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Foliar Nutrition in Vegetables

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Abstract:

Foliar feeding is characterized by a technique of feeding plants by applying liquid fertilizer directly to their leaves, its ability in uptake of nutrients which has been known for many years. Observed effects of foliar fertilization have included in yield increase, resistance to diseases and insect pests, improved drought tolerance and enhanced crop quality. Plant response is dependent upon the species, fertilizer form, concentration and frequency of application as well as the stage of plant growth. Foliar application is often timed to coincide with specific vegetative or fruiting stages of growth and the fertilizer formula is adjusted accordingly. In terms of nutrient absorption, foliar fertilization can be from 8 to 20 times as efficient as ground application. Foliar fertilization can efficiently supply nutrients during stages of high nutrient demand in crop and upsurge the nutrient content in crop foliage when the physiological efficiency of plant to take nutrients from soil is plummeted. Moreover, used to supplement soil fertilization, foliar fertilization has a great potential to give higher yield under intensive cropping system and also side-by-side enhance the quality, economic aspect, crop tolerance to diseases and drought conditions.

Keywords: Foliar fertilization, major nutrients, micro nutrients, deficiency of nutrients, fertilizers, vegetables.

Introduction:

Foliar feeding is the process whereby liquid fertilizers are introduced to plant leaves. The ability of plants to take the essential nutrients is through the leaves, where the plants to make of these leaves are typically quicker in the intake of nutrients compared to soil (Smolen, 2012). The leaves are green factories where the complex chemical

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processes of photosynthesis generate the compounds, plants required for growth. Fertilizers are absorbed right where they are used as acting quite quickly, whereas many soil fertilizers can never be used by plants. Now a days, foliar feeding is a widely adopted strategy in modern crop management, where it is used to ensure higher or optimal cropper performance by enhancing crop growth at certain stages of growth, correcting crop nutrient deficiencies and improving crop tolerance to adverse crop growth conditions. Foliar application over comes soil fertilization limitations such as leaching, insoluble fertilizer run off, antagonism between certain nutrients, low -dose heterogeneous soils and fixation / absorption reactions such as phosphorus and potassium.

Nowadays, micronutrients are gradually gaining momentum among the vegetable crops because of their beneficial nutritional support and at the same time ensure better harvest and returns. The demand for increasing vegetable production will require a thorough knowledge of micronutrients in vegetable crops. But the available information regarding the impact of foliar nutrition of micronutrients on vegetable crops is scanty. Therefore, in current review an attempt has been made to summarize the literature pertaining to overall significance of foliar nutrition micronutrients in vegetable crops.

Mobility of micronutrients in soil and plant.

Mobility	**Soil**	**Plant**
Mobile	B, Mn, Cl	-
Moderately mobile		Zn
Less mobile	Cu	Fe, Mn, Cu, Mo, Cl
immobile	Zn	B

Role of Micronutrients:

Among micronutrients, boron plays a vital role in growth, development and several other physiological processes such as N metabolism, protein formation, cell division, etc. [14]. Boron is necessary for cell wall formation, development of fruit and seed. It helps in pollen formation, pollination and flowering of plants.

The main function of boron in plants is to increase the solubility and metabolism of calcium. It also facilitates the uptake of nitrogen. Iron (Fe) is the structural component of

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porphyrin molecules like cytochromes, hemes, hematin, ferrichrome, and leghemoglobin. In respiration and photosynthesis, these substances take part in various oxidation-reduction reaction.

Zinc (Zn) is an indispensable for normal growth and development of plants. The production of plant hormones like auxin and the creation of carbohydrates can both benefit from it.

Copper (Cu) plays a pivotal role in regulating multiple biochemical reactions in plants. In their research with tomato plants, Arnon and Stout (1939) stated that copper was a crucial component for plants.

Copper is a crucial regulator of multiple metabolic and physiological processes in plants because it is a stable cofactor of numerous enzymes and proteins. It aids in the usage of iron during the production of chlorophyll. Both photosynthesis (reduction of CO2 to carbohydrates) and respiration (oxidation of carbohydrates to CO2) involve the transfer of electrons that requires copper (Cu). Numerous enzymes that aid in respiration and photosynthesis are activated by manganese (Mn).

Chlorine (Cl) is most commonly used as sanitizer, due to its low cost for maintaining the fruit quality like appearance, soluble solids content, acidity, pH, texture and flavour, shelf life and also control microbial growth.

Molybdenum (Mo) is required for the fixation of atmospheric nitrogen as well as assimilation of nitrates. It also helps in protein synthesis, sulphur metabolism and absorption of iron in plants. Nickel (Ni) stimulated the activity of urease enzyme which is essential for nitrogen metabolism and control senescence.

