also begun to prioritize the fruit for area expansion under Horticulture Technology Mission.

Despite suitable climate and soil, the lack of quality planting material, package of practices, modem technology of precision farming and trained manpower have been observed as the major constraints in

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enhancing the productivity of temperate fruits in general and Kiwi Fruit in particular. Keeping in view these concerns, ICAR Roving Team for Temperate Fruits recommended the road map for cultivation of temperate fruits in North Eastern Hill Region in general and Kiwi Fruit in particular. Extensive surveys of Kiwi Growing areas of Sikkim for monitoring, field demonstration and awareness has been undertaken with support and encouragement of the State Departments of Horticulture of respective states of Sikkim and Arunachal Pradesh.

Implementation of modern horticultural practices for growing Kiwi Fruit in the Mid-Himalayan region of the country should benefit its rural economy comprising mainly of small and marginal farmers whose practice of subsistence agriculture is under challenge from changing climate scenario.

As the kiwi fruit originated in China on the Northern front of the Eastern Sub-Himalayan ranges, the inherent potential for its commercial cultivation in Indian Mid-Himalayan ranges is worth considering by the scientific community and policymakers. The paper deliberates upon the key technologies developed for increased productivity of Kiwi fruit, the priority areas, economic estimates as well as upon organic production for precision farming of this fruit in combination with its inter-cropping with Large Cardamom.

It is worth mentioning that Kiwi is the emerging crop of Mid-Himalayan states in general and North-Eastern Sub-Temperate Zones in India, which are most suitable for horticulture based integrated farming system such as inter-cropping. The high potential for transformation from subsistence farming to sustainable horticulture will be discussed in detail.

INTRODUCTION

Kiwis have garnered an assortment of odd names throughout the century, including "melonette," "strange fruit," and the especially appetizing name of "hairy bush fruit."

The fruit got its current name, kiwi, as a result of a cleverly designed marketing campaign hatched in New Zealand in 1959. Unsurprisingly, its original name, "Chinese gooseberry" wasn't appealing to the US market. When it was newly dubbed as the kiwi fruit, sales took off. Because the name was never trademarked, however, other growers in various countries adopted the same name. New Zealand farmers have since adopted and trademarked the name "Zespri" for all of their kiwis.

ORIGIN OF KIWIFRUIT

Kiwis are native to Central China, and the Chinese today know the fruits as *mihoutao,* or, monkey fruit. Despite growing wild throughout China for centuries, cultivation of these fruits didn't begin until the late 19th century. According to the "Encyclopedia of Fruit and Nuts," Europeans and North Americans planted kiwis in their gardens in the early 1900s. When New Zealand got ahold of the fruit by the 1920s, orchards of the fruit took off. Forty years later, the country was refining cultivation techniques and exporting the fruit in large numbers.

Kiwis are even newer to India. According to a senior scientist at the National Bureau of Plant and Genetic Resources, kiwi cultivation was introduced to the Shimla district station in 1963.

2010 figures from the *World Kiwifruit Review* show that the world's top kiwi growers are China, Italy, New Zealand, Chile, Greece, and France.

AVAILABILITY OF KIWIFRUIT IN INDIA

Farmers grow several commercial varieties of kiwis throughout many of India's cooler regions, including Uttar Pradesh, Himachal Pradesh, Sikkim, Jammu and Kashmir, Arunachal Pradesh, Meghalaya, and the Nilgiri Hills. Of these areas, Himachal Pradesh produces some of the best kiwis. Serious cultivation efforts have only begun recently on account of growing demand from India's large city centers.

India's kiwifruit season is October through December, with several varieties coming and going in this time.

NUTRITIONAL VALUE OF KIWI FRUIT

Health benefits of Kiwifruit Kiwifruit is the most nutrient-rich of the top 26 fruits consumed in

the world today. It also has the highest density of any fruit for vitamin C and magnesium limited mineral in the food supply of most affluent countries and a nutrient important for cardiovascular health. Among the top three low-sodium, high-potassium fruits, kiwifruit ranks number one, having more potassium than a banana or citrus fruits. Cancer Kiwifruit has been shown to contain an anti-mutagenic component, helping to prevent the mutations of genes that may initiate the cancer process.

