AJH
eISSN- 0976-724X

THE ASIAN JOURNAL OF HORTICULTURE
Volume **11** | Issue 1 | June, 2016 | 242-251
Visit us -*www.researchjournal.co.in*

A REVIEW

DOI : 10.15740/HAS/TAJH/11.1/242-251

Article history :
Received : 24.04.2016
Accepted : 29.05.2016

Responds of vegetable crops to foliar feeding of water soluble fertilizer

■ **N. DEEPA DEVI**

Author for correspondence :

N. DEEPA DEVI
Department of Horticulture, Agriculture College and Research Institute, Tamil Nadu Agricultural University, MADURAI (T.N.) INDIA
Email : natesandeepa@gmail.com

ABSTRACT : Vegetables are important in the human diet as protective food. India is a leading vegetable producing country, in the world. However, the current per capita consumption of vegetable in our country is only 135g as against 300g of vegetables required per day per adult for maintaining good health. It is estimated that by 2020, the countries vegetable demand would be 135 million tonnes. To achieve this target, there is a need to integrate the various technologies right from production to post-harvest management. Exploiting of vigour for increased production of vegetables is becoming a popular method. As in other field crops, vegetable are generally more responsive to fertilizer application and thus produce more biomass through higher photosynthetic activity especially during critical stage of growth. The supply of adequate amount of nutrients is a prerequisite for exploiting the genetic potential of any vegetables. The major nutrients *viz*., N, P and K are supplied to the crop through soil application. The efficiency of fertilizers applied in soil is low due to various losses and fixation in soil. Foliar application of nutrients eliminates the problems like fixation and immobilization. Hence, foliar nutrition is recognized as an important method of fertilization in modern agriculture. Foliar nutrients usually penetrate the cuticle (or) the stomata of the leaf and enter into the cell. Thus foliar application provides ample scope for utilization of nutrients more efficiently and for correcting the deficiencies rapidly and also helping in the reduction of loss of nutrients.

KEY WORDS : Vegetables, Water soluble fertilizer, Polyfeed, Foliar spray

HOW TO CITE THIS ARTICLE : Devi, N. Deepa (2016). Responds of vegetable crops to foliar feeding of water soluble fertilizer. *Asian J. Hort.*, **11**(1) : 242-251, **DOI : 10.15740/HAS/TAJH/11.1/242-251.**

Vegetables are important in the human diet as protective food. India is a leading vegetable producing country, in the world. India accounts for 15 per cent of the world's production of vegetables. Currently vegetable production occupies 6.09 million hectare with an annual production of 84.8 million tonnes, accounting for 30 per cent of the total area under cultivation in the country. However, the current per capita consumption of vegetable in our country is only 135g as against 300g of vegetables required per day per adult for maintaining good health (Verma *et al*., 2002). It is estimated that by 2020, the countries vegetable demand would be 135 million tonnes (Rai and Pandey, 2006). To achieve this target, there is a need to integrate the various technologies right from production to post-harvest management. The increase in yield of vegetables are attributed to increase in fruit weight and more number of fruits per plant. As in other field, vegetables are generally more responsive to fertilizer application and thus produce more biomass through higher photosynthetic activity. The supply of adequate amount of nutrients is a prerequisite for exploiting the genetic potential of any vegetables. The great difficultly in supplying the macro nutrients through foliage is non-availability of suitable water soluble speciality fertilizers, which are better source of nutrients for foliar application (Vibhute, 1998).

Speciality fertilizer							
Product	Available nutrients % as						
	NO_3	NH_4	NH_2	P_2O_5	K_2O	EC@ 1%	pH @ 1%
Multi – K (13-00-46)	13.2	-	-	-	46	1.2	9.0-11.0
Polyfeed:(19:19:19+MEN)	5	4	10.0	19.0	19.0	0.88	5.3
MAP (12-61-00)	-	12.5	-	61	-	0.69	4.0-5.0
MKP (00-52-34)	-	-	-	52	34.5	NA	4.0-5.0

MULTI-K	Potassium nitrate	13-00-46
MAP	Mono ammonium phosphate	12-61-00
MKP	Mono potassium phosphate	00-52-34
Polyfeed	NPK blend	19-19-19 + MEN*
Polyfeed	NPK blend	13-40-13 + 2MgO + MEN*
Polyfeed (non-nominated FCO Grade)	NPK blend	15-15-30+ME
SOP	Sulphate of potash	00-00-50
Calcium nitrate	Calcium nitrate	15.5-00-00-19

MEN: Micro Elements Normal

Commonly available fertilizers such as urea, di-ammonium phosphate (DAP), muriate of potash (MOP) and other complex fertilizers are not totally soluble and leave some residues when dissolved.

Speciality fertilizer :

Speciality fertilizers are fully water soluble solid fertilizers, having high content of primary nutrients with low salt index. They may or may not have secondary or micro nutrients. These fertilizers have different ratios of N, P and K (Jeyabal *et al*., 1998). These water soluble fertilizers can advantageously be utilized for foliar feeding and fertigation, thus helping in precision agriculture. Foliar application of water soluble fertilizer plays an important role in supplying the nutrients at critical stages of flowering and fruit development. Today the demand for speciality fertilizers is increasing in most of the horticultural segments in the states of Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Gujarat, U.P. and Haryana.

It is theoretically possible to feed a plant completely through the leaves. In practice, however, more number of sprays would be required that would render the process uneconomical. Hence, foliar fertilizers are not a substitute for soil fertilization but an efficient additional means of supplying sudden demand.

