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Influence of spacing and fertilizer levels on the leaf nutrient contents of Bhendi (*Abelmoschus esculentus* L. Moench) under drip fertigation system

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Field experiments were conducted during 2010 to 2012 to study the effect of spacing and fertilizer levels on the leaf nutrient contents of Bhendi (*Abelmoschus esculentus* L. Moench) under drip fertigation system at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The treatments consisted two spacings (M_1-60 x 45 cm and M_2 - 60 x 30 cm) and eight drip fertigation levels. The study revealed that drip fertigation at 125% recommended dose of fertilizers (250:125:125 kg NPK/ha) as water soluble fertilizer combined with Azophosmet (0.5% at750 ml/ha) and humic acid (0.4% at2.5 litre/ha) under wider spacing registered the highest leaf nutrient status like nitrogen (2.31%), phosphorus (0.53%), potassium (1.33%), calcium (0.59%), magnesium (1.46%), zinc (45.55 ppm), manganese (102.81 ppm) and boron content (16.70 ppm), whereas, the leaf copper content (22.31 ppm) was the highest under 100% recommended dose of fertilizers as water soluble fertilizer combination with Azophosmet and humic acid under wider spacing.

Key words: Spacing, fertilizer levels, Bhendi, drip fertigation, leaf nutrients.

INTRODUCTION

Bhendi (*Abelmoschus esculentus* L. Moench) is an important vegetable crop belonging to the family Malvaceae. It is also referred as ladies finger or okra. It is an annual vegetable crop and generally propagated through seeds. It is a cheap and nutritious vegetable. Hundred grams of consumable unripe bhendi contains 10.4 g dry matter, 3100 calories of energy, 1.8 g protein, 90 mg calcium, 110 mg iron, 0.1 mg carotene, 0.01 mg thiamine, 0.08 mg riboflavin, 0.08 mg niacin and 18 mg vitamin C (Thamburaj and Narendra, 2001). The dry seeds contain 13 to 22% edible oil and 20 to 24% protein.

It is essential to provide optimum plant population density per unit area by adjusting the spacing levels in bhendi crop unlike in normal spacing the plants grown in closer spacing exhibited more vertical growth but give less yield and poor quality for need of sufficient space, light, nutrient and moisture due to heavier plant population pressure (Dhanraj et al., 2001). Whereas the plants grown in the wider spacing exhibit more horizontal and continuous vegetative growth due to less population pressure per unit area but they also give less yield per unit area (Anilkumar, 2004). However the plants grown under normal spacing will have optimum population density per unit area which provides optimum conditions for luxuriant crop growth

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and better plant canopy area due to maximum light interception, photosynthetic activity, assimilation and accumulation of more photosynthates into plant system and hence they produce more yields with best quality traits (Mazumdar et al., 2007). Similar to spacing, judicious application of balanced and adequate nutrients play vital role in deciding the ultimate success of yield and quality of bhendi crop by realizing higher yield and the best quality.

The growth, yield and quality of crop are largely influenced by the fertility status of the soil (or) soil fertility status apart from genetic potential of the variety. Altering the soil nutrients and fertility status by providing balanced and adequate major nutrients like nitrogen, phosphorus and potassium as per the crop requirement is one of the easiest way to boost up crop productivity of bhendi. Since the interception in the supply of major nutrients even for a brief period is determined by pattern of crop growth and development which may produce less yield and poor quality and it cannot be corrected or altered at later stages of the crop growth even by supplying with heavier doses of major nutrients (Dwivedi et al., 2002). It is estimated that losses of water and applied nutrients in the conventional method of usage of water and fertilizers are more than 30 to 40%.

So, there is a need for proper fertigation management in order to ensure maximum crop productivity. It is well known that organic manures, inorganic fertilizers and biofertilizers are essential to increase the yield of vegetable crops. Therefore, it is imperative that the judicious combinations of chemical fertilizers, organics as well as biofertilizers are to be utilized properly and effectively not only as source of the nutrients but also for increasing nutrient use efficiency without adversely disturbing the soil health.

