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Organic Crop Production Technology and Packages of Practices of Buckwheat (Fagopyrum spp.) Cultivation

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Abstract
Growing to be the third largest crop in Sikkim, buckwheat is a major grain crop that is extensively farmed throughout the Indian Himalayan states. The first grain used for cereal, buckwheat, was consumed by humans. Protein, fibre, and energy are all abundant in buckwheat grain, which is incredibly nourishing. Due to its gluten-free nature, buckwheat flour makes a great dietary substitute. Following rice and maize as the two most common cereal crops grown in Sikkim is buckwheat. Additionally, the crop is a good source of fagopyrin and rutin (quercetin-3-rutinosid), which are known to be utilised in the prevention of a number of human illnesses. Compared to regular buckwheat, tartary buckwheat has 100 times more rutin. The acreage and production of buckwheat are decreasing as a result of improvements in other crops' productivity and profitability. Because it has a more appetising flavour and grows more quickly than tartary buckwheat, common buckwheat is becoming more and more popular in the Himalayas. Buckwheat may solubilise native soil potassium and phosphorus and fix nitrogen from the atmosphere. Although buckwheat is a crop that is underappreciated and ignored, growers and consumers can benefit much from it. This crop is resistant to climate change, thriving in both marginal and poor soil types and under adverse environmental circumstances. It is hypothesised that the Indian Himalayan region has a good diversity of buckwheat. Therefore, crop-specific missions are needed to gather the diverse and unexploited germplasm, as well as to characterise and document buckwheat germplasm collections in a systematic manner for future use. The short growing season in the steep highlands leads to the prevalence of monocropping. Buckwheat grows next to rice in the lowlands and maize in the highlands of the mid-hills. Consequently, in vulnerable hill ecosystems, buckwheat may prove to be the food crop of the future. Researchers, developers, and policy makers must shift their focus immediately to creating and promoting location-specific scientific interventions and policies to stop the farmers' disinterest in buckwheat production in mountainous areas.

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INTRODUCTION

Buckwheat belongs to a group called pseudocereal which means these are seeds that are consumed as cereal grains but do not grow on the grass (Das et al., 2019). Buckwheat is a very nutritious whole grain that provides protein, fibre, and energy. It. Buckwheat has health advantages such as improving heart health, promoting weight loss, and helping control diabetes. It has also gained popularity due to its high mineral and antioxidant content (Mohammed & Satpathy, 2021). The advantages of normal turmeric are enhanced by organic buckwheat, which is grown without chemicals and has no adverse effects. Buckwheat is used in a variety of ordinary dishes, including breakfast cereals, flour, and noodles. Farmers also utilize it as animal feed. Sikkim IFFCO now produces and supports two items made from organic buckwheat. Buckwheat flour and kernels are what these are. Buckwheat flour does not contain gluten, making it an ideal nutritional option. It has also been used as a cover crop to control weeds and boost soil fertility (Pandey & Stevens, 2016). The crop appears to improve soil tilth and has been shown to increase phosphorus availability, perhaps through root-associated mycorrhizae. Buckwheat blossoms profusely, making it a favorite among beekeepers and an appealing crop in the environment. Buckwheat is grown primarily to produce grains for human use. It is also cultivated for cattle and poultry feed. To secure the livelihood security of the world's rising population, particularly in the hill areas, appropriate policies and scientific interventions must be devised for the use of this climate-resilient superfood crop (Varshney, 2004). The hulls are commonly used to fill cushions. The protein is of good quality due to its high lysine level, which is typically low in cereal products. Buckwheat is a nutritious food since it contains necessary elements like protein and minerals. It is known to contain a variety of antioxidants, including vitamins B, B, and E, as well as phenolic compounds including rutin, quercetin, and 1 2 proanthocyanidines (condensed tannins) (Das et al., 2023). Buckwheat is planted in Himalayan states such as Himachal Pradesh, Arunachal Pradesh, Uttarakhand, Sikkim, Meghalaya, Manipur, and the union territory of Jammu and Kashmir; however, statistical information regarding the crop's productivity and production at the national level is unavailable in India.

CLIMATIC CONDITIONS FOR BUCKWHEAT CULTIVATION

A plant native to temperate, damp, and chilly climates is buckwheat. Particularly when moisture is in short supply, it is susceptible to high temperatures and strong, dry winds. Fruit will dry out and yield will decrease when plants flower in temps higher than 30°C. The issue may worsen if there is low soil moisture during hot spells. For the duration of the growing season, a sufficient quantity of soil moisture appears to be critical. Early spring or late autumn frosts can cause serious harm to buckwheat. Though it thrives in a variety of environments, buckwheat tends to lodge in areas with strong winds, frequent rain, and extremely fertile soil. Hardy in low-lying areas and with short growing seasons, tartary buckwheat is a valuable plant. More so than regular buckwheat, it endures both heat and cold.