Foliar application recommendation of speciality fertilizers on different crops				
Crop	Speciality fertilizer	Concentration (%)	Number of sprays	Stage to be sprayed
Chilli	Polyfeed	1.0	1	Flower initation (60 DAP)
	Multi-K	2.0	2	Fruiting (75 and 90 DAP)
Tomato	Polyfeed	1.0	1	Flower initation (45 DAP)
	Multi-K	1.0	1	Fruiting (60 DAP)
Bhendi	Polyfeed	1.0	2	Fortightly interval from fruit formation (60 and 90 DAS)
Soybean	Polyfeed	1.0	1	Maximun vegetative (45 DAS)
	Multi-K	1.0	1	Grain filling (60 DAS)
Cabbage	Polyfeed	1.0	1	Curd initiation (45 DAP)
	Multi-K	1.0	1	Curd development (60 DAP)
Cauliflower	Polyfeed	1.0	1	Flower initiation (45 DAP)
	Multi-K	1.0	1	Flower development (60 DAP)
Baby corn	Polyfeed	1.0	2	Knee high (30 DAP)
	Multi-K	1.0	1	Cob initiation (45 DAS)
Gherkins	Multi-K	1.0	2	Fortnightly interval from fruit formation (25 and 45 DAS)

DAS: days after sowing; DAP : Days After Planting; sprays has to be done at the critical physiological stage indicated sprays dates mentioned are tentative. * In intercropped turmeric, speciality fertilizers spray can be initiated after the harvest of intercrop, whenever intercropping is done.

Effect of water soluble fertilizers (WSF) on yield, quality and economics of vegetable crops :

Growth, the progressive development of a plant occupies a significant place in the profitability of a farming enterprise. The reproductive efficiency and economic yield can be maximized by having adequate vegetative growth and maximum yield attribute. In vegetable crops the growth parameters such as plant height, number of primary branches per plant, days to 50 per cent flowering directly contribute to the economic yield of fruits. Foliar nutrition with different concentrations of water soluble fertilizer on growth attributes showed a progressive increase in growth and development of vegetables compared to soil application alone.

Chilli :

The foliar application of 100 per cent N and K with three sprays of polyfeed (45, 60 and 75 days after sowing) and two sprays of multi K (75 and 120 days after sowing) in chilli cv. PUSA JWALA recorded the highest number of fruits per plant, dry fruit yield and with higher net income and benefit cost ratio (Palaniappan *et al*., 1999). The highest yield was noticed in chilli upto 21.1 per cent over control by combined spray of polyfeed and multi K (Agro India, 2000).

Capsicum :

The application of NPK 17:10:27 with 5 sprays recorded the highest mean fruit yield and maximum benefit cost ratio (AICRP (VS), Annual report 2002-03). Application of NPK (19:09:19) with 5 sprays recorded the highest fruit yield 75.46 q ha^{-1} under IIVR condition, whereas under Pantnagar condition NPK (19:19:19) with five sprays recorded the highest fruit yield of 197.3 q ha^{-1} (AICRP (VS), Annual report 2002-03). Application of NPK 17:10:27 with three sprays recorded maximum benefit cost ratio and highest fruit yield in 'Nishat-I' cultivar (AICRP (VS), Annual report 2004-05).

Tomato :

The per cent increase in yield of tomato due to foliar spray of multi K was 11.3 and benefit cost ratio was 3.71 per cent, whereas combined spray of polyfeed and multi K increased the yield up to 18.7 per cent (NARDI Annual report 2000). Foliar feeding of water soluble fertilizers had significant effect on marketable fruit yield of tomato. Five sprays of 0.5 per cent NPK 15:15:30 gave significantly higher fruit yield over control and at par with NPK 19:19:19 three sprays. The maximum net return and B:C ratio was recorded in the treatment NPK 15:15:30 with five sprays followed by NPK 19:19:19 three sprays (Yadav *et al*., 2004).

The foliar application of NPK 19:19:19 five times recorded maximum plant height (105.3 cm), more number of branches (12.2), more number of fruits per plant and heavier fruit (52.6 g), the highest fruit yield of 72.83 t ha^{-1} with highest B:C ratio of 5.06 (AICRP (VS), Annual report 2004-05). Chapagain and Weisman (2004) observed that foliar spraying of Nutri-Vant-peak (contains 95 % MKP) at one per cent concentration increased the plant height, leaf potassium (44.54 mg g^{-1}) and phosphate content (9.40 mg g^{-1}), marketable yield of tomato grown under green house condition. Fruit quality of plant sprayed with Nutri-Vant-Peak was superior. Foliar application of water soluble fertilizers in tomato produced taller plants, more number of branches, more number of fruits per plant and heavier fruits than control which received recommended dose of fertilizer alone (AICRP (VS), Annual report 2005-06).

Brinjal :

Foliar spray of NPK 19:19:19 with five sprays recorded the highest fruit with highest B:C ratio (AICRP(VS), Annual report 2002-03). Experiment conducted at Junagarh condition revealed that foliar feeding of water soluble fertilizer containing 17:10:27 with three sprays recorded maximum yield of 282.22 q ha^{-1}. Whereas in Faizabad condition maximum yield (395.56 q ha^{-1}) with highest B:C ratio was obtained from water soluble fertilizer containing NPK 17:10:27 with five sprays (AICRP(VS), Annual report 2002-03).

Foliar spray of multi K increased the yield up to 9.5 per cent and B:C ratio was 3.17 per cent (AICRP(VS), Annual report 2002-03). Foliar application of polyfeed (19:19:19) on brinjal thrice at 30, 40 and 50 days after transplanting registered the highest fruit yield over control (Batra *et al*., 2002).

Karpagam *et al*. (2004) stated that foliar spray of different grades of water soluble fertilizers increased the growth, yield and quality parameters in brinjal hybrid. Among the different grades of water soluble fertilizers, foliar application of five sprays of NPK 19:19:19 along with the normal recommended dose recorded the highest plant height, number of branches, leaf area index, dry matter production, number of fruits per plant, fruit weight

and fruit yield.