With this context, this research will closely monitor the leaf nutrient content of hybrid bhendi under different doses of fertilizers and spacing by utilizing drip fertigation. This research will also offer information on spatial variations in relation to drip fertigation system.

MATERIALS AND METHODS

A field trial to study the influence of fertilizer levels and spacing on the leaf nutrient contents of Bhendi (*A. esculentus* L. Moench) under drip fertigation system was conducted at Thoppur village in Dharmapuri district of Tamil Nadu, India during Rabi 2010 to 2012 and Summer 2011. The experiment was laid out in split plot design (SPD) with three replications. Recommended dose of fertilizers – (NPK at 200:100:100 kg/ha), liquid bio inoculant (Azophosmet at 0.5%) at 750 ml/ha, liquid bio stimulant (Humic acid at 0.4%) at 2.5 litre/ha at 15 and 30 DAS through drip irrigation. Bio inoculant and bio stimulant were purchased from the Department of Agricultural Microbiology, Tamil Nadu Agricultural University. The treatments consisted of two levels of spacing in main plots and eight levels of drip fertigation in sub plots. The treatments consisted spacing of M_1 (60 x 45 cm) and M_2 (60 x 30 cm), drip fertigation levels of S_1 - Drip fertigation with WSF at 125% RDF + Azophosmet + Humic acid, S_2 - Drip fertigation with WSF at 100% RDF + Azophosmet + Humic acid, S_3 - Drip fertigation with WSF at 75% RDF + Azophosmet + Humic acid, S_4 - Drip fertigation with WSF at 100% RDF, S_5 - Drip fertigation with SF at 125% RDF + Azophosmet + Humic acid, S_6 - Drip fertigation with SF at 100% RDF + Azophosmet + Humic acid, S_7 - Drip fertigation with SF at 75% RDF + Azophosmet + Humic acid, S_8 - Drip fertigation with SF at 100% RDF.

In WSF 100% NPK application through drip fertigation system. In SF 100% phosphorus applied as basal and 100% nitrogen and potassium applied through drip fertigation. The water soluble fertilizer sources for supplying NPK through drip irrigation were urea, poly feed, MAP and Multi-k. The straight fertilizer sources for supplying nitrogen and potassium through drip irrigation were urea and MOP and the 100% phosphorus applied as SSP as basal. Leaf nutrient contents viz., Nitrogen, Phosphorus. Potassium, Calcium, Magnesium, Copper, Manganese, Zinc, Iron and Boron was estimated by the following methods.

RESULTS AND DISCUSSION

Efficient use of fertilizers in any crop plant was necessary for optimum growth and yield. So knowledge about the availability of nutrients in the soil is very essential. A clear understanding of specific nutrient requirement of the crop during various stages of growth will substantially reduce the possible wastage of applied nutrients and improve both potentiality of the plant and nutrient use efficiency. During vegetative stage, the plant vigorously absorbs nutrients to build up the plant framework (Pflunger and Mengel, 1972). Plant analysis serves as an elegant tool for understanding the growth and physiology of the plant at various growth stages (Hartz and Hochmuth, 1996).

Among the spacing, leaf nitrogen content was higher at wider spacing. At vegetative stage, the content was higher (Tables 1 and 2). The mean leaf nitrogen content was higher in wider spacing (M_1) and it was 1.83%, whereas in closer spacing (M_2) it was 1.45%. Among the different levels of drip fertigation, the 125% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (S_1) registered the maximum leaf nitrogen content (2.17%), whereas the minimum leaf nitrogen content was registered in 75% recommended dose of fertilizers as straight fertilizer along with Azophosmet and humic acid, S_7 (1.10%) at vegetative stage. The interaction effect was maximum in the 125% recommended dose of fertilizers as water soluble fertilizer with Azophosmet and humic acid (M_1S_1) which showed the maximum value (2.31%) under wider spacing, whereas the minimum interaction effect was observed in M_2S_7 (1.02%) in closer spacing at vegetative stage. The leaf nitrogen content was higher at vegetative stage and declined thereafter. Increased nitrogen content in different plant parts are due to the higher availability in the root zone, uptake and accumulation of nitrogen, which may take place gradually with the advancement of crop growth phase.

