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Exploring Effective Banana Cultivation Techniques in North Kerala, India

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I. INTRODUCTION

The banana plant (Musa sp.) is the largest herbaceous perennial and is part of the Musaceae family. It's India's alternate most significant fruit crop, after mango, due to its steady force, low cost, and high nutritive content. Bananas are cultivated in at least 107 countries. Kerala favours marketable Nendran banana husbandry due to consumer preferences, the banana's longer shelf life, inflexibility, and connection to the Onam jubilee. Still, banana civilization may be impacted by various natural disasters, such as cataracts, famines, tornadoes, and lightning. Still, the guaranteed income from banana cultivation significantly improves the fiscal well-being of individual farmers.

VARIETIES (Nendran) Mettuppalayam, Manjeri Nendran, Kaliyethan, Nedunendran, Chengazhikkodan, Attunendran, Mindoli, Zanzibar, and Big Ebanga are the main varieties cultivated in different parts of Kerala.

II. SEASON, SOIL AND CLIMATIC CONDITIONS

1) *Season:* April-May, August-September. Adjust planting season depending on local conditions. Avoid planting during the hottest summer months and the heaviest monsoon seasons. Planting should be timed to avoid drought and high temperatures during the 7–8 months after planting when bunches emerge.
2) *Soil:* An optimum range of pH 6.5 to 7.5 is recommended for banana cultivation. Soils exceeding pH 8.0 are not suitable. Bananas are known to grow well in slightly alkaline soil, and these soils can reduce the incidence of banana wilt. Red lateritic soil of the hilly tracks of Kerala is favourable for growth; however, bananas can be grown in almost all types of soils when they have a good water-holding capacity and are well drained. Poorly drained and aerated, nutritionally deficient soils are not suitable for bananas.
3) *Geography and Climate:* Ideal climate conditions for their production are tropical and subtropical humid lowlands, with optimum altitude ranges of 0-1000m. Optimal environmental conditions necessary for the cultivation are relative humidity ranging between 70 and 75 percent and temperature ranging between 20 and 30 degrees centigrade. Plants exposed to low temperatures and moisture during the active growth stage show reduced growth and yield. Hot winds blowing at high speed during the summer months shred and desiccate the leaves. High-velocity wind is one of the major obstacles to banana farming. When wind velocity exceeds 80 kmph, it causes damage to the plantation by uprooting the plants. The severity of the harm is exacerbated when the plants are overloaded with bunches.

III. LAND PREPARATION

Cultivate the field several times to integrate weeds and straw into the soil. Ensure the surface is smooth and levelled for planting suckers. Apply organic manure 10 to 15 days before planting. Dig planting pits based on soil type, water table depth, and plant variety, with a recommended size of 50cm x 50cm x 50cm in general. Fill these pits with topsoil mixed with organic matter such as well-decomposed farmyard manure and neem cake. Allow the prepared pits to be exposed to sunlight to eliminate harmful insects, enhance aeration, and mitigate soil-borne diseases.

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1) Soil Conditioning

Before planting the suckers, neutralize the soil using calcium hydroxide (kummayam) or dolomite. Calcium hydroxide is the best option for quicker soil neutralization. However, wait at least 14 days before applying fertilizer after using calcium hydroxide. Dolomite is also a good choice as it contains magnesium in addition to its neutralizing properties. Since Kerala's soil is deficient in magnesium, dolomite can be particularly beneficial. Fertilizers can be applied just 4 days after using dolomite. Another option is calcium carbonate, but it works slowly to neutralize the soil, making it unsuitable for short-duration crops.

IV. SUCKER TREATMENT

Select healthy sword suckers which are free from disease or pest infestation, prioritizing those with feathery leaves for optimal quality. Clean the suckers by removing excess roots and dirt. For sucker treatment, combine 400g of insecticide and 400g of fungicide in a 200 litre barrel.

For e.g. Chlorpyriphos + (Carbendazim + Mancozeb) or
Acephate 75% + Carbendazim

Popularly used insecticide brands are Hilban, Koranda, Pyricon, and Asataf, and fungicide brands are Saaf, Bavistin, and Fusion.