Experiment conducted on the effect of foliar feeding of water soluble fertilizers in brinjal hybrid 'Neelima' at KAU, Vellanikara revealed that foliar application of water soluble fertilizers had a significant effect on the growth and yield and the highest mean yield was obtained with five sprays of multi K given at an interval of 10 days starting from 30 days after planting (AICRP (VS), Annual report 2005-06).

Similarly, five foliar spray of polyfeed NPK 19:19:19 recorded the highest fruit yield of 49.20 t ha^{-1} in brinjal hybrid COBH-1 under Coimbatore condition (AICRP (VS), Annual report, 2005-06). Whereas, experiment conducted at Junagarh condition revealed that foliar feeding with water soluble fertilizers could not exert any significant effect on fruit of brinjal cultivar Gujarat Brinjal Long I. However, numerically the highest fruit yield was recorded with five sprays of NPK 17:10:27 (AICRP (VS), Annual report 2003-04).

Okra :

Manjunatha (2004) reported that foliar nutrition of water soluble fertilizer NPK 19:19:19 at 0.5 per cent concentration five times along with recommended dose of NPK exhibited an increase in plant height, number of leaves, number of branches, fruit length, fruit girth, individual fruit weight and number of fruits per plant. Quality traits of fruits like ascorbic acid content (16.92 %) and crude protein (23.19 %) also increased due to foliar nutrition of water soluble fertilizers.

Sundaram and Kanthaswamy (2005) studied the response of okra to foliar feeding of water soluble fertilizers. They found that foliar application of polyfeed NPK 19:19:19 five sprays along with recommended dose of fertilizers recorded the maximum fruit weight and yield per plant. The increase in yield was 69.35 per cent over control.

Similarly, in an experiment conducted at Kerala Agricultural University, Vellanikara, the highest fruit yield was obtained with foliar application of NPK 19:19:19 in okra cultivar Aruna (AICRP(VS), Annual report 2005). Foliar application of water soluble fertilizers had a significant effect on the growth and yield of okra. Among the different treatments, five foliar sprays of NPK 17:10:27 recorded the highest fruit yield of 465.9 q ha^{-1} under Karaikal condition (AICRP(VS), Annual report 2006).

Venkataraman (2007) stated that foliar nutrition of water soluble fertilizer NPK (19:19:19) at 0.5 per cent concentration five times with recommended dose of NPK (200:100:100 kg ha^{-1}) exhibited an increase in plant height, number of branches per plant, fruit length, fruit girth, number of fruits per plant, fruit weight, quality characters like ascorbic acid, crude protein. The physiological parameters like leaf area index, dry matter production, crop growth rate and relative growth rate also increased in this treatment. N, P and K uptake were also increased in this same treatment.

Onion :

The use of recommended dose of fertilizer along with foliar spray of polyfeed 19:19:19 one per cent at 15, 30 and 45 DAP and multi K one per cent at 60, 75 and 90 DAP gave higher bulb yield in onion cv. 'AGRIFOUND LIGHT RED' under Karnal condition. Maximum net return was also obtained in the same treatment (AICRP(VS), Annual report 2005).

Garlic :

The studies conducted in garlic variety 'Agrifound White' at Nasik revealed that application of NPK @ 100:50:50 kg ha^{-1} and spraying of polyfeed 1.0 per cent at 15, 30 and 45 and multi K 1.0 per cent at 60, 75 and 90 DAS performed better in giving bigger sized bulb and yield (AICRP(VS), Annual report, 2005).

Gherkins :

The increase in yield of gherkins due to foliar sprays of multi K and polyfeed was 26.7 and 18.7 per cent over control and the B:C ratio was 2.67 and 2.50, respectively. Whereas, combined spray of polyfeed and multi K increase the yield up to 19.8 per cent (AICRP(VS), Annual report 2000).

Cabbage :

In cabbage, significantly higher seed yield of 11.573 q ha^{-1} was produced by foliar application of polyfeed NPK 19:19:19 and NPK 13:00:45 (11.228 q ha^{-1}) and both were at par (AICRP(VS), Annual report 2006).

Cauliflower :

In cauliflower, the highest curd yield (168.33 q ha^{-1}) was recorded with five sprays of polyfeed NPK 19:19:19 which was significantly better than the control (130.00 q ha^{-1}). Three sprays of polyfeed (19:19:19) produced the second highest yield (AICRP(VS), Annual

report, 2006).

Effect of foliar feeding of macro nutrients and other substances on growth and yield in vegetables crops:

Chilli :

Muralidharan *et al*. (2002) reported application of vipul 0.1 per cent EC at 300 ml ha^{-1} recorded maximum dry pod yield, quality attributes and enhanced the uptake of major nutrients.

Joshi and Singh (2003) stated that application of paclobutrazol (PP333) @ 300ppm) recorded maximum fruit yield per plant and weight of seeds per fruit. Hatwar *et al*. (2003) reported the application of Zn, Fe and B @ 0.1 per cent recorded highest growth attributes and yields. Application of NAA 100 ppm recorded maximum plant growth, whereas, CCC 1000ppm recorded more dry matter and yield (Gollagi *et al*., 2006).

Gore *et al*. (2007) stated that maximum growth and yield was obtained from application of Nova charge 25ml per 100ml. Bharad *et al*. (2007) reported application of 0.50 per cent $ZnSO_4$ + 0 per cent $FeSO_4$ recorded maximum growth and yield.

Maheshwari and Haripriya (2008) stated application of vermicompost @ 5 t ha^{-1} and groundnut cake @ 250 kg ha^{-1} along with foliar spray of panchagavya 3 per cent for four times recorded maximum yield in hot pepper.