The presence of glutathione may account for the reduction. Carcinogenic nitrates are formed during the smoking or barbecuing of foods. When nitrates are ingested, a process called nitrosation can occur, in which free radicals 'nitrosamines' are formed that may lead to the formation of gastric or other cancers. Kiwi has been demonstrated to aid in the prevention of nitrosation. In another in vitro test with cultured mammalian-cell lines, kiwifruit extract was found to inhibit melanoma, or skin cancer. The amino acid arginine, present in kiwifruit, is being looked at by cardiologists to improve post angioplasty blood flow and actually prevent the formation (or reformation) of plaque in the arteries.

Kiwifruit is ranked as having the fourth highest natural antioxidant potential next to the red fruits containing high levels of beta carotene. Lutein, an important phytochemical found in kiwifruit, has been linked to the prevention of prostate and lung cancer. In addition to kiwifruit being recognized by the FDA as an excellent source of dietary fiber, studies indicate that it contains another not-yet-isolated compound that accelerates digestive transit time even faster than dietary fiber alone - important for colorectal cancer prevention. The benefit of this laxative action is to decrease the build-up of cancer-promoting metabolites.

Kiwifruit is one of the few fruits that are green at maturity, and chlorophyll is responsible for that color. Several studies have suggested that chlorophyllin, a derivative of chlorophyll, is an inhibitor of liver carcinogenesis. Depression Inositol is found in kiwifruit. Recent studies have shown that inositol, because of its function as a precursor of an intracellular second messenger system, can be beneficial in the treatment of depression. Diabetes Inositol, a sugar alcohol naturally occurring in kiwifruit, may play a positive role in regulating diabetes. Inositol supplements may improve nerve conduction velocity in diabetic neuropathy. Inositol plays a role in intracellular responses to hormones and neurotransmitters. It acts as a second messenger in cell signaling processes. Eye health/Macular degeneration Kiwifruit contains a wealth of carotenoids (beta carotenes, luteins and xanthophylls); phenolic compounds (flavonoids and anthocyanins) and antioxidants, including vitamins C and E. The excellent complement of antioxidants in kiwifruit may help prevent the oxidation of the good cholesterol (HDLs).

Kiwifruit is particularly high in two amino acids: arginine and glutamate. Arginine may help promote an increase in arteriolar dilation, working as a vasodilator and improving blood flow that is important for heart health. The FDA considers kiwifruit a good source of vitamin E, crucial for a healthy heart. Kiwifruit contains magnesium at 6% DV. Magnesium is thought to be in short supply in the diets of affluent countries. Poor magnesium status is associated with heart disease, myocardial infarction and hypertension. Kiwifruit contains pectin, which has been shown to lower cholesterol. Hypertension Cardiologists believe the sodium-to-potassium ratio is critical for heart health. That ratio is extremely favorable in kiwifruit.

Kiwifruit has been shown to be an immune booster, most likely due to its extremely high vitamin C content and its complement of antioxidant compounds. Impotence Kiwifruit contains the amino acid arginine, a well-known vasodilator that has been used to treat impotence in men. Physical Fitness Kiwifruit contains a wide range of minerals (electrolytes) essential for replenishing those lost during exercise especially in hot environments. It is also a naturally significant source of electrolytes for a pre-workout regimen.

