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Organic Nutrient Management Packages for Major Cereal Crops in Sikkim Himalaya

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Abstract

Maize is generally cultivated in a wide range of soil. But scientifically, it is able to sustain well in silt loam soil with adequate drainage facility, very good aeration having proper available nutrients as well as adequate amount of organic matter. Different types of microbial fertilizers, manure, vermicompost and oil cakes are very helpful to cultivate organic maize production. Rice may be grown on any type of soil, including troublesome soils like acidic and sodic soil. Sufficient and timely fertiliser supply is necessary for sustainable rice production. Farmers can cultivate buckwheat in a wide range of soil types and fertility levels. The crop buckwheat is able to sustain under acidic soil as compared with other grain crop. The crop barley can be grown well in terraced slopes of hills with a wide range of soil types (sandy loam to heavy soil).

Keywords: Buckwheat, Maize, Organic nutrient management, Rice

Introduction

The basic fundamental back bone of India is agriculture. The major cereal crops which are mainly cultivated in India are maize, rice, wheat. Besides, buckwheat, barley, sorghum, millet are also cultivated in India. The mineral nutrients like Fe, different vitamin B, E, protein, riboflavin, fibre, niacin, carbohydrates and thiamine are found in different cereal crops which are very essential for both human being as well as animal component. Rice, wheat and maize make up a substantial portion of 48% of total calories and 42% of total protein in developing nations. Cereal crop's residual feed (straw, stover, stalk) is essential for animals because it contains more protein than other diets. Cereal crops provide great promise for improving both environmental and human health. According to the EAT-Lancet report (Manjunatha *et al.,* 2014), cereal production has a low environmental impact when compared to other crops. It is very essential to improve the sustainability of cereal based cropping systems practices to judiciously use of soil, water, environment, pesticides fertilizers.

1. Maize (*Zea mays* L.)

Maize (*Zea mays* L.) is a major crop in Indian condition. It is called as "queen of cereals" because of its huge genetic capability. It contains different types of phytochemical substances along with various nutrients. The carotenoids, phenolics and phytosterols are very most common phytochemicals present within it.

Soil Requirement

Maize is cultivated in wide range of soil. But it grows well in silty loams soil with good drainage system and well aeration having sufficient organic matter content and adequate soil available nutrients. The most favourable pH for maize soil is 6.0-7.0. But it may be grown upto a pH of 5.0-7.0. Mineral toxicity and nutrient deficiencies occur when findings fall outside of the range. Good yields on more acidic soils require liming. Due to its high nitrogen requirements and large maize yields, it depletes soil nutrients significantly. A healthy plant population combined with proper soil fertility and sufficient soil moisture produces high yields. Regular soil analysis is recommended whenever feasible to learn about the properties of the soils and to receive guidance on how to raise soil fertility and/or adjust soil pH for the best maize production.

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Organic Nutrient Management

For nutritional supplements, manures, vermicompost, biofertilizers and various cakes are crucial components in organic maize cultivation. The green manuring [*Crotolaria juncea* (sun hemp), *Sesbania aculeata* (dhaincha)] and green leaf manuring [*Leuceana leucocephala* (subabul), Tephrosia] are some another alternative options for nutrient supplementation in the organic production system. A controlled supply of nutrients, especially N, is necessary for maize to thrive. Dolomite at 2 t ha^{-1}, mixed compost at 2.5 t ha^{-1}, neem cake at 0.5 t ha^{-1} and vermicompost at 2.5 t ha^{-1} were suggested by ICAR-Sikkim Centre as ways to meet crop needs and increase maize yield. Along with 150 kg of rock phosphate, ICAR-Sikkim centre advises applying well-decomposed FYM @ 15 t ha^{-1} 20 days before to planting. Additionally, 150 kg ha^{-1} of neem cake can be applied to the field to effectively reduce soil-borne insect pests and diseases. For getting a desirable economic yield the organic nutrient recommendation is FYM @ 10-15 t ha^{-1} + vermicompost @ 2.5-5.0 t ha^{-1}, either separately or in combination during final land preparation.