LAND PREPARATION

Only on recently cleared land cleared for farming and after one ploughing may buckwheat grow healthily. To ensure good germination and a uniform stand of the crop, the field is prepared with one deep plough, two harrowing/tilling operations and planking. It might also aid in the crop's early growth and increased rate of establishment. Since it's a cover crop, it doesn't need to be thoroughly prepared for growth and can thrive on badly tilled soil.

SOIL CONDITION AND WATER REQUIREMENT

Many types of soil and fertility levels are suitable for buckwheat growth. Of all the grain crops, buckwheat is the most resistant to acidic

soil. The ideal soil types for it include sandy loams, loams, and silt loams that have light to medium texture and good drainage. Soils with high quantities of limestone or those that are heavy and moist do not support its growth. In poor-drained, infertile soils, it yields a higher crop than other grains in moist, chilly climates. This crop works well for removing phosphorus from the soil that is not readily available (Das et al., 2018). Furthermore, lodging may develop in soils with high nitrogen content, which would lower output. Buckwheat plants don't stand back up after they've been lodged. Due to inadequate seedling emergence, crusting on clay soils may provide an unsatisfactory stand. In Sikkim, buckwheat is typically planted as a crop that receives rain. For buckwheat, however, the most important times are during the pre-flowering and pod formation periods.

ORGANIC NUTRIENT MANAGEMENT

In most cases, buckwheat is grown by state farmers using residual fertility alone—that is, without additional nutritional input. It yields 1600 kg/ha, however, for every hectare planted, removing 47 kilogramme of nitrogen, 22 kg of phosphorus, and 40 kg of potassium from the soil. Nitrogen fertilisation should be applied based on the results of a soil test because buckwheat does not respond well to it. Adequate nitrogen delivery can reduce grain production, promote excessive vegetative growth, induce lodging, and increase weed pressure. The ICAR Sikkim Centre suggests applying neem cake at 0.5 t/ha, mixed compost at 5 t/ha, and azophos seed treatment to achieve a satisfactory crop yield. The best yield will be obtained by applying FYM at 5 t/ha plus vermicompost at 2.5 t/ha.

SEED SOWING

When choosing seeds for planting, look for high-quality, disease-free stock. The State's growing season is not uniform because of differences in rainfall patterns and altitudes. In Sikkim, altitude and agroclimatic conditions have a major influence on when to cultivate buckwheat. Generally speaking, seeds should be sown at a moderate height following the harvest of Kharif crops, especially in the months of October through November. However, given its innate capacity to thrive all year round, it may be grown in Sikkim during any season. It can be grown under regulated settings for green vegetables from February to October. A grain crop is seeded at a rate of 35–40 kg/ha. Growing buckwheat as a vegetable crop, fodder crop, or cover crop yields roughly 50 kg/ha. Higher seed rates in buckwheat are typically employed to encourage quicker canopy formation and increased population for more effective weed control. Depending on the variety, buckwheat should be planted 3 to 5 cm deep in a row, separated 30-45 cm between rows, and 10-15 cm between plants. To preserve the appropriate area, thinning might begin 15 to 20 days after seeding. Usually in four to five days, the crop appears.

CROP WEED COMPETITION

Due to the extremely limited alternatives available for weed control in buckwheat in organic farming conditions, it may be limited to specific mechanical and cultural approaches. Despite being an excellent weed opponent, buckwheat plants are often a smother crop because of their rapid growth. To raise a productive crop under such conditions, one weeding and hoeing at 20–25 DAS is beneficial. The crop must first be sown into a fine, sturdy, and weed-free seedbed.
To guarantee prompt germination and emergence, the seed should also be planted in moist soil. This helps the crop fight off any weeds that may be coming up.

HILLING

Buckwheat tends to have weak stems and an extremely high branching capacity, which renders them prone to lodging. Hilling is necessary at the 30- to 35-DAS stage because the plants lodge readily (Singh et al., 2018). The number of plants and the distances between them determine lodging. Thus, to prevent lodging from reducing production, it is advised that plant populations in buckwheat be maintained at their ideal levels.

