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DEFICIENCY AND TOXICITY OF MAJOR CROPS IN KARAIKAL

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Abstract

The Karaikal area, part of the Union Territory of Puducherry, has a diverse farming environment that supports the growth of important crops like rice, pulses, okra, and peanuts. However, nutrient imbalances both shortages and excesses create serious problems for crop productivity and soil health in this coastal farming region. This study looks at the occurrence, signs, and effects of both macro- and micronutrient deficiencies (especially nitrogen, phosphorus, potassium, zinc, and iron) and toxicities (like boron and iron) affecting major crops in the area. Factors contributing to these issues include sandy coastal soils with low organic matter, high soil pH, poor nutrient retention, and intensive farming practices without proper nutrient management. Zinc and iron deficiencies are commonly seen in rice and vegetables, leading to stunted growth and yellowing leaves, while toxicity problems arise from improper fertilizer use or waterlogging in some areas. The findings highlight the need for proper nutrient management practices, such as soil testing, balanced fertilization, and organic amendments, to ensure sustainable crop production and soil fertility in Karaikal.

Keywords

Nutrient deficiency, nutrient toxicity, soil fertility, micronutrient Imbalance, coastal agriculture, fertilizer management, crop productivity, sustainable agriculture.

Introduction

Agriculture is very important for the economy and lives of people in the Karaikal area, a coastal district in the Union Territory of Puducherry. This region is famous for growing key crops like rice, pulses, okra, and groundnut, which depend a lot on the health and richness of the soil. However, in recent years, problems with nutrients showing up as both shortages and excesses have become major challenges to getting the best crop yields and achieving sustainable farming.

Nutrient shortages, especially of nitrogen (N), phosphorus (P), potassium (K), and small amounts of other elements like zinc (Zn) and iron (Fe), are often seen in different farming systems in Karaikal. These shortages are increased by the soil's properties, such as high pH, low organic matter, and weak ability to hold nutrients. On the other hand, bad fertilizer uses and issues like waterlogging can cause too many nutrients, such as boron (B), iron (Fe), and manganese (Mn), which can hurt plant growth and productivity. The link between the climate, soil health, and nutrient behavior in Karaikal requires a thorough understanding of the reasons, signs, and results of nutrient problems in main crops. Solving these issues with the right nutrient management plans is crucial for boosting crop

yields, enhancing soil fertility, and ensuring farming can last in the long run in the region. This article aims to look into the types, levels, and effects of nutrient shortages and excesses in the major crops grown in Karaikal and to suggest proper management methods suited to local farming conditions.

Agro-Climatic and Soil Conditions in Karaikal

The Karaikal region, a coastal enclave of the Union Territory of Puducherry located along the southeastern coast of India, falls within the East Coast Agro-Climatic Zone. This area has a tropical climate, shaped by both the southwest and northeast monsoons. The annual average rainfall ranges from 1200 to 1500 mm, with a significant portion (over 60%) received during the northeast monsoon (October to December). The mean annual temperature typically ranges between 25°C and 35°C, creating a warm and humid environment conducive to year-round crop cultivation.

The soil in Karaikal are primarily coastal alluvial soils, ordinarily portrayed as sandy soil to loamy in surface. These soils exhibit moderate to low water-holding capacity, making them prone to nutrient leaching, particularly under high rainfall or frequent irrigation. One of the critical challenges is the low organic matter content, often below 0.5%, which limits microbial activity and nutrient retention.

Another defining feature is the high soil pH, especially in inland areas, where pH values frequently exceed 7.5. This alkaline condition adversely affects the availability of several micronutrients, especially zinc, iron, and manganese, resulting in widespread deficiencies in crops like paddy and vegetables. In low-lying and poorly drained areas, periodic waterlogging can lead to iron and manganese toxicity, particularly in rice. Additionally, salinity and sodicity are emerging concerns in certain coastal belts due to seawater intrusion and poor-quality groundwater used for irrigation. These issues contribute further to nutrient imbalances and reduced crop performance.

Overall, the unique agro-climatic and soil conditions of Karaikal necessitate site-specific nutrient and water management strategies to maintain soil health and ensure sustainable agricultural productivity.

Major Crops in Karaikal

- Paddy (Rice) – most dominant
- Sugarcane
- Pulses (e.g., Black gram, green gram)
- Groundnut
- Vegetables (Brinjal, Chilli, Tomato)

Deficiencies and toxicity of major crops

1.Paddy

Nutrient imbalances, especially shortages and excesses, greatly influence crop growth and output in the Karaikal area. A lack of nitrogen (N) is often shown by yellowing of older leaves and slow growth, while too much nitrogen leads to abundant leafy growth and delayed flowering, which can lower grain crop yields. A shortage of phosphorus (P) usually causes a purplish color on older leaves, particularly during the early growth stages, while too much phosphorus can limit the availability and absorption of essential micronutrients like zinc and iron. A lack of potassium (K) appears as yellow-brown edges on leaves and weak stems, making plants more prone to falling over and disease; although

potassium toxicity is rare. For micronutrients, a lack of zinc (Zn) causes leaves to bronze and seedlings to grow poorly, particularly in rice, while zinc toxicity is not common. A shortage of iron (Fe) often shows up as yellowing between the veins in young leaves, especially in high pH soils, while iron toxicity, which occurs often in acidic and waterlogged soils, leads to leaf bronzing and dying tissue. Knowing these specific nutrient signs is important for proper diagnosis and good management in crop production systems in Karaikal.