Similar findings were also reported by Colla et al. (2001) and Umamaheswarappa et al. (2005). The principle physiological function of humic acid is that it reduces the oxygen deficiency in plants which result in

Table 1. Effect of spacing and fertilizer levels on the nutrient content (N, P, K, Ca and Mg) of Bhendi under drip fertigation system.

Treatment	Leaf nutrient content														
	Nitrogen content (percent)			Phosphorus content (percent)			Potassium content (percent)			Calcium content (percent)			Magnesium content (percent)		
	M_1	M_2	Mean	M_1	M_1	M_1	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
S_1	2.31	2.02	2.17	0.53	0.46	0.50	1.33	1.25	1.29	0.59	0.55	0.57	1.46	1.35	1.41
S_2	2.16	1.78	1.97	0.45	0.43	0.44	1.20	1.15	1.18	0.54	0.50	0.52	1.38	1.31	1.35
S_3	1.81	1.29	1.55	0.36	0.33	0.35	1.03	0.98	1.01	0.46	0.42	0.44	1.25	1.19	1.23
S_4	1.89	1.53	1.71	0.38	0.36	0.37	1.08	1.03	1.06	0.49	0.45	0.47	1.30	1.24	1.27
S_5	2.02	1.68	1.85	0.41	0.39	0.40	1.14	1.07	1.11	0.52	0.47	0.50	1.34	1.28	1.31
S_6	1.72	1.22	1.48	0.33	0.31	0.32	0.97	0.92	0.95	0.44	0.38	0.41	1.20	1.14	1.17
S_7	1.17	1.02	1.10	0.24	0.23	0.24	0.87	0.84	0.86	0.37	0.33	0.35	1.11	1.03	1.07
S_8	1.57	1.10	1.34	0.29	0.27	0.28	0.93	0.89	0.91	0.41	0.35	0.38	1.16	1.06	1.11
Mean	1.83	1.45	1.64	0.37	0.35	0.36	1.07	1.02	1.04	0.48	0.43	0.45	1.28	1.20	1.24
	SEd	**CD (0.05%)**		**SEd**	**CD (0.05%)**		**SEd**	**CD (0.05%)**		**SEd**	**CD (0.05%)**		**SEd**	**CD (0.05%)**	
M	0.01348	0.05801		0.00281	0.01211		0.01176	0.05060		0.00243	0.01044		0.00772	0.03323	
S	0.02997	0.06140		0.00520	0.01065		0.01506	0.03085		0.00819	0.01678		0.01796	0.03679	
M X S	0.04188	0.09557		0.00743	0.01763		0.02313	0.06086		0.01110	0.02394		0.02498	0.05415	
S X M	0.04239	0.08683		0.00736	0.01507		0.02130	0.04362		0.01158	0.02373		0.02540	0.05506	

uptake of larger amount of nitrogen reported by Bhuma (2001) and Kandasamy (1985). The very high ion exchange capacity of humates may bring about better utilization of applied nitrogen by making the nitrogen available in root zone (Seitz, 1960; Virghine, 2003). Another reason for enhanced nitrogen content may be the acid functionality of humic acid, which stimulated the nitrate uptake by the plants. Humic substances would have induced the activities of enzymes such as invertase and nitrate reductase and thereby helped in increased assimilation of nitrogen by plants (Ferretti et al., 1991).

