Foliar fertilizers

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Agricultural scientists are day night busy; to evolve high yielding crop varieties and introduce most easy and economical crop production technology, for fulfillment of the food requirements of the population, growing up very fast. They have conducted various studies world over and reveals that Soil Analysis, Land Preparation, Sowing time and methodologies, Irrigation, Interculturing, Thinning, Fertilizer application and Crop protection techniques are basic principles and necessities. Among these, fertilizers play a vital role, because regular cultivation results nutritional deficient soils and the cultivation in nutritionally poor soils not only result slow growth process but weak plants easily hit by insect pests and diseases also. Therefore, fertilizer application become compulsory similar to food supplements and multivitamin and mineral supplements as are necessary for human being.

Traditionally only organic and or some inorganic fertilizers are used to enrich soils with basic macro nutrients such as nitrogen, phosphorous and potassium (NPK). Gypsum is also now commonly used to improve saline soils or zinc is applied in zinc deficient soils in case of rice cultivation. The micro nutrients are totally ignored by near about all illiterate and the growers having no or very less interest in cropping. Whereas, all 16 macro and micro nutrients are equally important for all crops (living plants and trees), for normal growth, development and production. Otherwise, the crop may initially produce the symptoms of such deficiency and in case of ignorance; the pests and diseases may easily hit the poorly developing plants and trees due to less resistance or more susceptibility in nutrition deficit plants or trees.

However, the yield of our crops is not satisfactory in all over Pakistan as well as many other countries of the world due to many constraints. Among those, fertilizer management plays an important role for obtaining satisfactory yield. In order to increase crop productively nutrient management may be achieved by the involvement of organic sources, biofertilizers and micronutrients (Singh and Kalloo, 2000).

Ingredients of some Foliar Fertilizers					
Foliar Fertilizer-I		**Foliar Fertilizer-II**		**Foliar Fertilizer-III**	
Ingredients	mg/liter	Ingredients	mg/liter	Ingredients	mg/liter
Nitrogen	180,000	Nitrogen	180,000	Nitrogen	2, 00,000
Iron	1,000	Iron	1,500	Iron	1,000
Magnesium	100	Boron	300	Magnesium	100
Manganese	100	Potash	1,500	Manganese	100
Boron	100	Manganese	100	Boron	100
Copper	20	Magnesium	300	Zinc	50
Zinc	100	Zinc	900	Copper	10
Potash	1,000	Copper	10		
		Molybdenum	0.002		
		Cobalt	0.002		

Modern crop fertility programs are complex in nature, resulting from the interactions of many factors. One important factor is fertilizer cost, which is a large portion of the crop production expenses. Application of unneeded nutrients contributes to farming inefficiency and ground water pollution (Hochmuth and Hanlon, 2005).

The balanced nutrients have been paid little attention in agriculture areas of developing world. The deficiencies of micronutrients have emerged in the farmer's field and are recognized as symptoms on foliage and reduction in the quality and yield of the crop. The benefit of micronutrients is not limited solely to the replenishment of the micronutrient itself but in addition micronutrient acts as catalyst in the uptake and use of certain macronutrients (Phillips, 2004).

Recently, foliar fertilizers are widely used in vegetable and fruit crops, that contain various macro and micronutrients, which are essential for the proper growth and yield. Foliar fertilizer technology came into use early in this century, but did not become more common practice. After 1980s, the application of foliar fertilizers is the quickest way to deliver nutrients to the tissues and organs of the crop, and is proved that application of these micronutrients is beneficial to correct certain nutrient deficiencies (Anonymous, 2001).

Foliar feeding is the practice of applying liquid fertilizers to plant leaves. The leaves are green factories where the complex chemical processes of photosynthesis produce the compounds, plants needed for growth. Foliar fertilizers are absorbed right at the site where they are used as quite fast acting, whereas, much of the soil fertilizers may never get used by plants. For instance, 80% of the phosphorus applied through conventional fertilizers may get fixed up in the soil, but, up to 80% of foliar-added phosphorus directly absorbed by the plants (Donelon, 2005). Silberbush (2002) stated that foliar fertilization is widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots. Ca and B which are immobile in the plant should be applied in small amounts at high frequency rather than in one application for correcting temporary deficiencies in vegetables (Maynard and Hochmuth, 1996).