2. Rice (*Oryza sativa* L.)

Rice (*Oryza sativa* L.) is the major important food crops of Indian people. It is also a major food for more than 60% of world's population, mainly in Asia. Rice is a high-energy food. The milled rice usually has 6-7% protein. The biological value of its protein is very high.

Soil Requirement

There are very few soil types that rice cannot be cultivated on, including difficult soils like sodic and acidic soils. This is because rice is produced in a variety of soil conditions. Nonetheless, the best soils are those with a pH of 4.5 to 5.5, a high organic matter content and a good capacity to retain water. Given this, Sikkim's soils are perfect for growing rice because they have a pH of less than 6.5 and a 2% organic matter level. Upland rice cultivation is one of two types of soil management techniques used in Sikkim. In this approach, the ground is prepared dry (only in rain water) and the crop is seeded normally like any other cereal crop. For upland rice, the ideal soil type is said to be medium to fine soil that sits on top of a finer-textured subsoil. On the other hand, wet soil management is the alternative, where the land is flooded and soil preparation is carried out underwater (Manjunatha *et al.*, 2014).

Organic Nutrient Management

An adequate and timely supply of nutrients is necessary for obtaining sustainable rice production. However, farmers mostly apply nitrogenous fertilizers which may not only be responsible for lower grain yield but also causes serious environmental fallouts. Organic sources not only alter the physical, chemical and biological properties of soil positively for beneficial soil macro and microflora but are also a good source of micronutrients which is very essential for sustainable production. The best yield can be achieved by applying FYM at 10-15 t ha^{-1} and/or vermicompost at 3-6 t ha^{-1}, either separately or in combine. An established method of raising crop yields is the addition of organic matter to the soil. After reviewing the findings of numerous researchers, scientists concluded that the use of organic materials enhanced rice grain and straw yield. Compost made from discarded mushrooms and rice straw was found to boost rice grain yields by 20% more than NPK fertiliser, even though it was comparable to FYM. Applying 7.5 t FYM ha^{-1} was found to result in noticeably higher grain and straw yields than unfertilised fields. With rising rates of FYM, all of the rice yield-attributable characteristics increased. Organic farming with *Sesbania aculeata* L. (dhaincha) manifested in considerable improvement in grain yield of rice (Gupta *et al.*, 2020).

3. Barley (*Hordeum vulgare*)

Due to its lack of gluten, barley is a valuable cereal crop that is used to make bread (chapattis), which is easily digested. Barley malt is used more widely in the food, beverage and medicinal industries. When it comes to better quality protein and vitamin B complex, barley is far more abundant than maize and beans.

Soil Requirement

Barley can be grown successfully on a wide variety of soils ranging in texture from sandy to heavy loam in Indo-Gangetic plains and on the terraced slope of hills. However, it thrives best in well-drained, moderately fertile loam or light soil. Highly fertile soils cause severe lodging with an excess of nitrogen which also increases the nitrogen content in the grains, which is unsuitable for malting. Barley is more tolerant to saline and alkaline soil and less to acidic soil. Acidic soil is not fit for its cultivation but if it is unavoidable then can be grown with the appropriate quantity of liming at least one month earlier to sowing. Dolomite application @ 2 t ha^{-1} is recommended to raise soil pH to 6.0; however, soil testing is suggested.

Organic Nutrient Requirement

It is thought that high fertility causes barley to lodge, which in turn increases the amount of residual soil fertility. Rarely is barley, a rainfed crop, directly manured. Typically, barley and other coarse grains receive little to no manuring. Application of manure for barley crop is very minimal. The manure application vary depending on the its variety, soil type, water management and environment factor. But for getting a very good economic yield, the nitrogen application in the form of manure is very essential where the soil has very low organic matter content. But, application of huge amount of nitrogen may results in crop lodging as well as more protein content in seed grain which may deteriorate the quality of malting and brewing processes.

Nitrogen should thus not be added while the grain is still developing. Higher yields are obtained by applying organic nutrient sources in furrows one month prior to sowing, according to experiments, rather than at the time of sowing. FYM @ 3-5 t ha^{-1} application is advised (Praharaj *et al.*, 2005).