V. PLANTING

In the middle of the pits, plant suckers erect, leaving a 5 cm pseudostem above the ground. Avoid hollow air pockets by pressing soil around the sucker. Add 20g of Ralligold, M- Rhyzo or Vam Shakthi which are the popular brands commonly used by farmers to enhance soil fertility and promote plant growth through mycorrhizal fungi. (spacing changes according to variety)

VI. MANURING

Apply cattle manure, compost or green leaves at the rate of 10kg/plant at the time of planting.

VII. FERTILIZATION

Fertilization recommendation per plant,

A. First Method

For optimal growth during the first three months, apply the following fertilizer mix per plant:

- 100g of 16:16:16 NPK for balanced nutrient supply
- 200-250g of scientifically enriched organic manure for soil health
- 5-10 g of multi-micronutrients to support overall plant vitality
- 25 g of Polyhalite to provide essential secondary nutrients

After three months, replace the 16:16:16 NPK blend with a 10:5:26 fertilizer, as bananas require higher potassium levels for better fruit development. There is no need to add additional micronutrients after the initial application if the soil is sufficiently enriched with micronutrients to support continued plant growth.

B. Second Method

Drench the 25:25:25 NPK or 20:20:20 soluble fertilizer alternatively with the first method. For better results, add NPK solubilizing bacteria along with the fertilizer. Additionally, water-soluble micronutrients can be incorporated with this fertilizer.

The trade names of the aforementioned scientifically enriched organic manures are:

- Tata geogreen,
- Mahindra soil meal

The trade names of micronutrients are:

- Glucobeta(tata)

The trade names of water-soluble micronutrients are:

- Tracel
- Grandioplus
- Nutrifast

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The trade names of NPK 25:25:25 are:

- Aquaspeed (Netherlands imported).

The trade names of NPK 20:20:20 are:

- Omex bio20 (England imported)

VIII. PLANT PROTECTION

Bananas are among the world's most popular produce, but the crop is vulnerable to attack by pests and diseases. Sigatoka, which is a fungal disease, affects both the quality and quantity of the fruits and Panama Disease (Banana Wilt) where the plants slowly grow stunted and then die. Besides these diseases, pests such as nematode and banana aphids causes infections to the roots and stems and may lead to heavy loss. There is a need to develop proper management measures to guard the banana crops since these plants form the backbone of food supply and are vital means of subsistence to many growers around the globe. For instance, In places such as Kerala, these pests and diseases often infest the banana tree.

IX. PESTS

A. Pseudostem Weevil (Odoiporus longicollis)




The adult female weevil pierces the pseudostem and inserts the eggs. Emerging grubs dig into the fruit's pseudostem and peduncles, and these tunnels frequently get rotted. In heavily infested plants, the pseudostem is severely weakened and easily breaks. The adult is a little weevil, 14 mm long, with an extended snout, brown at first but eventually turning black.It may live up to two years and feed on tissue of banana plants, often being found in larval galleries.

Management

For effective management, farmers spray Fipronil 5% SC at a concentration of 2ml/ litre of water with popular brands such as Sonic Flo, Warrant, Kavach, etc at the time of pest incidence.

Remove affected plants along with the rhizome and destroy them by burning the life stages of the insect using kerosene or by burying the material in deep pits in the soil. C. Set traps using pseudostem of approximately 0.5 m length, which are split lengthwise and laid in the field. Adults drawn to it at night might be gathered and eliminated.

Spray Beauveria bassiana or Metarhizium anisopliae var. anisopliae @10 g per litre, or Beauveria bassiana @10 g per 30 cm long split pseudostem to attract and kill adult weevils.

B. Rhizome Weevil (Cosmopolites sordidus)




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Female adult weevils puncture healthy rhizomes and pseudostems at ground level and insert eggs through them. The rhizome is stunted as a result of the emerging grubs tunnelling into it and feeding on it. The tissues at the edge of the tunnels turn brown and rot. If the infestation occurs on a mature rhizome, damage symptoms such as yellowing and withering of leaves, reduction in leaf number, bunch size and fruit number appear.

Management

Application of Quinalphos 2ml/ litre formulation.

Sucker treatment with pseudomonas fluorescens @ 20 g litre +sucker treatment with entomopathogenic nematode *Heterorhabditis bacteriophora* @ 4 infected wax moth larvae /plant at planting, followed by two applications 2 and 5 months after planting.