Tomato :

Alan and Padem (1994) reported that application of palarosate 0.07 per cent recorded maximum dry matter content and vit-C. Reddy *et al*. (2004) stated that application of enriched carboxylic acid recorded maximum growth characters, maximum yield and quality in tomato. Tamilselvi *et al*. (2005) observed foliar spray of multiplex 100ppm recorded maximum growth and yield.

Kumari and Sharma (2006) stated that foliar application of boron @ 100ppm and repeated spray at 10 days interval twice from 30 DAT onwards, recorded the highest growth, seed yield with net returns and B:C ratio. Dhanasekaran and Bhuvaneswari (2007) observed foliar application of micronutrient NAA and enriched PCA to the plant supplied with 125 per cent NPK recorded highest fruit yield.

Application of recommended dose of fertilizer + 0.05 per cent Zn + ethephon 1000ppm recorded maximum growth, TSS with B:C ratio. Whereas, lycopene and juice recovery was maximum with the application of RDF + 0.5 per cent Ca + ethephon 1000ppm (Patil *et al*., 2006).

Padan *et al*. (2008) reported Bio-K 1ml/lit of water + RDF of NP and 50 per cent of K recorded better growth, yield and quality in tomato.

Pawar *et al*. (2008) stated that application of 200 g compost per 15 kg soil with Fulvic acid two sprays showed better effect on plant growth.

Okra :

Singh and Kumar (2005) observed that application of 200ppm NAA with 2 per cent urea recorded maximum fruit yield. Nawalkar *et al*. (2007) stated that application of 50 per cent RDF with spraying of 1300ppm CCC recorded maximum growth and yield. Dhanasekaran *et al*. (2007) reported application of humic acid 0.3 per cent recorded maximum growth and yield.

Soybean :

Application of boron through soil and foliar spray recorded maximum growth and yield (Cirak *et al*., 2006).

Lende *et al*. (2007) stated that spray of veriwash 200ppm recorded maximum plant growth and yield. Similarly, Deotabe *et al*. (2008) reported application of 200ppm vermiwash recorded maximum growth and yield.

Cucumber :

Foliar application of one per cent urea, 1.5 per cent DAP and 1.5 per cent KCl along with ¾th of soil recommended level of NPK was found to be the best with regard to yield. The NPK content was also very high in this treatment (Karuppaiah *et al*., 2001).

Onion :

Application of 100:50:50 kg NPK ha^{-1} along with FYM @ 15 t ha^{-1} and foliar spray of polyfeed one per cent at 15, 30 and 45 DAP and multi-K one per cent at different intervals recorded maximum bulb yield under Karnal condition (NHRDF Annual report 2005).

Sangeetha and Singaram (2007) reported that combined application of RDF of inorganic fertilizer and lignite humic acid @ 20 kg ha^{-1} resulted in maximum growth and bulb yield.

Effect of foliar and soil application of N, P and K on growth and yield in vegetable crops :

Plant height :

Application of N @ 300 kg ha^{-1} and K 120 kg ha^{-1} recorded maximum plant height in chilli.(AICRP(VS),

Annual report 2006).

Vitkar *et al*. (2007) stated that application of 50 per cent RDF along with 50 per cent nitrogen through neem cake recorded maximum plant height in chilli. Singegol *et al*. (2007) reported application of higher level of nitrogen @ 150 kg ha^{-1} and phosphorus @ 75 kg ha^{-1} recorded maximum plant height in chilli. Application of NPK along with FYM recorded maximum plant height in sweet pepper under mid hill condition (Yadav *et al*., 2007).

Chapagain and Weisman (2004) observed that foliar spraying of Nutri-vant-peak (contain 95 % MKP) at one per cent concentration increased the plant height in tomato. Foliar application of water soluble fertilizers in tomato produced taller plants (AICRP(VC), Annual report 2006). Manolikar *et al*. (2007) stated that application of 100 per cent FYM and 50 per cent RDF recorded maximum plant height in tomato. Foliar application of five sprays of NPK 19:19:19 along with the normal recommended dose recorded the highest plant height in brinjal (Karpagam *et al*., 2004).

Application of nitrogen @ 150 kg ha^{-1} recorded maximum plant height in bhendi (Dwivedi *et al*., 1994). Sannigrahi and Borah (2000) observed that the treatment which received 50 per cent recommended dose fertilizer along with FYM @ 10 t ha^{-1} recorded the maximum plant height in bhendi and similar result was noticed by Kadam *et al*. (2006) in moringa. Application of 75 per cent nitrogen through recommended dose of fertilizer with vermicompost @ 5 t ha^{-1} gave the maximum plant height in bhendi (Tripathy *et al*., 2004).

Manjunatha (2004) reported that foliar nutrition of water soluble fertilizer NPK 19:19:19 at 0.5 per cent concentration five times along with recommended dose of NPK exhibited an increase in plant height on okra. Venkataraman (2007) reported that foliar nutrition of water soluble fertilizer NPK 19:19:19 at 0.5 per cent concentration five times along with recommended dose of NPK exhibited an increase in plant height in okra. Kushwaha *et al*. (2008) reported that application of N @ 100 kg ha^{-1} and P @ 80 kg ha^{-1} recorded maximum plant height in bhendi. The maximum plant height in soy bean was noticed in the treatment which received recommended dose of fertilizer with vermicompost @ 5 t ha^{-1}, *Azospirillum* 2 kg ha^{-1} and $ZnSO_4$ @ 25 kg ha^{-1} (Kalayarasan and Vaiyapuri, 2007).

Number of branches per plant :

Vitkar *et al*. (2007) observed application of 50 per cent RDF along with 50 per cent nitrogen through neem cake recorded more number of branches per plant, in chilli. Singegol *et al*. (2007) stated that application of higher levels of nitrogen @ 150 kg ha^{-1} and phosphorus @ 75 kg ha^{-1} recorded more number of branches per plant in chilli. Application of NPK along with FYM recorded more number of branches per plant in sweet pepper under mid hill condition (Yadav *et al*., 2007).