4. Buckwheat (*Fagopyrum* sp.)

Buckwheat is one of the major pseudocereal in mountain areas having an elevation of 1400 meters above sea level. It is an important crop for both grain purpose (flower) and green

leaves as vegetables. It is generally grown in high altitude of the Himalayas. Generally, two species of buckwheat namely *F. esculentum* and *F. tataricum* are grown. It contained high amount of different nutrients, minerals and protein which makes it a nutritious food.

Soil Requirement

Buckwheat can be grown in a wide range of soil having high to low fertility. As compared with other cereal crops, it is able to sustain more acidity in soil. Light to medium-textured well-drained sandy loam soil is ideal for its cultivation in hilly area. It is not able to thrive in soils which have a lot of limestone. On infertile, poorly drained soils, it yields a superior crop to other grains in a cool, damp climate. This crop is effective at drawing low-availability phosphorus from the soil. Additionally, lodging may happen in nitrogen-rich soils, which would lower production. Buckwheat plants no longer stand up straight after becoming stuck. Crusting on clay soils may result in an unsatisfactory stand because of poor seedling emergence.

Organic Nutrient Management

Buckwheat is often grown by state farmers using residual fertility and no additional nutrient inputs. However, it yields 1600 kg ha^{-1} and extracts 40 kilogramme potassium, 22 kg phosphorus and 47 kg nitrogen from the soil for every hectare planted. Since buckwheat does not react well to nitrogen fertiliser, nitrogen should be added based on the results of the soil test. In addition to causing lodging, excessive vegetative growth and weed pressure, high nitrogen application can also reduce grain production. Applying Azophos seed treatment plus mixed compost at 5 t ha^{-1} and neem cake at 0.5 t ha^{-1} is what the ICAR Sikkim Centre advises doing to have a decent crop output. Applying FYM at 5 t ha^{-1} and vermicompost at 2.5 t ha^{-1} will result in the highest yield (Das *et al.*, 2022).

5. Finger Millet (*Elusine coracana*)

Elusine coracana, or finger millet, is a significant crop that is farmed from sea level to 2100 meters above mean sea level. Ca, P, Fe and vitamins A and B are well-present in the grain. For adults of all ages, it is regarded as a mutative meal and is beneficial for expectant mothers.

Soil Requirement

Both sandy loams that drain well and light red loamy soils that have a good water-holding capacity are suitable for finger millet cultivation. A lot of organic matter should be present in the soil. Because of Sikkim's light soil texture class, the crop can withstand heavy rainfall.

Organic Nutrient Management

Due to the crop's reactivity to organic manure, adding sufficient amounts of organic matter to soil is thought to improve physical conditions that assist soils hold onto moisture for larger periods of time. It is recommended to apply 5 t ha^{-1} of FYM and/or compost or vermicompost at 2.5 t ha^{-1} at least 15-30 days before sowing of seeds. Additionally, different types of biofertilizers like *Aspergillus awamori* (a P-solubilizing fungus) and *Azospirillum brasilense* (an N-fixing bacterium) can be apply into the crop as seed treatment (25 g kg^{-1} seed). Since it is essential for successful seed inoculation, adhesive gum in solution form, such as Arabic gum, jaggery, *etc*., should also be employed. You can make this by dissolving 25 g of sugar or jaggery in 250 ml of water and then boiling it for five minutes. Using the necessary amount of adhesive solution, the solution is cooled and then applied to the seeds. In order to achieve a fine layer of culture on the seed, add the culture to the seeds and mix well. It is necessary to shade-dry the culture-coated seeds in order to prevent clumping (Das *et al.*, 2020).

Conclusion

Unlike farmers in other parts of the country, Sikkim proactively maintain high levels of organic matter in their fields by continuing to use organic manure to replenish nutrients lost as a result of crop removal and erosion. While organic farming in Sikkim Himalayan regions usually concentrates on generating income from small-scale rainfed farms, the Sikkim government's plan seeks to make every square inch of soil biologically viable and sustainable in order to position Sikkim as a major destination for organic farming.

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