C. Black Aphid (Pentalonia nigronervosa)




Leaves are bunched into a rosette appearance, stunted growth, and leaf margins are wavy with upward rolling, the plant fails to produce bunches. Insects are seen in colonies on leaf axils and pseudostem. It is the vector of banana bunchy top virus, which causes the deformation of the crop.

Management

Imidacloprid 17.8% SL(Tatamida), at a concentration of 2 ml per litre, is sprayed to control banana aphids.

D. Banana cut Worm (Spodoptera litura)

When the larvae are young, they scrape the leaves from the ventral surface. Later, they eat the leaves in large quantities at night.




Management

For control of Banana Cutworm, 2 ml per litre of Flubendiamide 20% WG (Takumi) or Flubendiamide 480 SC (Bayer Fame) can be used as an effective treatment.

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E. Hairy Caterpillar (Pericallia ricini)




Caterpillar scraps off the chlorophyll content and windowing in unfurled leaves.

Management
For control of banana hairy caterpillar, 2 ml per litre of Flubendiamide 20% WG (Takumi) or Lambacyhalothrin 5% EC (Syngenta karate) can be used as an effective treatment.

F. Nematodes



Major plant parasitic nematodes like Root-knot nematodes, Root lesion nematodes, Burrowing nematodes, Spiral nematodes, and cyst nematodes are most prevalent in banana growing tracts. The plant parasitic nematodes cause Typical root galls, lesions, or tissue loss to cause xylem vessels to be damaged and die, which hinders the flow of nutrients and water. Stunted growth and the development of tiny, chlorotic leaves are among the above-ground signs. The symptoms above ground are typically confused with a nutrition shortage because the microorganisms live underground.

Management
Verticillium chlamydosporium is a beneficial fungus used as a natural biocontrol agent, particularly to manage root-knot nematodes in the soil. It works by producing chlamysdospores that survive in soil and parasitize nematode eggs and larvae, reducing their population and minimizing damage to plants. Application of Verticillium 1% WP 5g/litre of water with popular brands such as Nematofree and Nematokrush resulted in pest reduction.

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X. DISEASES

A. Banana Root Rot





Banana root rot symptoms are primarily observed in the roots, which become rotten and dysfunctional. Also, the lower leaves of the plant turn yellow, indicating stress and poor nutrient uptake. As the condition progresses, the infection intensifies, causing the entire root region to turn black and decay. This severe stage hampers the plant's stability and nutrient absorption, eventually leading to stunted growth or plant death if left untreated.

Management

To control banana root rot, soil drench with Carbendazim 12% + Mancozeb 63% WP 2g/litre (such as UPL Saaf or Mahindra Fusion) or Metalaxyl 8% + Mancozeb 64% WP 2g/litre (Tata Master). Each plant should be soil-drenched with one litre of this mixture for effective management.

B. Panama Wilt



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Panama disease is a destructive banana disease brought on by the soil-dwelling fungus *Fusarium oxysporum forma specialis cubense*. The Fusarium fungus attacks young roots or root bases, often entering through wounds. It can spread into the rhizome (the root-like stem) and then quickly infect the rootstock and leaf bases. The fungus moves through the plant's vascular system, turning the bundles brown or dark red, and eventually purplish or black. Older leaves begin to yellow at the edges. Within one to two months, all leaves except the youngest will yellow, wilt, collapse, and droop, covering the trunk with dead, brown leaves. Over time, all aboveground parts of the plant die, though new shoots may appear at the base. These shoots also wilt, and the entire plant usually dies within a few years. The fungus survives in the soil, making it difficult for future plants to grow successfully.

Management

To control Panama wilt, soil drench with Carbendazim 12% + Mancozeb 63% WP 2g/litre (such as UPL Saaf or Mahindra Fusion) or Metalaxyl 8% + Mancozeb 64% WP 2g/litre (Tata Master). Each plant should be soil drenched with one liter of this mixture for effective management.

In Kerala,where conditions favour increased fungal incidence, it is important to apply a soil drench with fungicides before the second and fourth fertilizer applications, rather than waiting for the symptoms to occur.