Foliar application of water soluble fertilizers in tomato produced more number of branches per plant (AICRP(VS), Annual report 2006). Sable *et al*. (2007) reported application of 50 per cent nitrogen through neem cake and 50 per cent 'N' through vermicompost combination recorded more number of branches per plant in tomato. Manolikar *et al*. (2007) stated that application of 100 per cent FYM along with 50 per cent RDF recorded more number of branches per plant in tomato.

Karpagam *et al*. (2004) observed application of five sprays of NPK 19:19:19 along with the normal RDF recorded more number of branches per plant in brinjal. Application of nitrogen @ 150 kg ha^{-1} recorded more number of branches per plant in bhendi (Dwivedi *et al*., 1994). More number of branches per plant in bhendi was observed when 75 per cent recommended dose of fertilizer was applied along with vermicompost @ 5 t ha^{-1} (Tripathy *et al*., 2004) or with FYM @ 25 t ha^{-1} and vermicompost @ 4 t ha^{-1} (Barani and Anburani, 2004).

Application of NPK 19:19:19 at 0.5 per cent concentration five times along with RDF of NPK recorded more number of branches per plant in okra (Manjunatha, 2004). Venkataraman (2007) reported that foliar nutrition of water soluble fertilizer NPK 19:19:19 at 0.5 per cent concentration five times along with recommended dose of NPK exhibited more number of branches per plant in okra.

Application of 50 per cent of recommended nitrogen through fertilizer with enriched slurry @ 4.5 t ha^{-1} gave the maximum number of branches per plant in soybean (Anitha Choury *et al*., 2001).

Number of fruits per plant :

In chilli application of N @ 300 kg ha^{-1} and 120 kg of phosphorus ha^{-1} recorded more number of fruits per plant. (AICRP(VS), Annual report 2006). Application of higher level of 'N' @ 150 kg ha^{-1} and 'P' @ 75 kg ha^{-1} recorded more number of fruits per plant in chilli. (Singegol *et al*., 2007).

In sweet pepper Yadav *et al*. (2007) reported that application of NPK with FYM recorded more number of fruits per plant under mid hill condition.

The number of fruits per plant in tomato was found to be the maximum when compost @ 2 t ha^{-1} with 30 kg nitrogen ha^{-1} was applied (Togun *et al*., 2003). Foliar spray of water soluble fertilizer in tomato produced more number of fruits per plant (AICRP(VC) Annual report, 2006). Application of 100 per cent FYM and 50 per cent RDF recorded more number of fruits per plant in tomato (Manolikar *et al*., 2007).

The number of fruits per plant in okra was found to be the maximum with application of NPK 19:19:19 at 0.5 per cent concentration five times along with RDF (Manjunatha, 2004). Paramasivam *et al*. (2005) observed that application of 100 per cent RDF combined with FYM @ 25 t ha^{-1}, composted coirpith @ 12.5 t ha^{-1} and vermicompost @ 1.5 t ha^{-1} recorded maximum numbers of fruits per plant in okra.

Venkataraman (2007) reported that foliar nutrition of water soluble fertilizer NPK 19:19:19 at 0.5 per cent concentration five times along with recommended dose of NPK exhibited an maximum number of fruits per plant in okra. Application of N @ 150 kg ha^{-1} and phosphorus and @ 80 kg ha^{-1} recorded more number of fruits per plant in okra (Kushwaha *et al*., 2008).

Application of recommended dose of fertilizer with vermicompost @ 10 t ha^{-1} recorded the maximum number of fruits per plant in melon (Anitha *et al*., 2003).

Fruit weight :

In chilli Singegol *et al*. (2007) reported that application of nitrogen @ 150 kg ha^{-1} and phosphorus @ 75 kg ha^{-1} recorded higher fruit weight.

The treatment combination of 50 per cent recommended dose of fertilizer with 50 per cent nitrogen through FYM recorded the maximum fruit weight in tomato (Mohd *et al*., 2002). Togun *et al*. (2003) found that application of compost 2 t ha^{-1} with 30 kg N ha^{-1} through fertilizer gave the maximum fruit weight in tomato.

Manjunatha (2004) stated that application of NPK 19:19:19 at 0.5 per cent, five times along with recommended dose of fertilizer recorded maximum fruit weight in okra. Venkataraman (2007) reported that foliar nutrition of water soluble fertilizer NPK 19:19:19 at 0.5 per cent concentration five times along with recommended dose of NPK exhibited maximum fruit weight in okra. Application of 'N' @ 150 kg ha^{-1} and 'P' @ 80 kg ha^{-1} recorded higher fruit weight in okra (Kushwaha *et al*., 2008).

According to Sreenivas *et al*. (2000) application of recommended dose of fertilizer with 10 t ha^{-1} of vermicompost gave the maximum fruit weight in ridged gourd.

Combined application of 50 per cent recommended dose of fertilizer plus vermicompost @ 2 t ha^{-1} and biofertilizers @ 2 kg ha^{-1} gave the highest fruit weight in cucumber (Prabu *et al*., 2006).

Yield per plant :

In chilli, Vitkar *et al*. (2007) found higher fruit yield per plant when applying 50 per cent RDF along with 50 per cent nitrogen through neem cake.

Application of chemical fertilizer and FYM together recorded higher fruit yield per plant in sweet pepper (Yadav *et al*., 2007).

Manolikar *et al*. (2007) stated that application of 100 per cent FYM and 50 per cent recorded higher yield per plant in tomato.

Venkataraman (2007) reported that foliar nutrition of water soluble fertilizer NPK 19:19:19 at 0.5 per cent concentration five times along with recommended dose of NPK exhibited an maximum fruit yield per plant in okra.