2. Sugarcane

Deficiency and toxicity symptoms of essential nutrients such as nitrogen, potassium, and magnesium significantly affect plant health and productivity. A deficiency of nitrogen is typically indicated by pale green leaves and poor tillering, reflecting the plant's limited ability to produce chlorophyll and grow vigorously. In contrast, abundance nitrogen can lead to intemperate leaf development and expanded hazard of lodging, where plants drop over due to weak stems. Potassium deficiency often shows up as scorched tips and edges of leaves, compromising the plant's water regulation and disease resistance, while its toxicity is rare. Magnesium deficiency is identified by interveinal chlorosis, a condition where the areas between the veins turn yellow while the veins themselves remain green, affecting photosynthesis. However, magnesium toxicity is also rarely observed in plants. Proper nutrient management is essential to ensure balanced growth and optimal crop yield.

3. Pulses (Black gram, green gram)

Insufficiency and harmfulness of supplements such as nitrogen, phosphorus, and molybdenum have outstanding impacts on plant improvement. A nitrogen insufficiency is commonly seen through light green foliage and destitute unit set, showing insufficient chlorophyll generation and disabled regenerative advancement. Abundance nitrogen may delay trim development, influencing collect timing and in general surrender quality. Phosphorus lack comes about in hindered plant development and a characteristic purpling of clears out, especially in more seasoned foliage, due to prevented vitality exchange and root improvement; in any case, phosphorus poisonous quality is seldom watched. Molybdenum lack is stamped by pale takes off and destitute nodulation, particularly in vegetables, because it plays a pivotal part in nitrogen obsession. Poisonous quality of molybdenum is additionally uncommon in plants. Keeping up adjusted supplement levels is crucial to guarantee sound development and compelling physiological working in crops.

4.Groundnut

Deficiency symptoms of calcium, sulphur, and boron can significantly hinder plant development, while toxicity though rare for most can also pose risks. Calcium deficiency is typically expressed as poor pod filling and the presence of empty pods, due to its essential role in cell wall formation and reproductive development. Sulphur deficiency leads to general yellowing of the plant and smaller leaves, resembling nitrogen deficiency but affecting younger leaves first. Boron plays a crucial role in cell wall stability and reproductive growth; its deficiency causes hollow heart and poor kernel development, particularly in crops like groundnut and maize. Unlike calcium and sulphur, excess boron is toxic to plants, leading to leaf burn and necrosis. Therefore, precise nutrient

management is essential to avoid both deficiency and toxicity for optimal crop health and productivity.

5.Vegetables (Brinjal, Chilli, Tomato)

Deficiencies of calcium, magnesium, and boron can cause distinct symptoms that negatively impact crop growth and quality. Calcium deficiency is often observed as blossom-end rot in crops like tomato and chilli, resulting from weakened cell walls and poor calcium translocation to developing fruits. Magnesium deficiency appears as yellowing between the veins of older leaves, known as interveinal chlorosis, due to its critical role in chlorophyll formation and enzyme activation. Boron lacks influence regenerative improvement, driving to destitute natural product set and twisted vegetables. While calcium and magnesium toxicity are rare, excessive boron can be harmful, causing yellow or brown leaf tip burn and reducing plant vigor. Balanced nutrient application is essential to prevent such disorders and ensure healthy crop production.

Management and Remedial Strategies

Both nutrient deficiencies and toxicities in Karaikal's major crops demands a holistic and integrated approach tailored to the region's coastal agro-ecological conditions. Standard soil testing is fundamental to distinguish particular supplement awkward nature and direct suitable fertilizer suggestions. For macronutrient deficiencies, such as nitrogen (N), phosphorus (P), and potassium (K), balanced and need-based application of fertilizers should be ensured, avoiding blanket doses that can lead to toxicity or secondary deficiencies. In the case of micronutrient deficiencies—particularly zinc (Zn) and iron (Fe), which are common in Karaikal, corrective measures include soil application of zinc sulphate ($ZnSO_4$) or ferrous sulphate ($FeSO_4$) and foliar sprays for faster correction. In high pH soils where nutrient availability is low, chelated forms like Zn-EDTA and Fe-EDTA offer improved effectiveness.

To mitigate nutrient toxicities, especially of iron and manganese in waterlogged or acidic soils, effective drainage management, liming, and controlled irrigation practices are critical. Avoiding excessive or unbalanced fertilizer use—particularly phosphorus, which can suppress micronutrient uptake—is also key to preventing toxicity-related issues. The integration of organic manures, compost, green manures, and biofertilizers not only improves soil organic matter content and microbial activity but also buffers nutrient availability, reducing both deficiency and toxicity risks.

Integrated Nutrient Management (INM), which combines chemical fertilizers, organic amendments, and biological inputs, should be promoted as a sustainable solution. Additionally, crop rotation, intercropping, and the cultivation of nutrient-efficient varieties can help maintain long-term soil health. Regular training and capacity building for farmers through extension services are essential to improve awareness and adoption of site-specific nutrient management practices in Karaikal.

Conclusion

In Karaikal, nutrient deficiency and toxicity significantly affect the growth and yield of major crops such as paddy, pulses, groundnut, and vegetables. Deficiencies of nitrogen, phosphorus, potassium, and

micronutrients like zinc and iron are common due to the region's light-textured, nutrient-leaching soils and variable climatic conditions. On the other hand, improper use of chemical fertilizers and poor drainage can lead to nutrient toxicities, such as excess nitrogen or boron, which harm plant health. To address these challenges, it is essential to adopt balanced and need-based nutrient management practices, regular soil testing, and the use of organic inputs. By improving soil health and managing nutrients effectively, farmers in Karaikal can enhance crop productivity and maintain sustainable agricultural practices.