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Popular Article

Article: RT0466

Biotica Research Today

Vol 3:1 001/002

2021

Techniques of Optimizing Fertilizer Use Efficiency (FUE)

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Open Access

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Keywords

Fertilizer, Fertilizer use efficiency, Nutrient, Techniques

How to cite this article?

Singh *et al.*, 2021. Techniques of Optimizing Fertilizer Use Efficiency (FUE). Biotica Research Today 3(1): 001-002.

Abstract

The fertilizer recommendation based on nutrient supplying power of soils and by specific soil, plant and climatic factors. Fertilizers are considered as efficient when maximum yield is acquired with minimum possible amount of fertilizer application. Fertilizer use efficiency depends on the ability of plant to take up nutrients efficiently from the applied fertilizer in soil, but also depends on internal transport, storage and remobilization of nutrients.

Introduction

Fertilizer is an important source of crop nutrients needed for optimal crop growth. Fertilizer use efficiency indicates the potential output of any cropper unit of the nutrient applied under a specified set of soil, plant and climatic conditions.

The nutrient use efficiency can be expressed several ways. Mosier *et al.* (2004) described four agronomic indices commonly used to describe nutrient use efficiency: partial factor productivity (PFP, kg crop yield per kg nutrient applied); agronomic efficiency (AE, kg crop yield increase per kg nutrient applied); apparent recovery efficiency (RE, kg nutrient taken up per kg nutrient applied); and physiological efficiency (PE, kg yield increase per kg nutrient taken up). Crop removal efficiency (removal of nutrient in harvested crop as % of nutrient applied) is also commonly used to explain nutrient efficiency.

Various Techniques of Optimizing FUE

To increase the fertilizer use efficiency the nutrient must be available at the right rate (quantity), right time, and right form of its requirement by the crop and in right place as a best management practices (BMP). On application there occur certain inevitable/ evitable losses of nutrients that reduce the efficiency. The losses are due to: (i) leaching, (ii) volatilization, (iii) immobilization, (iv) denitrification, (v) runoff, (vi) chemical reaction between various components in the mixture, (vii) change in capacity to supply nutrients, and (viii) unfavourable effects associated with fertilizer application. Each component of loss can be reduced to a great extent by management of the soil, fertilizer and crop system. This requires knowledge and experience on (i) how much of the fertilizer to be applied, (ii) what/ which (type of fertilizer) to be applied, (iii) when to be applied (time of application), (iv) how (method of application), (v) where (placement of fertilizer) and (vi) other considerations (cost, availability of fertilizer, labour, ease of application, awareness on benefits of fertilizer use, etc.).

Article History

Received in 1st January 2021

Received in revised form 3rd January 2021

Accepted in final form 4th January 2021

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How Much (Quantity of Fertilizer)

The most of crops are location and season specific depending on cultivar, management practices and climate etc., so it is critical that realistic yield goals are established and that nutrient are applied to meet the target yield. Inorganic source is a supplement to other sources of nutrients. Among other sources, the most important one is soil source. Availability of nutrients from soil and fertilizer sources can be estimated from field experiments involving response to fertilizers and tracer techniques.

What and Which (Type of Fertilizer)

Chemical fertilizers vary with respect to their solubility besides their grade. Choice of fertilizer is location specific and needs to be found out by field experimentation. The choice is more with respect to nitrogen and phosphatic fertilizers than for potassic. Studies on crop response is also more for N than for P or K fertilizers because leaching loss is more in nitrogenous fertilizer and its residual effect is nil or negligible. In case of P, its indirect, residual and cumulative effects are more important.

Nitrogen in form of NO^{3-} is subject to more leaching. Leaching loss is also more in wet (*kharif*) than in summer and in sandy soils than in clayey soils. Losses can be minimized by choosing suitable time and method of application.

When to Apply (Time)

It necessarily means time of application. The objective of time of application is to get maximum benefit from the fertilizer nutrient. If the nutrient is applied too earlier than the time of requirement, it is lost in different ways or is absorbed more than required. If applied late it is either not absorbed or if absorbed not utilized for the purpose and only gets accumulated in plant parts. Some amendments need to be applied before commencement of crop season so that it reacts well with the soil and becomes available to the crop after sowing/ planting.

Where to Apply (Placements)

The objective of placement of fertilizer is to make the nutrient available easily to the crop. Determining the right placement is as important as determining the right application rate. Application may be surface broadcast, at furrow bottom, placed deep at or slightly below the root zone, top dressed, side dressed or to foliage. This depends on type of crop, rooting pattern, feeding area and ease of application. The choice of method of application depends on soil-crop-fertilizer interaction too.

Other Considerations

• Balanced fertilization should be applied based on the soil test.

• Weeds, if not controlled effectively particularly during early stages (7-21 days) of crop growth in kharif season, take away about 25 to 30 percent of the applied plant nutrients. Therefore, the weed control, particularly during early stages of crop growth is essential and control of insects and diseases is must for realizing maximum effectiveness from fertilizers.

• When the soils are acidic or saline or alkali, appropriate amendments *viz.,* lime, gypsum etc. should be applied before using fertilizers. In alkali soils 8 to 10 tonnes of gypsum per hectare should be applied broadcast only once and mixed with the top 10 cm of the soil layer.

• For rice crop, wherever possible, mix urea with available nitrification inhibitors such as neem cake and karanj cake (1 kg of cake blend with 5 kg of urea). This will reduce N losses from the soil.

• The introduction of leguminous crops in diverse rotational and inter-cropping sequence and use of bacterial and algal cultures play a very important role in meeting the fertilizer need of the crop.

• To the extent possible, green manuring with daincha (*Sesbania aculeata*) or sunhemp (*Crotalaria juncea*) should be grown in low land paddy cultivation.

• For the compost made from straw and leaves having wide C:N ratio, add small quantity of N to increase N availability to young crop. Incorporation of finely ground rock phosphate or super phosphate with organic manures will make the manure more balanced.

• Ensure proper plant spacing and sow the crop timely to get maximum benefit from fertilizers.

Conclusion

Fertilizer use efficiency shows the ability of crops to take up and utilize nutrients for maximum yields. It is a critically important concept in the evaluation of crop production systems. It can be greatly affected by fertilizer management as well as by soil and plant-water management. Fertilizer management practices improve FUE without reducing crop productivity or the potential for future productivity increases are likely to be most valuable.

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