Phosphorus plays key role in the plants energy transfer system. The data on leaf phosphorus as influenced by spacing and different levels of drip fertigation. Under wider spacing (M_1), the maximum leaf phosphorus content (0.37%) was observed and in the closer spacing (M_2) the minimum leaf phosphorus content was 0.35% at flowering stage. Different levels of drip fertigation showed significant differences. Application of 125% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (S_1) registered the maximum leaf phosphorus content of 0.50%, whereas the minimum leaf phosphorus content was registered in 75%recommended dose of fertilizers as straight fertilizer along with Azophosmet and humic acid, S_7 (0.24%) at flowering stage. The maximum interaction effect was found in 125%recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (M_1S_1) under wider spacing (0.53%). The lower interaction effect was found (0.23%) in M_2S_7 in the closer spacing at flowering stage. This finding was in accordance with Balasubramanian (2008).

The application with humic acid recorded the highest level of phosphorus content at the flowering stage of the crop growth. The nutrients present in humic acid might have increased the synthesis of cytokinin and auxin in the root tissues, which would have resulted in the better mobilization of assimilates from the source. Similar findings were recorded by Ken (2000) in onion.

Potassium being a protoplasmic factor is an essential plant nutrient. Many enzymes are activated by potassium and potassium is also involved in photo and oxidative phosphorylation thus augmenting the energy required for pod

Table 2. Effect of spacing and fertilizer levels on the nutrient content (micro nutrients) of Bhendi under drip fertigation system.

Treatment	Leaf nutrient content														
	Iron content (ppm)			Zinc content (ppm)			Manganese content (ppm)			Copper content (ppm)			Boron content (ppm)		
	M_1	M_2	Mean	M_1	M_1	M_1	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
S_1	261.55	256.68	259.11	45.55	40.55	43.06	102.81	97.84	100.33	19.63	18.28	18.96	16.70	15.49	16.10
S_2	255.59	252.09	253.84	41.19	38.08	39.64	98.40	94.76	96.58	22.31	19.02	20.67	16.02	15.29	15.65
S_3	250.84	241.78	246.31	35.87	33.24	34.56	94.43	91.91	93.18	17.97	17.15	17.56	14.69	13.93	14.31
S_4	252.60	246.05	249.32	37.80	34.98	36.39	94.94	93.09	94.02	18.61	17.56	18.09	14.90	14.36	14.63
S_5	254.31	250.47	252.39	38.09	37.72	37.90	96.22	93.76	94.99	19.07	18.05	18.56	15.51	14.73	15.12
S_6	249.29	238.59	243.94	34.65	32.84	33.74	93.92	90.89	92.41	17.91	16.83	17.37	14.60	13.82	14.21
S_7	244.54	232.34	238.44	31.26	29.99	30.63	91.98	89.84	90.91	17.01	16.56	16.79	13.58	13.31	13.45
S_8	247.40	238.03	242.71	32.19	31.30	31.75	92.63	90.32	91.48	17.47	16.75	17.12	14.22	13.80	14.01
Mean	252.02	244.50	248.26	37.07	34.84	35.96	95.67	92.80	94.23	18.75	17.53	18.14	15.03	14.34	14.69
	SEd	**CD (0.05%)**		**SEd**	**CD (0.05%)**		**SEd**	**CD (0.05%)**		**SEd**	**CD (0.05%)**		**SEd**	**CD (0.05%)**	
M	2.53079	5.48650		0.26029	1.11994		0.51041	2.19617		0.01028	0.04423		0.03349	0.14408	
S	2.98848	6.12178		0.46458	0.95168		1.65865	3.39768		0.23874	0.48904		0.23070	0.47258	
M X S	4.69405	NS		0.66743	1.59603		2.25277	4.41263		0.31599	0.64804		0.30702	0.66558	
S X M	4.22634	NS		0.65702	1.34589		2.34568	4.75134		0.33762	0.69161		0.32626	0.70729	

growth (Ghanta and Mitra, 1993). The results showed that both spacings and fertilizer levels had significant variation on leaf potassium. Under the wider spacing (M_1) at flowering stage the leaf potassium content was found maximum (1.07%), whereas in closer spacing (M_2) the leaf potassium content was found minimum (1.02%). Application of 125% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (S_1) registered the maximum leaf potassium content (1.29%), whereas the treatment S_7 registered the minimum leaf potassium content (0.86%) at flowering stage. The interaction effect was found maximum (1.33%) in M_1S_1 (125% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid) under the wider spacing, whereas the interaction effect was low in M_2S_7 in closers pacing (0.84%) at flowering stage. Fontes et al. (2000) and Dangler and Lacascio (1990) opined that application of N and K in combination with drip irrigation increased the potassium content and yield by the way of maximizing the mobility of the nutrients around the root zone. These results were in agreement with those obtained by Kavitha (2005) in tomato.