Ascorbic acid :

Application of 60 kg potassium ha^{-1} recorded higher level of ascorbic acid in chilli (Ananthi *et al.*, 2004). Dange *et al*. (2004) observed that ascorbic acid content of chilli was higher when 50 per cent recommended dose of nitrogen through fertilizer and remaining 50 per cent of nitrogen through FYM was applied. The increase in ascorbic acid content was more, than the plant which received 100 per cent nitrogen through urea.

Ascorbic acid content was highest when applied with 50 per cent RDF and 50 per cent FYM in tomato (Rafi *et al*., 2002). Sable *et al*. (2007) stated that application of 50 per cent nitrogen through neem cake and 50 per cent nitrogen through vermicompost recorded more ascorbic acid in tomato.

Venkataraman (2007) reported that foliar nutrition of water soluble fertilizer NPK 19:19:19 at 0.5 per cent concentration five times along with recommended dose of NPK exhibited an higher level of ascorbic acid content in okra.

Application of 100 per cent recommended nitrogen through urea registered higher level of ascorbic acid content in brinjal (Prabu *et al*., 2003) and similar results was reported by Singh and Parmar (2004) in tomato.

Dry matter production :

Sable *et al*. (2007) reported that application of 50 per cent nitrogen through neem cake and 50 per cent nitrogen through vermicompost combination recorded maximum dry matter production in tomato.

Karpagam *et al*. (2004) reported that application of NPK 19:19:19 along with normal recommended dose of fertilizer recorded highest dry matter production in brinjal.

Venkataraman (2007) reported that foliar nutrition of water soluble fertilizer NPK 19:19:19 at 0.5 per cent concentration five times along with recommended dose of NPK exhibited an higher dry matter production in okra.

Anitha Choury *et al*. (2001) reported that application of 50 per cent of recommended nitrogen through fertilizer plus enriched slurry @ 4.5 t ha^{-1} gave higher dry matter production in soybean. Application of recommended dose of fertilizer with vermicompost @ 5t ha^{-1} *Azospirillum* @ 2 kg ha^{-1} and $ZnSO_4$ @ 25 kg ha^{-1} recorded the higher dry matter production in soy bean (Kalayarasan and Vaiyapuri, 2007). Application of *Azospirillum* with 100 per cent N and PK produced maximum dry matter content in onion (Mahanthesh *et al*., 2008). Ghuge *et al*. (2007) stated that application of 50 per cent RDF with 50 per cent vermicompost @ 25 t ha^{-1} recorded highest dry matter production in cabbage.

Conclusion :

Hence, it is concluded that foliar nutrition with highly water soluble fertilizers can eliminate the problems like fixation and immobilization of nutrients. Foliar nutrients usually penerate the cuticle of the leaf or stomata, enter the cells rapidly and fulfil the nutrient demand of the growing plant and thus ameliorate nutrient deficiencies rapidly.

REFERENCES

Agro India (2000). Water soluble fertilizers -A potential source of nutrients for foliar spray and fertigation. *Farm Digest*, Oct-Dec:10-12.

Alan, R. and Padem, H. (1994). The influence of some foliar fertilizers on growth and chemical composition of tomatoes under greenhouse conditions. In: Proc. Solanacea in Mild Winter Climates. *Acta Hort.*, **366** : 397–404.

All India Coordinated Research Project (Vegetable crops) Annual report. 2002-03 & 2003-04. XXIV AICRP (VC) Group meeting, UAS, Dharwad, pp.197-220.

All India Coordinated Research Project (Vegetable crops) Annual report. 2004-05. XXIII AICRP (VC) Group meeting, BCKV, Kalyani, pp.129-134.

All India Coordinated Research Project (Vegetable crops) Annual report. 2005-06. XXIV AICRP (VC) Group meeting, UAS, Dharwad, pp.197-198.

Ananthi, S., Veeraragavathatham, D. and Srinivasan, K. (2004). Comparative efficacy of muriate of potash and sulphate of potash on yield attributes, yield and economics of chilli (*Capsicum annuum* L.). *South Indian J. Hort.*, **52**(1-6) : 158-163.

Anitha Choury, J., Rajendran, K. and Anal, P.S. Mariam (2001). Effect of organic and inorganic nitrogen on growth and yield of soybean. *Agrl. Sci. Digest*, **23**: 119-121.

Anitha, S., Jyoti, M.L., Kutty, M.C. Narayanan and Nair, Lekha B. (2003). Evaluation of various organic manure as components in the integrated nutrient management of oriental picking melon. *Prog. Hort.*, **35**: 155-157.

Barani, P. and Anburani, A. (2004). Influence of vemicomposting on major nutrients in bhendi. *South Indian J. Hort.*, **52** : 351-354.

Batra, V.K., Singh, Birender and Singh, Virender (2002). Response of brinjal to foliar feeding of water soluble fertilizers. International Conference on Vegetables, Nov: 11-14.

Bharad, S.G., Kapagate, A.M., Gonge, V.S., Dala, S.R. and Chandan, P.M. (2007). Effect of foliar applications of zinc and iron on growth and yield of capsicum cv. CALIFORNIA WONDER under net house condition. *Asian J. Hort.*, **2**(2): 209-211.

Chapagain, B.P. and Weisman, Z. (2004). Effect of Nutri-Vant-peaK foliar spray on plant development, yield and pod quality in greenhouse tomatoes. *Scientia Hort*., **102** : 177-188.

Cirak,C., Mehmet Serhat Odabas, Kudret Kevseroglu, Emel Karaca and Ali Gulumser (2006). Response of soybean (*Glycine max*) to soil and foliar applied boron at different rates. *Agri. Sci.*, **76**(10): 603-606.

Dange, R.R., Naik, D.M. and Prabhu, T. (2004). Effect of organic and inorganic fertilizers on growth, yield and quality of chilli. *South Ind. Hort.*, **50** : 578-583.