C. Banana bunchy top disease



It is caused by banana bunchy top virus, which is transmitted through infected suckers and black aphids *(Pentalonia nigronervosa).* After a "mother" plant has contracted BBTV, the suckers that grow are typically very stunted, with leaves that do not spread out regularly and stay bundled at the top of the pseudostem. These leaves have chlorotic margins, are shorter and narrower than typical leaves, and are stiff and upright. Suckers with these symptoms will not bear fruit. On mature plants infected with BBTV, new leaves emerge with difficulty, are narrower than normal, are wavy rather than flat, and have yellow (chlorotic) leaf margins. The disease's name comes from the way they seem to be grouped at the top of the plant. Banana hands and fingers are likely to be twisted and deformed if fruit is produced, however severely affected banana plants typically do not bear fruit.

Management

Use virus free plant materials, remove infected banana plants, maintain clean, weed free field for early detection of infected suckers.

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D. Kokkan Disease



Banana bract mosaic disease (BBrMD) was first reported in nendran cultivar from Thrissur in Kerala and was referred to as 'Kokkan' disease of banana. Banana Bract Mosaic Virus (BBrMV) causes several distinct symptoms in banana plants. Infected plants typically display a dark red-brown mosaic pattern on the flower bracts. New leaves show green or red streaks, along with spindle-shaped lesions along the petioles and midribs. As the disease progresses, reddish-brown spindle-like streaks become visible on the stem, particularly when the outer, dead leaves are removed. Chlorotic streaks may also appear on the bunch stems and fingers of the fruit. In severe cases, the infection can lead to the rejection of the fruit due to the resulting damage and compromised quality. These symptoms can severely affect both the appearance and marketability of bananas. The virus is transmitted through infected suckers and aphid vectors such as *Aphis gossypii* and *Rhopalosiphum maidis.*

Management
Disease can be managed with the use of virus free planting material and roguing.

E. Sigatoka



Types of Sigatoka leaf spot commonly affecting banana plantations include Yellow Sigatoka leaf spot *(Mycosphaerella musicola)* and Black Sigatoka leaf spot *(Mycosphaerella fijiensis)*. Of the two fungal species that produce Sigatoka leaf spot in bananas, yellow Sigatoka leaf spot poses the greatest risk to banana production, while black Sigatoka leaf spot is not much prevalent in India. At first, light yellow or brownish-green streaks appear near the tip or edges of the leaf lamina, as well as along the midrib. Over time, these streaks expand and transform into spindle-shaped spots on the foliage, with a light grey centre surrounded by a yellow halo that runs parallel to the veins. As the disease progresses, the affected leaves dry out, leading to defoliation. Under favourable conditions, the disease can spread across the entire leaf, becoming more severe after the fruit bunches emerge. Infected plants produce smaller fruits, which may ripen prematurely, ultimately resulting in a reduced yield

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Management

For effective management of Banana Sigatoka, it is recommended to use a 1-2ml/ liter spray of Propiconazole 25% EC (Syngenta Tilt), Tebuconazole 250 EC 25.9% (Bayer Folicur), or a combination of Propiconazole 13.9% + Difenconazole 13.9% EC (Mahindra Phina).

