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Management strategies to enhance fertilizers use efficiency of major nutrients

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Abstract

There are seventeen essential nutrients which are required for the optimum growth and development of crop. Among these, there are major nutrients (N P K) which are required in higher quantity by crop and their supply is utmost essential. Not only nutrient supply, but they should be supply at balanced form. Moreover their rate, source, time and method of application are also important for increasing the efficiency of applied fertilizers. The efficiency of nitrogen fertilizers can be increased by use of slow release nitrogen fertilizers, foliar application of Urea, split application methods, use of non-nitrate fertilizers and incorporation of urea fertilizers. For the phosphatic fertilizers, localized application, use of sufficient quantity of organic matter and liming of soil to raise its pH near neutrality (pH 6.5) could be done. In case of potassium, soil type and crop grown are the most important parameters while deciding the fertilizer source. Crop growth and fruit types and their sensitivity towards to K fertilisers are also important.

Keywords: Nutrient losses, soil fertility, fertilizer use efficiency

Introduction

In modern agriculture use of essential plant nutrients in crop production is very important to increase crop productivity and maintain sustainability of the cropping system. It is important to take into account the climate, soil and plant status before determining the management ways of fertilizer source. In general, nutrient use efficiency by crop plants is lower than 50 % under all agro-ecological conditions. Hence, large part of the applied nutrients is lost in the soil-plant system. The lower nutrient use efficiency is related to loss and/or unavailability due to many environmental factors. The low nutrient use efficiency not only increase cost of crop production but also responsible for environmental pollution. Improving nutrient use efficiency is essential from economic and environmental point of view. The most important strategies to improve nutrient use efficiency are the use of adequate rate, effective source, timing, and methods of application. In addition, decreasing abiotic and biotic stresses and use of nutrient efficient crop species and genotypes within species are also important in increasing nutrient use efficiency. Here, strategies regarding increasing Fertilizer use efficiency of N, P and K fertilizers are discussed.

Nitrogen fertilizers

Nitrogen is lost from fertilizer by volatilisation, leaching, denitrification, decomposition and soil erosion. Volatilization of nitrogen occurs in the form of ammonia largely in soil having pH >7.0. However, if the fertilizer source is urea, then the losses can also occur in neutral and acid soils. In case of urea for the control of volatilization losses, urea must be incorporated with soil by tillage or washed into soil through irrigation. In acid or neutral soil, ammonium fertilizers that is ammonium sulphate, ammonium nitrate may be applied on the surface but urea must be incorporated with soil. Slow release nitrogen fertilizers, foliar application of urea and split application methods should be adopted (Dibb D W *et al.*, 1990)^[3].

Denitrification occurs mostly in submerged rice soil where nitrate is denitrified. Leaching of nitrogen occurs in coarse texture sandy soil, having low organic matter and bare soil. For this, non-nitrate fertilizers should be used instead of nitrate fertilizers. In submerged rice fields, fertilizer should place in reduced zone.

Split application of fertilizers, foliar application of urea, slow release nitrogen fertilizers, nitrification inhibitors, urea mud ball, may also be adopted considering soil and climatic conditions.

Phosphate fertilizers

Unlike nitrogen fertilizers, the phosphate fertilizers have the management difficulty with respect to its high fixation in soil colloidal complexes. Phosphorus fixation causes phosphorus availability problem for the crop. In order to minimize its fixation and to improve its use efficiency, it should be applied at high rate to make the soil supersaturated with phosphate if the P availability and cost is not a concern. Once the adsorption site are saturated with phosphate, further adsorption will not occur. The excess phosphate left in the soil solution will become readily available to the crops. Localized application of phosphatic fertilizer near the seed or seedling roots should be followed. Sufficient quantity of organic matter should be applied, as on decomposition organic matter produces organic anions, humus, these products reduce phosphorus fixation and release phosphorus to the soil solution. The acid soil may be limed to raise its pH near neutrality (pH 6.5). Over liming should be avoided. Pelleted or aggregated phosphatic fertilizers may be used. When applied to soil the contact between fertilizers and soil decreases which result in less phosphorus fixation.