In China, a kiwi-based sport drink was designed to overcome athletic training in a hot environment, where large amounts of minerals can be lost in sweat. A 5% addition of carbohydrates to the kiwifruit juice helped to maintain a normal

glucose level during exhaustive training. Stress Reduction Kiwifruit contains a relatively high level of serotonin. Serotonin causes a calming effect in most individuals Weight Control Calorie for calorie, kiwifruit is one of the most nutrient-rich fruits. You get the best balance of nutrients per calorie (the most nutrients for the fewest calories) from kiwifruit, cantaloupe, papaya and lemons. Source: Dr Vikram Sharma, Email-drvsharma99@gmail.com 2006–2019 C–DAC. All content appearing on the vikaspedia portal is through collaborative effort of vikaspedia and its partners.We encourage you to use and share the content in a respectful and fair manner. Please leave all source links intact and adhere to applicable copyright and intellectual property guidelines and laws

NUTRITIONAL CONTENT AND DIETARY REQUIREMENT

The table below shows the amounts of specific nutrients in a kiwi weighing 69 g. It also shows how much of each nutrient an adult needs per day, according to the Dietary Guidelines for Americans 2015–2020. However, specific requirements vary, depending on a person's age and sex Kiwi also contains small amounts of iron, vitamin A, and vitamins other than folate.

Nutrient	Amount in 1 kiwi (69 g)	Daily adult requirement
Energy (calories)	42.1	1,600–3,000
Carbohydrates (g)	10.1, including 6.2 g of sugar	130
Fiber (g)	2.1	22.4–33.6
Calcium (mg)	23.5	1,000–1,300
Magnesium (mg)	11.7	310–420
Phosphorus (mg)	23.5	700–1,250
Potassium (mg)	215	4,700
Copper (mcg)	90	890–900
Vitamin C (mg)	64	65–90
Folate (mcg)	17.2	400
Beta carotene (mcg)	35.9	No data
Lutein & zeaxanthin (mcg)	84.2	No data
Vitamin E (mg)	1.0	15
Vitamin K (mcg)	27.8	75–120

CULTIVARS

The genus Actinidia contains around 60 species. Though most kiwifruit are easily recognized as kiwifruit (due to basic shape) their fruit is quite variable. The skin of the fruit can vary in size, shape, hairiness, and color. The flesh can also vary in color, juiciness, texture, and taste. Some fruits are unpalatable while others taste considerably better than the majority of the commercial varieties. The most common kiwifruit is the Fuzzy Kiwifruit and comes from the species *A. deliciosa*. Other species have fruits that are commonly eaten; some examples are: Golden Kiwifruit (*A. chinensis*), Chinese Egg Gooseberry (*A. coriacea*), Baby Kiwifruit (*A. arguta*), Arctic Kiwifruit (*A. kolomikta*), Red Kiwifruit (*A. melanandra*), Silver Vine (*A. polygama*), Purple Kiwifruit (*A. purpurea*).

CULTIVATION

Kiwifruit can be grown in most temperate climates with adequate summer heat. Where fuzzy kiwis (*A. deliciosa*) are not hardy, other species can be grown as substitutes. Kiwifruit is commercially grown on sturdy support structures, as it can produce several tonnes per hectare, more than the rather weak vines can support. These are generally equipped with a watering system for irrigation and frost protection in the spring. Kiwifruit vines require vigorous pruning, similar to that of grapevines. Fruit is borne on one-year-old and older canes, but production declines as each cane ages. Canes should be pruned off and replaced after their third year.

SOIL AND CLIMATE

Deep well drained, sandy-loam soil with good amount of organic matter is ideal for its cultivation. A soil pH 5.5 to 6.5 is consi dered ideal for vine growth and fruit production.

It can be grown successfully in warm temperate to sub-tropical regions lying between 3000 to 5500 feet amsl, which provide 600 800 chilling hours to break dormancy. Low temperature (-2.5°C or below) and frost during spring and autumn is very injurious, which kills immature shoots and fruit buds. In summer, high temperature (>38°C) accompanied by high insolation (loo) and low humidity may cause scorching of leaves and sun burn of fruits and even death of the plant. A rainfall of about 120-150 cm well distributed throughout the growing period is sufficient for proper growth and development.