The different levels of drip fertigation showed significant differences. Under wider spacing (M_1) leaf Ca content was maximum with 0.48%, whereas in closer spacing (M_2) the leaf Ca content was found minimum (0.43%) and which was observed at vegetative stage (Table 3). At vegetative stage, leaf Ca content was the maximum at 125% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (S_1) with 0.57%. The minimum leaf Ca content was noticed at 75% recommended dose of fertilizers as straight fertilizer with Azophosmet and humic acid (S_7) with 0.35%. The maximum interaction effect was found in 125% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (M_1S_1) under wider spacing (0.59%). The lower interaction effect was found (0.33%) in M_2S_7 under closer spacing at vegetative stage. The improved content of calcium by the highest amount of nutrients along with humic acid may be attributed to (i) complexation of calcium by various functional groups of humic acid, (ii) altered membrane permeability of humic acid, which allows active nutrient uptake process and (iii) enhanced cuticle and cell membrane penetration. Similar results were obtained by David et al. (1994) and Virgine (2003) in tomato.

Among the spacings, the wider spacing (M_1)

Table 3. Methods of chemical analysis on the nutrient contents of Bhendi under drip fertigation system.

S/N	Determination	Method	Reference
1.	Triple acid extract HNO_3; H_2SO_4; $HClO_4$	Wet digestion of known quantity of plant material with 12 ml of triple acid and made up to desired volume	Piper (1966)
2.	Diacid extract H_2SO_4 : $HClO_4$ (4:1)	Wet digestion of 0.5 g of plant material with 10 ml of diacid mixture and made up to desired volume	Piper (1966)
3.	Nitrogen	Microkjeldahl method	Piper (1966)
4.	Phosphorus	Vandamolybdate method	Piper (1966)
5.	Potassium	Flame photometry method	Piper (1966)
6.	Calcium, Magnesium, Copper and Manganese	Versenate titration method	Jackson (1973)
7.	Zinc and Iron	Triple acid extract fed into atomic absorption spectrophotometer	Jackson (1973)
8.	Boron	Colorimetric micro determination	Naftel (1986)

recorded maximum leaf Mg content of 1.28%, whereas in closer spacing (M_2) the leaf Mg content was found minimum (1.20%) and was observed at flowering stage. Considering the treatments and stage of growth, the treatment S_1 (125% recommended dose of fertilizers as water soluble fertilizer plus Azophosmet and humic acid) recorded the maximum leaf Mg content of 1.41%. The minimum leaf Mg content was noticed at 75% recommended dose of fertilizers as straight fertilizer with Azophosmet and humic acid (S_7) with 1.07% at flowering stage. The maximum interaction effect was found in 125% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (M_1S_1) under wider spacing (1.46%). The lower interaction effect was found (1.03%) in M_2S_7 in the closer spacing at flowering stage. This may be due to altered membrane permeability by nutrients, which would have allowed higher nutrient absorption process and enhanced the cuticle and cell membrane penetration Singh et al. (1995) humic acid by the formation of complex compounds with magnesium probably would have played a decisive role in the transport of magnesium in tissues (Mylona and McCants, 1980). Similar findings were reported by Pal and Sengupta (1985) and David et al. (1994).