Potassic Fertilizer

Potassium deficiency may appear in soil in following conditions -Soil low in mica, soil low in clay, strongly acidic soil in humid region, sandy soil in humid region, muck soil flooded with either irrigation water or rainwater, highly weathered soils (Baligar and Barber, 1978)^[1]. Plants need for potassium is high during early growth. Hence, adequate potassium fertilizer should be applied to seedlings. Care must be taken so that fertilizer salt cannot damage the seedlings. For crops which need high potassium such as sugar producing crops the dose of potassium fertilizer should be high. For potato and tobacco muriate of potash should be replaced with sulphate of potash. Because large amount of chloride affect the burning quality of tobacco i.e., induces poor fire holding quality of tobacco leaf and decreases starch yield of potato and make potato poor for fries. As a result crisp quality of potato chips deteriorates (Clarke and Zeto, 2008)^[2]. Under prolonged submerge condition of soil, high dose of sulphate of potash should not be applied otherwise it will induce hydrogen sulphide toxicity and unavailability of cationic micronutrients. For potassium loving plants such as coconut common salt (NaCl) may be applied to increase potassium availability. For perennial crops, gypsum may be applied to increase potassium availability. For strongly acid soil, very high dose of muriate of potash should not be applied in bands. It should be applied in splits at low dose and broadcasted. For calcareous soil or over limed soil, application of potassic fertilizers is must though soil test shows adequate potassium content. Peat, muck, and sandy soil may need larger application of K fertilizers due to heavy leaching.

Certain practical approaches to increase efficiency of fertilizers

1. High yielding varieties of crops give higher yields than local varieties without fertilization as well as a higher unit response to fertilizer even at the lower rate of application. Therefore wherever possible, high yielding varieties should be grown.

2. Deviation from normal planting or sowing time suited for a particular crop variety in a particular locality will effect the efficiency of fertilizers.
3. Optimum plant spacing and maintenance of optimum plant population are essential to get maximum benefit from the applied fertilizers.
4. Ensure effective organic matter recycling, in order to maintain fertility and productivity. Response for a nutrient is generally higher in soils supplied with adequate amount of organic matter.
5. While applying organic manures having high C:N ratio ensure that adequate amount of nitrogenous fertilizers are applied to soils to compensate biological locking up of N in microorganisms.
6. Include a legume either in rotational sequence or as an intercrop. Legumes besides fixing atmospheric N, transform non-available native phosphorus and precipitated or fixed fertilizer P into available forms.
7. Excessive irrigation should be avoided as it results in the loss of N and K fertilizers. Further, there is also gaseous loss of N under waterlogged condition. There should not be excess water in the soil particularly at the time of fertilizer application. Fertilizer application should be made after draining the excess water.
8. Crop response to phosphatic fertilizers is generally more in dry seasons.
9. Balanced fertilization should be practiced based on the soil test values. Efficiency of a straight fertilizer (containing nutrient) depends on the sufficiency of other nutrient in the soil.
10. The phosphates in general are more efficient when the entire dose applied as basal dressing, potash entire quantity as basal dressing or part as basal and rest in split doses depending on the soil texture and the nitrogen in 2-3 (or 4) split doses.
11. Water soluble phosphatic fertilizers should be placed 4-6 cm below the soil and 4-6 cm away from the seeds to ensure maximum availability to plants. Insoluble fertilizers should be thoroughly mixed in soil.
12. Sometimes it is better to cure the urea by mixing the urea with 5-10 parts of soil thoroughly and keeping the mixture for overnight. This enhances the conversion rate of urea into ammonia carbonate.
13. Whenever N loss in drainage water is suspected due to efficiency of the N fertilizer can be increased by mixing the fertilizer with crushed neem seed (5:1 parts)
14. Foliar application of fertilizers should be resorted to under certain soil conditions and climatic conditions.
15. Zinc deficiency is becoming more and more widespread day by day. In such cases application of zinc sulphate at the rate of 10-25 kg of zinc sulphate as basal dressing, not only corrects the zinc deficiency but also enhances generally the efficiency of the other applied fertilizers.
16. Adverse soil condition should be corrected by using appropriate amendments, to get maximum benefit from fertilizer.
17. Absence of weeds, pest and diseases ensures the efficiency of fertilizer.

Conclusion

It is essential to have the sustainable yield production with the minimum use of available resources. Fertilizers are one of the most indispensable inputs in agriculture. The N, P and K are the major nutrients required by any crop. Hence, their use must be done with proper care considering the soil, climate

and crop growth stages. However with any management strategies, it is not possible to achieve the 100% use efficiency because of dynamic nature of agri-ecosystem but it could be improved to the tolerable levels with adoption of above mentioned management strategies.

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