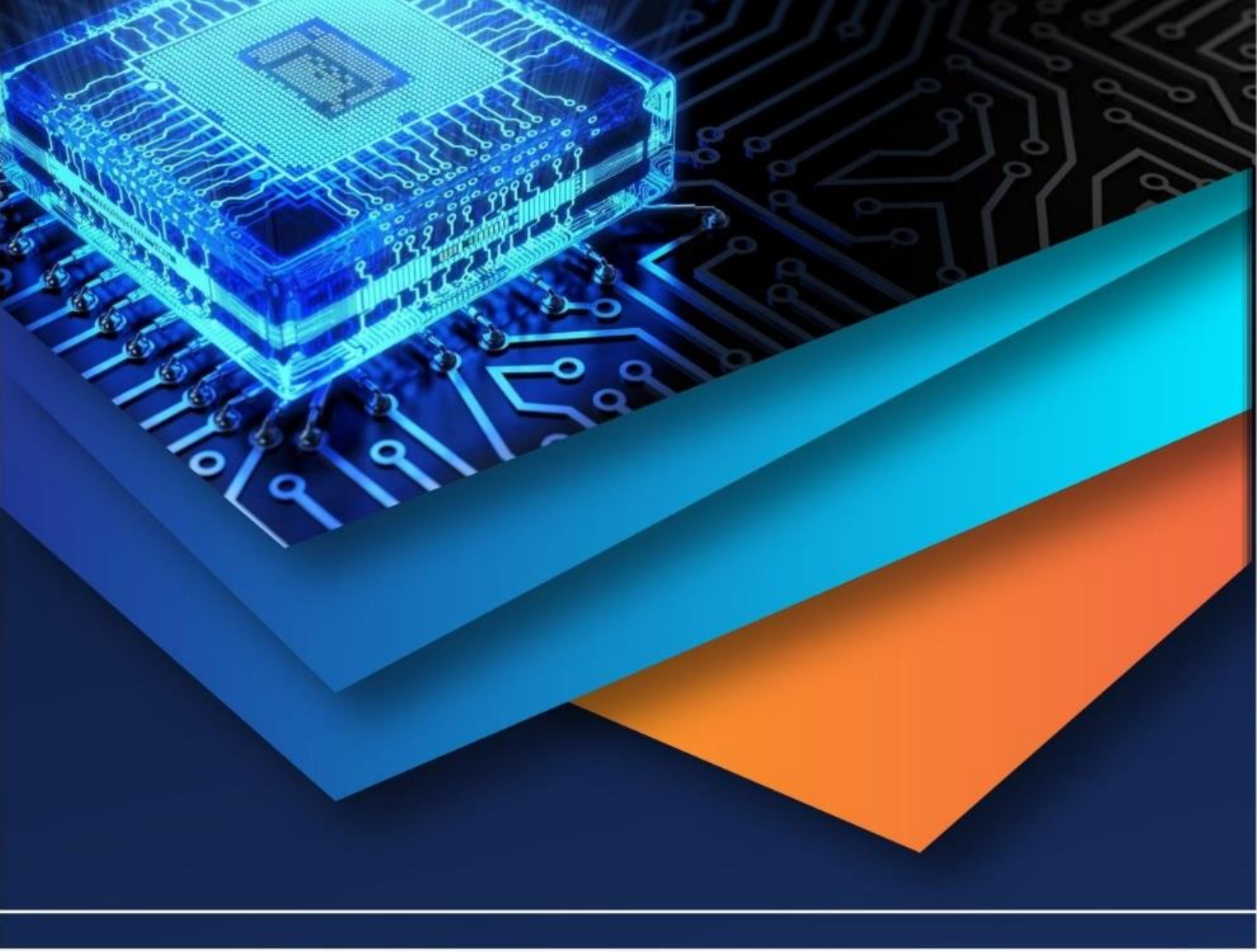
XI. ADDITIONAL POINTS

1) Spraying 19:19:19 NPK at a dosage of 5g per liter is beneficial for plant growth, especially if soil-applied fertilizers are not yielding results.
2) Applying potassium sulfate (0:0:50 SOP) at 5g per liter on the bunch or leaves can help increase the weight of the bunch.
3) Adding hexaconazole 5% SC at 1-2 ml per liter to the SOP spray can effectively prevent cigar-end rot and black spots on the fruit.

XII. CONCLUSION

The cultivation of bananas especially that of the Nendran type is very important for agriculture in Kerala and it also serves the purpose of many farmers. It is also essential culturally; the fruit is an essential delicacy that families take during the Onam festival. However, banana farming as we have seen is not without its main challenges. Special emphasis is made to the period of planting and marketing season, the type of soil, and proper management practices towards healthy yield. Due to various factors like Panama Wilt and Sigatoka, vulnerability affects banana plantation and farmers should ensure they are keen on pest and disease control. Understanding and applying correct treatments of suckers, appropriate use of fertilizers, and proper crop protection issues are the ways farmers can avoid all the mentioned threats and have well-developed productive plants. As you may be aware planting of banana crops is not a merry go round affair; however, the rewards that come with it are immeasurable. But if the right measures are followed, there is potential for the banana industry to continue to prosper for the coming years conveniently for the farmer, the consumers and the economy. The durability of this fruit plant coupled with efforts that has been invested and knowledge by banana growers makes it possible for this tasty fruit to be available in kerala as well as other regions.

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