VARIETAL STATUS

Kiwifruit is a dioecious plant, bears staminate and pistillate flowers on separate plants. The commercially grown pistillate cultivars in different agro-climatic conditions of our country are Hayward, Allison, Abbott, Monty and Bruno, and staminate cultivars are Allison, Matua and Tomuri.

ROOTSTOCKS AND NURSERY PRODUCTION

Seedlings of some cultivated cultivars like Bruno and Abbott are commonly used as a rootstock in kiwifruit. Seeds of these two cultivars are preferred because of good germination and strong seedling vigour.

Propagation through cuttings is most rapid and easiest method. Both soft, semihard and hardwood cuttings are used to raise own rooted plants (Kishore et al., 2001). The ideal cutting is 0.5 to 1.0 cm thick with relatively short internodes about 10-15 cm in length having at least 3 to 4 buds. Cuttings should be taken from middle portion of current season's growth shoot during July in case of semi-hard cuttings and one year old shoot during January February in case of hardwood cuttings. After preparation, the cuttings are dipped in 4000 to 5000 ppm IBA solution for 10-15 seconds.

Although budding or grafting takes two years to develop a nursery plant, yet is easiest, economical and used for large scale multiplication. Before sowing seeds are stratified for 30-35 days at 0-5°C to break dormancy. Stratified seeds are sown in the sand beds during February. Germinating or baby seedlings are very sensitive to direct sunlight so it must be protected by creating a shade. Seedling are transplanted in nursery beds during July August, which attain a graftable size within a year. Tongue grafting and chip budding done in last week of January to end of February gave 90-95 per cent budtake success (Chandel et al., 1998). Nursery plants are also produced through tissue culture.

PLANTING

Flat land with gentle slope is ideal for planting of kiwifruit. Plant spacing varies according to cultivar being grown and training system adopted. In general, planting is done at a spacing of 6 m from plant to plant and 4 m from row to row in vigorous varieties like Allison, Abbott and Monty trained on T-bar trellis system. Whereas Hayward is less vigorous and planted at a spacing of 5x5 m. In pergola system of training, a spacing of 6x6 m is recommen ded for getting better fruit production. Planting is done during dormant season i.e. December-January. While doing the planting, the male plants are spread throughout the block with every female adjacent to a male. This is achieved by 1:8 or 1:9 male to female ratio.

POLLINATION

Wind and insects play a significant role in pollination, however, introduction of honeybees in the orchards further increase fruit set and size of the fruits. Palmer Jones and Clinch (1974) recommended 9 colonies per hectare for better pollination. Male flowers produce viable pollen for 2-3 days after opening, after which they become senescent and die. Female flowers in contrast are receptive for 7-9 days after opening even when the petals have started falling. Besides, insect and wind pollination, hand polli nation is essential to get fruits of better size and quality.

CANOPY MANAGEMENT

Kiwifruit is a vine like grape, thus require similar training structure but more stronger than grape. In T-bar trellis system, the pillars of iron or concrete about 1.8 m in height above the ground level are erected at a distance of 6 m from each other in a row in straight line. A cross arm (1.5 m) is fixed on each pole, which carries 5 outrigger wires at a distance of 45 cm each. Vine is trained up to the wire as single stem, than two leaders in opposite direction along the center wire are selected or developed. From these permanent leaders, temporary fruiting arms 25-30 cm apart are selected at right angle along both sides of each leader. Training of vine on pergola system is similar to that of T-bar.

A flat topped network of criss-cross wires is prepared on the erected pillar. This system is costly to prepare but gives higher yield.

