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NPK Deficiency Symptoms in Maize and their Integrated Nutrient Management

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Abstract

During Green revolution, Dr. M.S. Swaminathan, promoted to use more chemicals so as to increase the crop production and feed the growing population by giving the slogan "More Chemicals, More Production", as a result soil became problematic due to extensive use of chemicals and intensive cropping system, leading to toxicity in crops started occurring nation-wide and imbalance of nutrients in soil, which has adverse effect on soil health and also on crop yields. Soil macronutrients are essential to maintain ecosystems and high crop yields. As a result, soil became in detritus condition. There is need to improve nutrient supply system in terms of Integrated Nutrient Management involving the use of chemical fertilizers in conjunction with organic manures through biological process. Maize is highly sensitive to nitrogen deficiency, 'V'-shaped yellowing(chlorosis) at the tip of lower leaves. Deficiency symptoms of P appear on the older leaves can develop reddish-brown in colour or purple colour develops on the margins of lower leaf edges. Potassium is highly mobile in plants and its deficiency symptoms, first appear on older leaves and tips burn and margin scorching or burnt. Maize is also known as "Queen of cereals" and kind of fodder. Maize (Zea mays L.) or Corn is one of the important cereal crops next only to wheat and rice in the world. Maize is high genetic yield potential than other cereals. Adoption of Integrated plant nutrient supply system in maize cultivation can improve soil health, maintain ecosystem balance and ensure sustainable high yields through balanced fertilization practices.

Keywords: Green revolution, NPK deficiency, Maize and INM

Introduction

The term Maize is derived from two different languages. *"Zea"* originates from the ancient Greek word used as a generic name for cereals and grains. Some agronomists also interpret *"Zea"* as meaning "sustaining life." The word "mays" comes from the Taino language, where it means "life giver." Maize is one of the most important cereal crops in the world, it is a member of family Gramineae (Poaceae)genus *Zea*, species *Zea mays* L. and sub family Panicoideae.

The exact origin of maize is still uncertain. Some researchers consider Peru, Bolivia and Southern Mexico and Central America are the original homelands of maize. In the past four decades, global maize production has greatly increased (FA0, 2018) mainly due to application of nitrogen(N) fertilizers. Worldwide, N fertilizer has widely been excessively applied to achieve higher grain yield. (Meng *et al.*, 2016 and Liang *et al.*, 2020). Among these countries, Poland records an attainable maize yield of about 11-12 tonnes per hectare.

In India, major maize-growing states include Gujarat, Rajasthan, Punjab, Haryana, Bihar, Madhya Pradesh, Uttar Pradesh andhra Pradesh, Himachal Pradesh and Jammu and Kashmir. Research Scientists, in their researches have reported that Indian Soils are deficient in Macronutrients (NPK).

Maize is the world's third most consumed cereal after wheat and rice, with India being the 5th largest producer and 14th largest exporter. India's maize production was 356.7 lakh metric tonnes of maize during in 2023-24. Major growing states include Karnataka, Madya pradesh, Bihar, Tamil nadu, Telangana,

Maharashtra and Andhra Pradesh (Ministry of Agriculture& Farmers Welfare, GOI, 2023-24). In India, over 85% of maize is consumed as human food, while it's also a key ingredient in animal feed, especially for poultry. Industrially, it's used to produce starch, oil, dextrose, ethanol and various other products.

Nitrogen is essential constituent of protein and is present in many other compounds of great physiological important in plant metabolism. Nitrogen is called a basic constituent of life. Nitrogen tends primarily to encourage above ground vegetative growth and it imparts dark green colour to plants. Nitrogen governs the utilization of potassium, phosphorus and other elements in maize crops.

Phosphorus is a constituent of nucleic acid, phytin and phospho-lipid phosphorus compound act as "energy currency" within plants. Phosphorus has a great role in energy storage and transfer and closely related to cell division and development of maize. Phosphorus (P) is one of the most limiting nutrients in agricultural cropping systems (Khan *et al.*, 2018).

Potassium plays important role in formation of protein and chlorophyll and it provide much of osmotic pull that draw water into plant roots. Potassium produces strong stiff straw in maize and reduces lodging in maize. Potassium imparts increase vigor and disease resistance to plant (Singh *et al.*, 2010).

Integrated Nutrient Management: The soil health can be maintained through integrated nutrient management. Modern researches have shown that the use of fertilizers with organic manures, biofertilizers and crop residues increases productivity significantly. The best results are obtained by using 75% recommended dose of fertilizers (RDF) with 10-12 tonnes of organic manure and 4-5 kg of biofertilizers/ha. INM not only ensures more crop yield but also maintains good soil health.

Nitrogen (N) Deficiency

1.The deficiency symptoms appear first and become severs, on older leaves. **2.**Maize is highly sensitive to nitrogen deficiency; deficient plants become stunted and develop small ears.**3.** Nitrogen deficiency symptoms seen such as yellow or pale green colour of leaves, drying up or firing of bottom leaves and short stature.**4.** Affected ears have small kernels and low numbers of kernels per ear. **5.** 'V'-shaped yellowing(chlorosis) at the tip of lower leaves.

Integrated nutrient management

1.Basal application of organic manures, nitrogenous fertilizers, biofertilizers.**2.** Split nitrogen application (at sowing stage, knee-high stage and tasselling stage) **3.** Top dressing of urea in two split doses. **4.**In standing crops, apply urea (2 % solution) as foliar spray. Foliar sprays are required to be repeated every 10 to 15 days.**5.** Incorporate legume crops into the rotation.

Phosphorus (P) Deficiency

1.Deficiency symptoms of P appear first on the older leaves.**2.** Stunted growth.**3.** Delay in maturity. **4.**Severely deficient condition, the bluish-green leaves can develop reddish-brown in colour or purple colour develops on the margins of lower leaf edges (Source: Sahai, 2011). **5.** Lower leaves become dry.

Figure 1. Nitrogen deficient corn leaf exhibiting the inverted "V".

Figure 2. Phosphorus deficient corn plant.

Integrated nutrient management

1. Analyse the soil before planting to measure the amount of plant available P.

2. Basal application of organic manures, phosphatic fertilizers.**3.**VAM, Phosphorus-solubilizing microbial inoculants. **4.**In standing crops apply phosphatic fertilizers like SSP, DAP, MAP etc. with irrigation water.

Potassium Deficiency

Potassium (K) Deficiency in Maize

1.Potassium is highly mobile in plants and its deficiency symptoms, first appear on older leaves and at early growth stage. **2.** Potassium deficiency causes shortening of the internodes,

dwarfing of plants.**3.** Midrib usually remains green (Source: Havlin *et al.*, 2010) **4.** Tips burn and margin scorching or burnt. **5.** Brown spots near margin.**6.** Stems of plants remain small and less tillering occurs.

Integrated nutrient management

1. Analyse the soil before planting to measure the amount of plant available K.

2. Add organic manures such as FYM, Compost, Green manures etc.

3. Apply KCl, K_2SO_4, KNO_3 to the soil at or before planting as per soil testing.

4. Potassium sulphate may also be applied as foliar spray. In standing crops, apply soluble K sources with irrigation water.

Conclusion

Conduct soil testing before fertilizer application applying nutrient doses on soil fertility status, foliar spray can correct deficiencies quickly, incorporate previous crop residues into soil for organic matter and microbial activity. Based on the results, it is concluded that the application of organic fertilizers, inorganic fertilizers, biofertilizers and crop residues gave the best results on the growth, seed yield and productivity of maize.

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