Bhonde et al. (1995) evaluated the effect of zinc, copper and boron on onion crop. Bulb size and yield as well as quality of bulb enhanced when micronutrients were applied in combination instead of alone. The foliar application of zinc 3 ppm, copper 1 ppm and boron 0.5 ppm were found to give maximum net return to the growers Pascua, et al. (1996) applied Green Bee All Purpose and Growth Booster foliar fertilizers to explore the possibility of substituting soil applied fertilizer with foliar fertilizer on garlic plants. They reported that the plants fertilized with ½ fertilizer recommendation and supplemented with Green Bee All Purpose + Growth Booster were tallest, most vigorous, produced heaviest bulbs and gave the highest yield per hectare.

Naruka and Singh (1998) applied two concentrations of urea sprays (1 and 2%) and three concentrations of gibberellic acid (GA3) spray (50, 100 and 150 ppm); both urea and gibberellic acid application enhanced the growth and fruit yield of okra significantly. Tumbare, et al. (1999) applied NPK at recommended rate as solid fertilizer and as liquid fertilizer; the yield and yield component values increased with increasing fertilizer rate by liquid as compared to conventional application. Whereas, Palaniappan et al. (1999) applied N and K fertilizers (100 and 75% of recommended rate), Multi-K and Polyfeed (Both at 1%) foliar fertilizers and the combination of these two fertilizer sets on tomato. The application of 100% NK + 2 sprays of Polyfeed (30 and 45 days after sowing, DAS) + 3 sprays of Multi-K (60, 75 and 90 DAS) gave the highest tomato fruit yield, marketable yield, net income and benefit cost ratio. Similarly for chili, the treatment of 100% NK +3 sprays of Polyfeed + 2 sprays of Multi-K produced the highest number of fruits per plant, dry fruit yield, net income and benefit cost ratio. Increasing the frequency of Polyfeed spraying from 3 to 4 times do not increased the number of chili fruits per plant. Souza et al. (1999) applied kumulus (containing sulfur) at 4 kg/ha to see the effect on cotton crop. Treatments with increased sulfur produced 11.5% more cottonseed then the untreated control.

Naruka et al. (2000) studied the effect of foliar application of zinc and molybdenum through foliar spray at 0.2, 0.4 and 0.6% and 30, 60 and 90 ppm, respectively. Increasing zinc and molybdenum levels resulted in increasing plant height, number of fruits, fruit diameter and fruit yield. However, increasing levels resulted increasing in growth and height fruit yield. Selvi and Rani, (2000) reported that okra plants were treated with NPK (40: 50: 30 kg/ha) alone, NPK + micronutrients (MNS; soil application of FeSO4 at 50 kg/ha and Zn SO4 at 25 kg/ha, or foliar spraying of FeSO4 at 1.0% and ZnSO4 at 0.5%) or foliar and soil application of microfood (SMF, 750 and 25 kg/ha, respectively). The highest yield, income and benefit cost ratio were recorded from NPK+SMF and MNS foliar treatment; whereas, lowest yield among the treated plants was recorded from the single NPK treatment.

Barge (2001) used the foliar fertilizers, ElamMax (27% Mn) at 0.5 pints/acre, Folizyme (12% N, 3% K, 3% Ca and 3% Mn) at 2q/acre, Keylate (5% Mn) at 2 pints/acre, White Label (6% Mn) at 2 pints/acre and Harvest More Urea Mate (N, P, K, Ca, Mg, B, Co, Cu, Mn, Mo and Zn) at 5 ponds/acre. All treatments resulted in higher yields of soybean than the control. Bajapai and Chauhan (2001) worked on effect of zinc, boron and manganese and reported that all treatments significantly improved the performance of okra in terms of number of fruits per plant, fresh and dry fruit weight, seed per fruit and seed weight.