The fruit is developed on current season's growth arising from one year old shoot. Only

the basal buds of nodes 4 to 12 current season's growth are productive. Vine grows 2-3 m every year, which become over-crowded if not controlled by both summer and winter pruning. The shoots developed on older wood by heading back will not fruit normally in the first season. Vine pruning is carried out in such a way that the fruiting areas are available every year requiring the wood to be young. This is achieved by 3 to 4 years lateral replacement system. In dormant pruning, the fruiting lateral is cut back to 2 vegetative buds beyond the last fruit. In the second year these vegetative buds produce the fruiting shoots, which is pruned again. The arm on lateral shoots are pruned and allowed to fruit for 3 to 4 years. After this the lateral is removed from the main branch and other laterals. are selected and pruned accordingly so that the balance between vegetative and reproductive growth is maintained for the continuity in the fruit production. In summer pruning, a fruiting shoot is headed back beyond 6-8 buds from the last fruiting bud during June-July.

ORCHARD FLOOR MANAGEMENT

The vines make much vegetative growth, and yield. heavily, thus require adequate amount of manure and fertilizers for normal vine growth and quality fruit production (Sale and Clark, 2002). In general, a basal dose of 20 kg FYM along with 0.5 kg of NPK fertilizer mixture containing 15 per cent N be applied each year age of vine. After 5 year of age, 40-50 kg FYM, 850-950 g N, 500-600 g P_2O, and 800-900 g K_2O per vine is applied every year. FYM along with full dose of P_2O, and K,O is applied during December-January, while the nitrogen is applied in two equal dressing, half before bud-burst and remaining half dose at the onset of monsoon i.e. in July.

Water requirement of kiwifruit is very high because of vigorous vegetative growth and larger leaf surface area. In general, fully grown vine requires 80-100 litres of water for total daily transpiration from 16-17 m^2 canopy area during summer. Young plants should be irrigated at 2-3 days interval, while bearing plants are to be irrigated at 20 per cent depletion of soil moisture from field capacity (5-6 days interval) during summer to get better size fruits (Rana et al., 2000).

Clean cultivation with mulching of tree basin area with 15 cm thick hay grass is recommended for kiwifruit orchards. In the initial two years, inter-crops like strawberry, peas, beans, cowpeas and vegetable crops like tomato, zinger etc. can also be grown.

CROP AND QUALITY REGULATION

All the cultivars of kiwifruit except Hayward bears heavily every year. This heavy crop create a severe competition between the fruits for water, nutrients and photosynthates, which leads to production of small sized fruits. Therefore, to harvest quality crop of good size, hand thinning is essential, as chemical thinning is ineffective. In a study on thinning in kiwifruit, flowers or fruit thinning (20% thinning) to the extent of retaining 5 to 6 fruits/ flowering shoot produced more fruits of A grade without any adverse effect on total yield (Thakur, 2000). In hand thinning only lateral flowers or fruits are removed.

MATURITY, HARVESTING AND MARKETING

In kiwifruit, determination of optimum fruit maturity is difficult because no change take place into the skin or flesh colour or size of fruit due to maturity. A maturity index of 6.2°B TSS is consi dered satisfactory for fruit harvest. Days from full bloom to harvest in lower elevations ranges between 190+4 and 205+4 to 223+4 at higher elevation. Beside this at maturity the hairs present on the fruit skin are removed very easily and can be used to judge the harvesting or maturity.

After harvesting, fruits can be stored for 3-4 weeks at room temperature and for 4-6 months in cold storage at 0°C with 80-90 per cent relative humidity. Fruits can be processed into jam, juice and squash.

PROSPECTS

Kiwifruit has a bright prospects in our country and has been assessed as one of the important future commercial fruit. It provides high return per unit area and the farmers can earn about Rs. 4 to 5 lakhs per hectare annually. Kiwifruit

bears heavily every year with no crop failure. The fruit is highly acclaimed for the nutritive and medicinal value. It hold a wealth of health giving property, thus recommended for patients suffering from diabetes and heart diseases. In kiwifruit no serious pests and diseases have been observed, thus it has a better scope to become commercial ecofriendly fruit crop of the country. Due to hard nature of the fruit with hairy skin surface, the fruits are not damaged by any bird and even not by the monkeys. It has a longer shelf life and can be stored for one month in open at room temperature and for 4-6 months in cold storage.

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