e ISSN–2321–7987 | ●●● Article ●●● |Visit us : *www.researchjournal.co.in*|

Foliar application of fertilizer for increasing nutrient use efficiency and crop production

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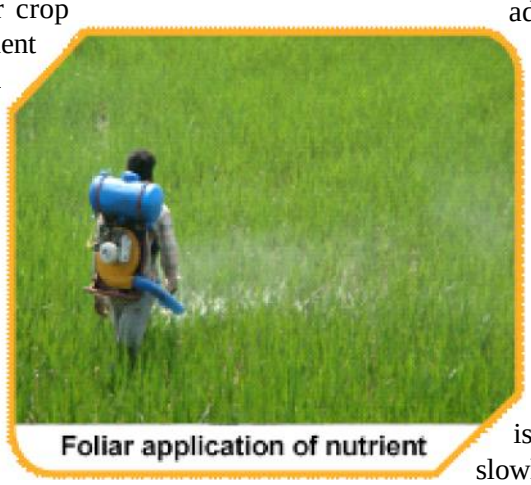
Foliar fertilization is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Foliar feeding has been used as a means of giving supplemental doses of major and minor nutrients, plant hormones, stimulants and other beneficial substances. Observed effects of foliar fertilization included yield increases, resistance to diseases and insect/pests, improved drought tolerance and enhanced crop quality. Plant response is dependent on species, fertilizer form, concentration and frequency of application as well as the stage of plant growth. Foliar applications are often time to coincide with specific vegetative or fruiting stages of growth.

The soil application of any fertilizer including organic and commercial forms for higher crop production may be relatively inefficient due to biological, chemical and physical properties of the soil that can decrease nutrient availability. Increasing cost of commercial fertilizers (nitrogen, phosphorus, and potassium) also make their non-traditional fertilizer applications, specifically foliar fertilization is more attractive, but foliar fertilization take care of all the plant's nutrient needs. Foliar fertilization is generally used for better management of nutritional status, growth, to correct deficiencies quickly, and improve disease resistance for batter crop quality.



Foliar application of nutrient

Objectives of foliar fertilization :

–To stimulate the production process of high yielding crops by application at deficit peak / critical requirements.

–To promote crop growth under adverse conditions (Stress).

–To improve nutrient use efficiency.

–To reduce chemical load.

Components of foliar fertilization :

Liquid fertilizer :

– Materials added to the soil or applied directly to crop foliage to supply elements needed for plant nutrition. These materials may be in the form of liquid, aqueous solutions.

– Liquid fertilizers provide plants with concentrations of easily-absorbed, soluble nutrients, thereby enhancing their health and productivity.

Water soluble fertilizer : Powdered and granule synthetic fertilizers that is mixed with water and poured on the soil or sprayed on the foliage of plants. Water soluble fertilizers are urea, urea phosphate, magnesium sulphate, potassium sulphate, ammonium sulphate, NPK 18-18-18, NPK 15-30-15.

Sticker : Stickers are the agents which improve the adhesion of spray droplet on target plant. A fertilizer is fairly water soluble, it may be washed off the leaf during heavy rainfalls that follow deposition.

Neutralizing agent : It is a foam concentrate formulation that can be mixed with either acid or alkaline water-based solution and discharged through an air-aspirated foam discharge device to produce expanded foam. The foam produced is extremely stable, meaning that it will slowly release its solution from the bubble walls and neutralize the spill.

Why foliar fertilization?

– Better management of nutritional status of plant
– Improve plant growth
– Quickly correct nutrient deficiencies
– Improve disease resistance
– Improvement of crop quality

Criteria foliar fertilization :

–The amount of nutrient required by the crop.

–The effectiveness of the application at the growth stage that best matches the crop response.

–The suitability of a product formulation for uptake.

–The impact of method, time and concentration of

applied foliar product on crop foliage.

Keys to success :

– Understanding the interaction between the leaf surface and the foliar material.

– Uptake and mobility.

– Spray coverage, droplet size, etc.

– Understanding product quality–avoid chloride and nitrate based products especially.

Foliar application may be preferred under the following conditions :

– When visual symptoms of nutrient deficiencies observed during early stages of deficiency.

– When unfavourable soil physical and chemical conditions which reduce fertilizer use efficiency.

– Small quantity of micronutrient is needed to apply and it cannot be applied effectively through root or soil.

– During drought period where in the soil application could not be done due to lack of soil moisture.

– Foliar application is effective for the application of minor nutrients like iron, copper, boron, zinc and manganese.

Ideal period for foliar spray : The cuticle is more permeable when swollen. Foliar fertilization should be carried out at times when the relative humidity of the air is high *i.e.* in the early hours of the morning and in the evening, not during the hot hours of the day. Another advantage is the spray deposit evaporates more slowly and so there is less danger to the leaves being burned by bright sunlight. The high humidity in the evenings and during the night causes the nutrients from dried spray deposits to be dissolved so that they can enter in the leaf.

Mechanism of foliar fertilization : Foliar fertilizer nutrient to be utilized by the plant for growth, it must first gain entry into leaf prior to entering the cytoplasm of a cell in the leaf. To achieve the nutrient must effectively penetrate the outer cuticle and wall of the underlying epidermal cell. Once penetrate is occurs, nutrient absorption by the cell is the similar to absorption by the roots. All the components of the pathway of foliar-applied nutrients, the cuticle offers the greatest resistance.

When foliar fertilization is best ?

In the case of calcium, transport from roots to fruit is limited, so foliar applications are the best method we know to get more calcium into fruit tissue to reduce post harvest disorders. The expense of the calcium spray is more than justified by the potential post harvest losses.

Leaf cuticle : The leaf cuticle is a thin covering on the outside of the leaf and other organs which protects the plant from the extremes of the environment. The cuticle is dynamic and responds to changes in the environment and also to management.eg. Drought stress and extreme temperatures.

Movement of nutrients through the cuticle :

Originally it was held that movement of solutes occurred in ectodesmeta. These pores have a diameter of <1nm, with a density of about 10^{10} pores/cm and are lined with negative charges increasing in density towards the inside facilitating movement of cations. Actual movement through the cuticle depends on the nutrient concentration, molecular size, organic or inorganic form, time as a solution on the leaf surface, charge density across the cuticle.

Change in the leaf cuticle with water deficit stress : Cuticle thickness was increased by 33 per cent. Cuticle composition changed to predominantly high molecular weight (longer chain) waxes which increased the hydrophobicity. The caused a resultant decrease in uptake of agrochemical (urea, defoliants etc.)

Foliar spray of chelate :

Chelate : A chelate is a word derived from the Greek word 'chela' meaning 'claw' to describe a kind of organic chemical compound in which the metal part of the molecule held so tightly that it cannot be 'stolen' by contact with other substances which would convert it into an insoluble form.

Table 1: Common chemical names and abbreviations for chelating agents

Abbreviation	Name
CIT	Citric acid (Citrate)
CDTA	Cyclohexane diamine tetra acetic acid
DTPA	Diethylenetriaminepenta acetic acid
EDDHA	Ethylene diaminedihydroxy phenyl acetic acid
EDTA	Ethylene diamine tetra acetic acid
EGTA	Ethylene glycol tetra acetic acid
HEEDTA	Hydroxy ethyl ethylene diamine tri acetic acid
NTA	Nitrilo tri acetic acid

Advantages of chelates :

– Lower quantities
– More absorption
– More translocation
– More assimilation
– No 'burn' damage
– Alkaline conditions
– Compatibility.

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