Deotabe, R.D., Lende, S.R., Kamble, P.S., Baviskar, S.B. and Kuchanwar, O.D. (2008). Effectivity of foliar sprays of vermiwash and cowdung wash on morpho-physiological parameters on soybean. *J. Soils & Crops*, **18**(1): 169-175.

Dhanasekaran, K. and Bhuvaneswari, R. (2007). Effect of different levels of NPK and foliar application of enriched humic substances on growth and yield of tomato. *Indian J. Agric. Sci*., **3**(1): 90-94.

Dhanasekaran, K., Bhuvaneswari, R., Sathiyamurthi, S. and Sivakumar, K. (2007). Response of foliar application of humic acid on the growth and yield of bhendi. *Internat. J. Trop. Agric*., **25**(4): 871-876.

Dwivedi, V.C., Sengupta, S.K. and Sharma, R.S. (1994). Effect of sowing dates and nitrogen fertilization on seed crops of okra. *Veg. Sci.*, **21**(2): 122-125.

Ghuge, T.D., Jadhav, S.B. and Gore, A.K. (2007). Effect of organic and inorganic sources of nutrients on uptake and nutrient availability of soil after harvesting of cabbage. *J. Soils & Crops*, **17**(2): 294-298.

Gollagi, S.G., Hiremath, S.M. and Chetti, M.B. (2006). Influence of growth regulators and nutrients on morphological traits and yield potential in chilli cv. BYADAGI. *J. Asian Hort*., **2**(3) : 182-185.

Gore, A.K., Jadhav, S.B., Gore, A.K. and Ghuge, T.D. (2007). Effect of different bioenzymes on growth, flowering and yield of green chilli (*Capsicum annuum* L.) variety Pusa Jwala. *J. Soils & Crops*, **17**(1): 105-109.

Hatwar, G.P., Gondane, S.U., Urkude, S.M. and Gahukar, O.V. (2003). Effect of micronutrients on growth and yield of chilli. *J. Soils & Crops*, **13**(1): 123-125.

Jeyabal, A., Rao, M. Murlidhar, Palaniappan, S.P. and Chelliah, S. (1998). Technical bulletin on speciality fertilizers. Nagarjuna Agricultural Research and Development Institute. Serunderabad.

Joshi, N.C. and Singh, D.K. (2003). Effect of plant bio regulators on growth and yield of chilli (*Capsicum annuum* L.) *Prog. Hort.*, **35**(2): 212-215.

Kadam, V.D., Giri, D.G., Solunke, P.S., Desh Much, M.R. and Giri, M.D. (2006). Effect of integrated nutrient management on growth and yield of drumstick varieties. *Crop Protec. & Prod.*, **2** : 22-24.

Kalayarasan, K. and Vaiyapuri (2007). Effect of organic manure and tillage practices on soil properties and crop yields under sorghum- soybean cropping sequence. *Madras Agric. J.*, **86**: 561-565.

Karpagam, R., Kannan, M., Natarajan, S. and Srinivasan, K. (2004). Studies on the efficacy of foliar feeding of water soluble fertilizers on growth parameters and yield of brinjal (*Solanum melongena* L.) hybrid COBH-1. *South Indian J. Hort.*, **52** (1-6): 139-145.

Karuppaiah, P., Manivannan, K., Sriramachandrasekaran, M.V. and Kuppusamy, G. (2001). Response of cucumber to foliar application of nutrients on lignite mine spoil. *J. Ind. Soc. Soil Sci*., **49**(1): 150-153.

Kumari, S. and Sharma, S.K. (2006). Effect of micronutrient sprays on tomato (*Lycopersicon esculentum*) seed production. *Indian J. Agric. Sci.*, **76**(10): 676-678.

Kushwaha, A.S., Tomar, K.S. and Bhadauria, S.K.S. (2008). Response of hybrid summer okra to nitrogen and phosphorus. *Res. Crops*, 9(1): 76-78.

Lende, S.R., Deotale, R.D., Kamble, P.S., Ghadge, P.R. and Suryapujary, S.M. (2007). Influence of foliar sprays of vermiwash and cowdung wash on bio chemical and yield contributing parameters and yield of soybean. *J. Soils & Crops*, **17**(1): 398-402.

Mahanthesh, B., Sajjan, M. Raviprasad, Srinivasa, V., Harshavardhan, M. and Thippesha, D. (2008). Studies on the influences of bio-fertilizers with levels of NPK on the yield and processing qualities of onion (*Allium cepa* L.) cv. BELLART RED in *Rabi* season under irrigated situation. *Res. Crops,* **9**(1): 98-102.

Maheswari, U.T. and Haripriya, K. (2008). Response of hot pepper (*Capsicum annuum* L.) cv. K2 to various sources of organic manures and foliar nutrients. *Asian J. Hort*., **3**(1): 51-53.

Manjunatha, G. (2004). Effect of foliar nutrition of water soluble fertilizers in bhendi (*Abelmoschus esculentus*) hybrid. M.Sc. (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Manolikar, P.R., Vitkar, M.N., Vasmate, S.D., Patil, R.F. and Kalalbandi, B.M. (2007). Effect of integrated nutrient management on growth and yield of tomato. *Asian J. Hort*., **2** (2) : 178-180.

Mohd, R., Narwadkar, P.R., Prabu, T. and Sajindranath, A.K. (2002). Effect of organic and inorganic fertilizers on growth and yield of tomato. *South Ind. Hort.*, **50**: 522-526.

Muralidharan, R., Saravanan, A. and Muthuvel, P. (2002). Effect of plant growth regulators on yield, quality, available soil nutrients and uptake of nutrients by chilli. *Madras Agri. J.*, **89**(1-3): 63-66.