Deficiency of Micronutrients:

Micronutrients are essential to the metabolism of the plant system. Successful vegetable cultivation is most frequently hampered by micronutrient problems, either a deficit or toxicity.

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The region of appearance of deficiency symptoms depends on mobility of micronutrient in plants. A mobile nutrient in the plant moves to the growing points in case of deficiency. vegetable cultivation needs judicious use of micronutrients to produce yield of high quality. The most common micronutrient disorders in vegetables are due to the deficiency of B, Mo, Zn and Fe. So, it is very important for the vegetable growers to have knowledge about the management of micronutrients.

Older leaves develop interveinal chlorosis due to zinc (Zn) deficiency, which causes the leaves to turn grey-white, drop off early or die. Short internodes and a reduction in leaf size are the two most noticeable signs of Zn deficiency. Mottling and rosseting in vegetables and fern leaf in potato are the major disorders of zinc deficiency. Boron does not easily move around the plant and therefore, the deficiency appears first in young tissues and growing points. Sterility, poor fruit set, small fruit size and eventually poorer yield can all result from boron deficiency. Additionally, a lack of boron results in the breaking and deformed development of fruits. The vegetable crops like cabbage, cauliflower, sugar beet, potato etc. is highly sensitive to boron deficiency.

Iron deficiency is common with interveinal chlorosis of young leaves and veins remain green except in severe cases. Its deficiency is mainly manifested by yellow leaves due to low levels of chlorophyll. Leaf yellowing first appears on the younger upper leaves. Deficiency of iron observed in soil with pH above 6.8, calcareous in nature and containing considerable amount of sodium and calcium. A lack of copper results in stunted growth, distorted young leaves, necrosis of the apical meristem, curled tips, dieback of stems and twigs, ragged leaf edges and a probability of plant top withering.

Manganese (Mn) deficiency is found in soils with pH above 6.7, calcareous and sandy soils. Increased soil pH and high quantities of accessible iron in soils have a negative impact on the uptake of manganese. Molybdenum (Mo) deficiency can be common in nitrogen-fixing legumes. Deficiency of Mo is associated with acidic soils having pH below 5.2 and highly leached sandy soils. In contrast to other micronutrients, Mo is more readily absorbed by plants as soil pH rises.

Whiptail in cauliflower is the most common disorder caused due to molybdenum deficiency.The common signs of a chlorine deficit include chlorosis in young leaves and overall plant wilting.

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Chlorosis of younger leaves and overall wilting of the plant are the most common symptoms of chlorine deficiency. The sensitivity of chlorine deficiency is higher in vegetable crops like potato and beans. The deficiency of nickel also delayed nodulation and reduced efficiency of nitrogen fixation in leguminous vegetable crops. Nickel is an important micronutrient in cowpea at reproductive phase.

Foliar Nutrition:

Spraying of fertilizer solutions containing one or more nutrients on the foliage of growing plants is known as foliar spray. Application of nutrients through foliar spray is known as foliar nutrition. Several nutrient elements are readily absorbed by leaves when they are sprayed on them. Foliar Spray is highly effective for the application of minor nutrients like iron, copper, boron, zinc, molybdenum and manganese. Foliar nutrition will enhance the efficiency of the use of nutrients which plants need to increase ungently for maximum growth and yield. Foliar nutrition is the most efficient method for placing fertilizers under problems of soil fixation which normally needs reduced amounts of nutrients compared to soil application.

Foliar application of micronutrients is widely used in vegetable crops. Most of the micronutrients are enter in the plant body though leaves within few hours to day of foliar spray. In arid and semi-arid regions, foliar application is widely recommended to overcome the deficiencies of micro nutrients viz., Fe, Cu, Mn, Zn and B.

Factors Affecting the Efficiency of Foliar Nutrition:

Efficiency of foliar applied fertilizers depends on crop type, leaf coverage, weather conditions and product quality. Efficiency of foliar fertilizers can be improved by using wetting agents and stickers. Wetting agents improve coverage and stickers prevent nutrients being washed off by rainfall. Growth stage is one of the most critical factors that determine the efficacy of foliar fertilization. Foliar application should be timed to provide needed nutrients at the yield determining stages of plant development. physical and biological aspects of foliar application are influenced by environmental factors, such as, temperature, humidity and wind velocity. The fertilizer used for foliar application should be completely soluble in water. It should not leave any residue on plant surface. The concentration of spray solution should be such that it should not cause any harm to leaf tissue while permitting sufficient uptake of applied nutrients.