Singh, et al. (2002) reported that bulb diameter, bulb size index, total soluble solids, dry matter weight 20 bulbs, and gross and marketable yield of onion were highest with basal application of NPK and foliar application of 1% Multi-K 30, 45 and 60 days after planting. Katkar et al. (2002) conducted an experiment to study the effect of foliar sprays of nutrients and chemicals on yield and quality of cotton. Results indicated that the foliar application of different nutrients and chemicals significantly increased seed cotton yield by 38.7, 37.1, 31.3 and 21.2% over control. Naresh and Singh (2002) conducted study on the effect of zinc (0.2, 0.4 and 0.6 %), copper (0.1, 0.2 and 0.3%) and boron (0.1. 0.2 and 0.3%) on the yield components of litchi plants and observed significant improvement in fruit set, normal fruit, cracked fruits and fruit maturity in the treated plants over control. Mishra et al. (2003) also observed significant improvement in chlorophyll content and fresh weight of kinnow treated with zinc, iron and boron. Chattopadhyay et al. (2003) applied B at 0.28, 0.56 and 1.12 kg/ha and Mo at 0.1, 0.2 and 0.4 kg/ha alone or in combination (as single or double) to okra cv Pusa Sawani in field experiment. Mo at 0.4 kg/ha resulted in the highest yield of 223.18 q/ha, while B at 0.56 kg/ha produced the highest yield of 222.71 q/ha. B at 1.12 kg/ha + Mo at 0.2 kg/ha produced the highest yield of 229.37 q/ha. Alkaff and Hassan (2003) determined the effect of foliar application 0, 2, 4, 6g of power 4 on the growth and yield of okra plants. Foliar application of 4g of power 4/litre had the highest value for fresh and dry weight, number of pods per plant, average yield, average pod weight and early yield. Sharaf and El-Naggar, (2003) conducted field experiment to record the response of carnation plant to phosphorus and boron foliar fertilization. The results showed that foliar application of P2O5 alone or in combination with different levels of B stimulated the length, diameter and dry

weight of stem, number and dry weight of leaves per branch as well as enhanced flowering time, number, size and dry weight of flower per plant. The best results of vegetative growth and flowering characteristics were obtained at 200 mg P2O5 per liter plus 50mg B per liter.

Tuncay et al. (2004) investigated the effects of Superalg, NZN, Croptec and Polyfeed foliar fertilizers on yield and quality related characters of sunflower. They had significant effects on seed yield, seed height, seed/husk ratio, oil content, plant height, seed dry matter and stem yield ($P<0.01$). The best results were obtained from Croptec and Polyfeed fertilizers. However, according to economic analysis, NZN application had the highest gross margin per hectare. Alexander, et al. (2004) applied Boron (B) through Disodium Octaborate Tetrahydrate (DOT) in the form of Solubor as foliar spray @ 1.5g/l twice at 15 days interval and calcium (Ca) through Calcium Nitrate (CN) as Hydro Calcium Nitrate as soil application to supply top dressed N, twice @ 30 kg/acre. Among the various treatments, foliar spray of DOT with soil application of CN gave maximum yield of 20.93 t/acre and had a long shelf life of 12 days in comparison to control where yield of 16.63 t/ac and a shelf life of 4 days were recorded.

However, many other experiments have been carried out on the effect of commercial foliar fertilizers alone and in combination with recommended NPK levels, on growth and yield potential of different crops. The results showed significant differences with reference to the data recorded on days taken to flowering, plant height, number of branches per plant, number of fruits per plant, fruit length, fruit weight per plant, fruit yield per hectare, fruit quality and cost benefit ratio.

Foliar fertilizers are fast acting because these are absorbed right at the site where they are used. Foliar feeding of these fertilizers not only replenishment of micronutrients but, also act as catalyst in the uptake and use of certain macronutrients. Hence, where the crop is going to be sown in low fertile soils, these foliar applications must be applied.

Available literature indicates that in Pakistan, deficiencies of micronutrients have been emerged in most of the farmer's fields due to little attention; but very little work has been done locally on commercial foliar fertilizers. It is therefore concluded and the growers are advised to use and or include foliar fertilizers in combination with recommended NPK for obtaining healthy, early and high yielding crop with good fruit quality. The researchers are also suggested to conduct further experiments on all available foliar fertilizers and also research required to test other aspects of these products alone and in combination with NPK on growth and yield parameters of crops under agro-ecological conditions of Pakistan.