Nawalkar, L.R., Khiratkar, S.D., Badge, S.A., Chopde, N.K. and Dadgal, S.S. (2007). Effect of biofertilizers and growth regulator with reduced doses of NPK on growth and yield of okra. *J. Soils & Crops*, **17**(1): 145-149.

NHRDF Annual report (2004-05). Effect of level of FYM combined with foliar application of NPK mixture, zinc, copper and boron on growth and yield of quality onion. pp.8-14.

Palaniappan, S.P., Jeyabal, A. and Chelliah, S. (1999).

Response of tomato and chilli to foliar application of water soluble fertilizers. *Veg. Sci.*, **23** (1): 9-15.

Paramasivam, N., Jawahar, D. and Krishnamoorthi, V.V. (2005). Effect of organic manure and inorganic fertilizers on yield and economics of okra in an alfisol tamarabarani track. *South Indian Hort.*, **53** : 312-315.

Patil, M.G., Krishnappan and Hugar, Ashok (2006). Influence of foliar nutrients and ethrel on yield and quality traits of processing tomato. *J. Asian Hort.*, **2**(4): 264-267.

Pawar, J. B, Amrutsagar, V.B. and Bhosale, S.N. (2008). Effect of different compost and their fulvic acid application on plant growth parameters of tomato. *Green Farming*, **1** (7) : 40-42.

Prabu, M., Natrajan, S., Srenivasan, K. and Pugalendhi, L. (2006). Integrated nutrient management in cucumber. *Indian J. Agri. Res.*, **40** : 123-126.

Rai and Pandey (2006). Focus to be on vertical expansion. The Hindu: Survey of Indian Agriculture pp: 155.

Rafi, M., Narwadkar, P.R., Prabu, T. and SajIndranath, A.K. (2002). *J. Soils & Crops*, **12**(2): 167-169.

Reddy, M., Dhanasekaran, K., Saravanan, K.P. and Venkatakrishnan, D. (2004). Effect of foliar application of enriched humic substances on the performance of tomato (*Lycopersicon esculentum*, Mill). *Mysore J. Agric. Sci*., **38**(4): 468-473.

Sable, C.R., Ghuge, T.D., Jadhav, S.B. and Gore, A.K. (2007). Impact of organic sources on uptake, quality and availability of nutrients after harvest of tomato. *J. Soils & Crops*, **17**(2): 284-287.

Sangeetha, M. and Singaram, P. (2007). Effect of lignite humic acid and inorganic fertilizers on growth and yield of onion. *Asian J. Soil Sci.*, **2**(1):108-110.

Sannigrahi, A.K. and Borah, B.C. (2000). Response of okra to varying levels of FYM and chemical fertilizer. *Soils & Fertilizers*, **65**(4): 750.

Singegol, H.V., Patil, H.B. and Patil, D.R. (2007). Growth and yield of green chilli (*Capsicum annuum* L.) cv. PUSA JWALA as influenced by nitrogen and phosphorus. *Asian J. Hort.*, **2**(2): 184-187.

Singh, Arunkumar and Parmar, A.S. (2004). Effect of nitrogen and spacing on bio-chemical components in hybrid tomato. *Prog. Hort.*, **36**: 118-121.

Singh, R.K. and Kumar, Mahesh (2005). Response of summer season okra to plant growth regulators and foliar application of nitrogen. *Haryana J. Hort. Sci.*, **34** (1-2): 187-188.

Sreenivas, C.A, Muralidhar, S. and Rao, M. Singa (2000). Yield and quality of ridged gourd as influenced by different levels of inorganic fertilizer and vermicompost. *Ann. Agri. Res.*, **21**: 262-266.

Sundaram, V. and Kanthaswamy, V. (2005). Response of okra to foliar feeding of water soluble fertilizers. *Veg. Sci.*, **32** (1): 92-93.

Tamilselvi, P., Vijayakumar, R.M. and Nainar, P. (2005). Studies on the effect of foliar application of micronutrients on growth and yield of tomato cv. PKM-1. *South Indian J. Hort.*, **53**(1-6): 46-51.

Togun, A.O., Akanbi, W.B. and Dris, R. (2003). Influence of compost and nitrogen fertilizer on growth, nutrient uptake and fruit yield of tomato (*Lycopersicon esculentum*). *Crop Res.*, **26** : 98-105.

Tripathy, P., Bhattacharya, B. and Maity, T.K. (2004). Response of okra to integrated nutrient management system. *Orissa Hort. J.*, **32**: 14-18.

Venkataraman, R. (2007). Response of okra [*Abelmoschus esculentus* (L.) Moench] to foliar feeding of water soluble fertilizers. M.Sc. (Hort.) Thesis. PAJANCOA & RI, Karaikal.

Verma, A., Kallo, G., Singh, K.P. and Banerjee, M.K. (2002). Production, productivity and exporting of vegetables. Technical bulletin-7, IIVR, Varanasi- pp.6.

Vibhute, C.P. (1998). A process for manufacturing complex solid and liquid completely water soluble fertilizers. *Fert. News*, **43**(8): 63.

Vitkar, M.N., Manolikar, R.R., Vasmate, S.D., Kalabandi, B.M. and Patil, M.F. (2007). Effect of organic and inorganic fertilizers on growth and green fruit of chilli (*Capsicum annuum* L.). *Asian J. Hort.*, **2**(2): 273-276.

Yadav, B.D., Khandelwal, R.B. and Sharma, Y.K. (2004). Response of tomato to foliar feeding of water soluble fertilizers. *Veg. Sci.*, **31** (1): 98-100.

Yadav, S.K., Rana, J.C., Pradheep, K., Yadav, Sangit, Hussain, Z. and Mishra, S.K. (2007). Effect of NPK, FYM and climatic zones on fruits and seed yield of sweet pepper. *Internat. J. Trop. Agric*., **25**(3): 481-485.