PEST AND DISEASE MANAGEMENT

Generally resilient to freezing temperatures, buckwheat is not frequently harmed by pests or illnesses. On this crop, however, there have been reports of several pests and diseases. Leaf spot (Septoria polygonicola), smut (Sphacelotheca jagopyri), root and stem rot (Phytophthora jagopyri), brown leaf spot (Ascochyta italica), powdery mildew (Erysiphe polygoni), rust (Puccinia jagopyri), root and collar rot (Sclerotinia libertianai), root rot (Fusarium spp.), stem rot (Botrytis cinerea), chlorotic leaf spot (Alternaria alternata), downy mildew (Peronospora ducumeti), and bruchids (Acanthecelids obtectus), grain moth (Cephitinea spp.), cutworm (Cirphis spp.), storage beetles (Mycetophagus spp.) and aphids are the diseases (Gopi et al., 2015). Grain yield losses and a decrease in plant height are also brought on by viral attacks. There have been reports of bird damage to this crop, especially from doves.

NUTRITIONAL VALUES AND CONSUMPTION PATTERN

Rutin and other polyphenols are present in substantial amounts in buckwheat. When it comes to nutrition, rutin is one of buckwheat's most significant features. The green sections of the buckwheat plant and its blossoms are the primary sources of rutin. Less rutin is found in seeds than in leaves, although buckwheat flour may include some rutin—more so in the darker varieties. The genotype and growth environment of buckwheat affects its rutin content. In general, tartary buckwheat has a higher rutin content than regular buckwheat (Singh et al., 2020). Although quercetin is typically not found in larger concentrations in ripe buckwheat plants, it can sometimes be found as a byproduct of rutin degradation in harvested plant components. It is not suggested for people to be exposed to sunlight right after eating a meal that includes a lot of green portions and/or flowers of the buckwheat plant, as gopyrin, a chemical found in flowering buckwheat plants, is photosensitive. Buckwheat's strong nutritional value and the medicine rutin's high content in its leaf are the key factors contributing to its commercial significance (Stanly et al., 2020). A good source of protein supplementation is the groat, as evidenced by numerous studies. There are roughly 10.2% protein in tartary buckwheat. High levels of carbohydrates, primarily starch, have been detected in buckwheat grains. Although there is a significant concentration of important amino acids in buckwheat, particularly lysine, threonine, tryptophan, and amino acids containing sulphur, the real digestibility of the grain is less than 80% because of the high level of crude fibre and tannin. A good amino acid composition in buckwheat is also correlated with its low prolamins level as compared to other cereals, according to numerous reports from workers. Given that buckwheat's high lysine level makes up for the diets heavy in cereals' limiting lysine content, buckwheat may be a useful addition to cereal grains. Additionally, he proposed that certain cultivars of common buckwheat will facilitate better animal performance. Tartary buckwheat's high tannin content and high hull percentage have been discovered to result in a poorer biological value than common buckwheat. The glycoside rutin (quercitin-3-rutlnoside) is primarily found in the leaf of buckwheat plants. Rutin is used medicinally to treat hypertension coupled with increased capillary fragility, which can result in bleeding from the kidneys, purpura, and haemorrhage.

HARVESTING AND THRESHING

Buckwheat harvesting must be done quickly to avoid grain cracking. In general, early harvesting was carried out in the mid- and low-altitude regions, whereas late harvesting was seen in high altitudes. A well-managed crop should yield between 12 and 14 q/ha. Due to its unpredictable growth behaviour, the plant exhibits variable times of maturity. Delayed harvesting might lead to shattering and significant losses. Because grain shattering can result in losses of up to 25%, careful management of the crop is crucial. Harvesting occurs periodically due to the crop's gradual

creation and maturity. When the remaining seeds reach complete maturity, the crop is eventually cut and threshed. Unlike common buckwheat (*Mithey*), Tartary (*Tithey*) buckwheat (F. tataricum) has an unlimited harvesting time (*F. esculentum*). The '*Tithey*' type grows later than the '*Mithey*' type. For the proper storage of buckwheat grains, the seeds need to be thoroughly dried and maintained at a moisture content of no more than 14%. When exposed to elevated moisture levels, over-matured seeds exhibit rapid germination due to their viviparous nature.

CONCLUSION

This crop is resistant to climate change, thriving in both marginal and poor soil types and under adverse environmental circumstances. It is hypothesised that the Indian Himalayan region has a good diversity of buckwheat. Therefore, crop-specific missions are needed to gather the diverse and unexploited germplasm, as well as to characterise and document buckwheat germplasm collections in a systematic manner for future use. Because of its short growing season, buckwheat is a great fit for high hill, rainfed environments. As a backup crop, it is also appropriate in unusual weather conditions. A suitable crop to consider for sustainable intensification and diversification initiatives is buckwheat.

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