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Crop	Fertilizers		References
Chilli	100 % N and K, 3 sprays= polyfeed (45, 60 and 75 DAS) & 2 sprays =multi K (75 & 120 DAS)	Highest number of fruits/ plant, dry fruit yield, higher net income and benefit cost ratio	(Palaniappan et al., 1999)
	50 % RDF + 50 % nitrogen through neem cake	Plant height, fruits, less diseases and pests	(Vitkar et al., 2007)
Cucumber	1% urea, 1.5% DAP and 1.5% KCl + 3/4th of NPK RDF	Yield	(Karuppaiah et al., 2001)
Brinjal	Normal RDF + NPK 19:19:19	Highest dry matter production	(Karpagam et al., 2004)
Onion	polyfeed 19:19:19 one per cent at 15, 30 and 45 DAP and multi K 1% at 60, 75 and 90 DAP	Bulb yield and maximum net return	(Anon., 2005)
Cabbage	urea 0.8 % and 1.0 %	large and weighty heads	(Yildirim et al., 2007)
Cauliflower	N 1.5 % & 40 ppm zinc	Plant height, plant spread, number of leaves/plant, fresh weight diameter, dry weight, TSS, compactness, color and yield of curd q/ha and earliness in complete maturity of curd	(Yadav et al., 2014)
Broccoli	RDF 50% NPK + one foliar spray of amino magical	plant height, leaves number, fresh and dry weight of leaves, stems and apical heads	(Abou El-Magd et al., 2015)
Tomato	0.2% $FeSO_4$, Calcium nitrate, $ZnSO_4$ and Boron 0.1%	Plant height ,girth, Days to first flowering, fruiting, Days to maturity, No. of fruits/plant, Fruit length, Fruit diameter, Fruit weight, Yield/plant and Yield/ha	(Dixit et al., 2018)

Benefits of Foliar Nutrition:

Foliar feeding of nutrients is a way of rapid correction of nutrient deficiencies and physiological disorders of crop plants pointed out the economic viability of foliar fertilization in vegetable production. It is an effective means of reducing soil and ground water pollution. Plant response to soil application is seen in five to six days, whereas foliar application takes three to four days to show results. Foliar feeding supports efficient and quick nutrient uptake regardless of the state of the soil and encourages roots to be more effective at absorbing nutrients from the ground [32]. It ensures improved nutrient balance in crop. Foliar feeding is environment friendly when compared to soil application as it avoids accumulation of toxic concentration of nutrients in soil. Foliar fertilization is a practice that can be used to apply the proper amount of nutrients to crops at the right time throughout the entire growth season.

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Pesticides that are compatible with fertilizers can be combined. This reduces the cost of plant protection. Only small quantity of fertilizer is required in foliar spray as nutrients are utilized properly and efficiently in foliar spray. Foliar nutrition of micronutrients is convenience in application as compared to soil applications. Moreover, foliar nutrition has a great potential to give higher yield under intensive cropping system and also side- by-side enhance the quality, economic aspect and crop tolerance to various biotic and abiotic stresses. Foliar nutrition can be used as an important tool in integrated nutrient management for the production of vegetables.

Micronutrient	Fertilizers
Boron	Borax (11% B), Solubor (20% B), Boric acid (17% B)
Iron	Ferrous sulphate (19% Fe), Ferrous ammonium sulphate (14% Fe), Chelated Fe (12% Fe)
Manganese	Manganese sulphate (30% Mn), Manganese oxide (41-68% Mn), Manganese chloride (17% Mn), Chelated Mn (12% Mn)
Copper	Copper sulphate (25% Cu), Cupric oxide (75% Cu), Cuprous oxide (89% Cu), Chelated Cu (13% Cu)
Zinc	Zinc sulphate (33% Zn), Zinc oxide (55-70% Zn), Chelated Zn (12% Zn)
Molybdenum	Sodium molybdate (39% Mo), Ammonium molybdate (54% Mo)
Chlorine	Potassium chloride (47% Cl), Ammonium chloride (66% Cl)

Conclusion:

Micronutrients play a crucial role in growth and development of vegetables crops. The nutritional value of crops is becoming a major issue in recent times. Therefore, application of micronutrients has a great importance to sustain the soil health and crop productivity besides maintaining the nutritional quality of vegetables. Application of micronutrients at right concentration and at right growth stage with the right method of application confers maximum benefits. Foliar nutrition is the one of the most efficient methods of applying micronutrients directly on the plant leaves. Thus, it can be concluded that foliar nutrition of micronutrients proves beneficial for improving growth, yield and quality attributes along with increasing post-harvest life of vegetable crops.

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