All the drip fertigation treatments had significant influence on leaf Fe content. Among the drip fertigation treatments, the leaf Fe content was higher under wider spacing (M_1) with 252.02 ppm than under closer spacing (M_2). The leaf Fe content was lowers with 244.50 ppm at flowering stage. At flowering stage, application of 125% recommended dose of fertilizers as water soluble fertilizer in combination with Azophosmet and humic acid (S_1) recorded the maximum leaf Fe content of 259.11 ppm. The minimum leaf Fe content was registered in the treatment applied with 75% recommended dose of fertilizers as straight fertilizer with Azophosmet and humic acid (S_7) with values of 238.44 ppm. The interaction effect showed non-significant variation among the spacing and drip fertigation treatments. Enhanced solubilisation and increased extractability of iron and reduction of non-available higher oxidase forms to available form may account for its increased iron content. The results of the present study are in accordance with the findings of Dursun et al. (1999) in tomato and Demir et al. (1999) in cucumber.

All the drip fertigation treatments had significant influence on leaf Zn content. Among the different drip fertigation treatments, the leaf Zn content was maximum under wider spacing (M_1) with 37.07 ppm than under closer spacing (M_2). The leaf Zn content was minimum with 34.84 ppm at flowering stage (Table 3). Application of 125% recommended dose of fertilizers as water soluble fertilizer in combination with Azophosmet and humic acid (S_1) recorded the maximum leaf Zn content of 43.06 ppm, whereas the minimum leaf Zn content was registered in the treatment applied with 75% recommended dose of fertilizers as straight fertilizer with Azophosmet and humic acid (S_7) with values of 30.63 ppm at flowering stage. The maximum interaction effect was found in 125% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (M_1S_1) under wider spacing (45.55 ppm). The minimum interaction effect was found (29.99 ppm) in M_2S_7 in the closer spacing at flowering stage. The better photosynthetic efficiency coupled vegetative growth would have encouraged nutrient absorption of nutrients. It is in confirmation with the findings of More and Shinde (1991). The results may also be attributed to the 3 x 10^4 times increase in zinc solubility due to humic acid which contains fulvic acid and act as chelation of native zinc by chelating agent. Singaravel et al. (1998) opined that the beneficial influence of humic acid in soil would have prevented the formation of insoluble complexes of zinc and facilitated its uptake by plants. Similar findings were recorded by Chen et al. (2001) in cucumber and Virgine (2003) in tomato.

All the drip fertigation treatments had significant influence on leaf Mn content. Among the different drip fertigation treatments the leaf Mn content was higher under wider spacing (M_1) with 95.67 ppm than under closer spacing (M_2). The leaf Mn content was lower with 92.80 ppm at flowering stage. Application of 125% recommended dose of fertilizers as water soluble fertilizer in combination with Azophosmet and humic acid (S_1) recorded the maximum leaf Mn content of 100.33 ppm, whereas the minimum leaf Mn content was registered in the treatment applied with 75% recommended dose of fertilizers as straight fertilizer along with Azophosmet and humic acid (S_7) with values of 90.91 ppm at flowering stage. The interaction effect was found in 125% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (M_1S_1) which produced the maximum leaf Mn under wider spacing (102.81 ppm). The lower interaction effect, 89.84 ppm in (M_2S_7) was found under closer spacing at flowering stage.

All the drip fertigation treatments had significant influence on leaf Cu content. Among the spacings, the leaf Cu content was higher under wider spacing (M_1) with 18.75 ppm than under closer spacing (M_2). The leaf Cu content was lower with 17.53 ppm at vegetative stage. Application of 100% recommended dose of fertilizers as water soluble fertilizer in combination with Azophosmet and humic acid (S_2) recorded the maximum leaf Cu content of 20.67 ppm at vegetative stage. The minimum leaf Cu content was registered in the treatment, 75% recommended dose of fertilizers as straight fertilizer with Azophosmet and humic acid (S_7) with values of 16.79 ppm at vegetative stage. The maximum interaction effect was found in 100% recommended dose of fertilizers as water soluble fertilizer along with Azophosmet and humic acid (M_1S_2) under wider spacing (22.31 ppm). The minimum interaction effect was found (16.56 ppm) in M_2S_7 in the closer spacing at vegetative stage.

The results showed that wider spacing (M_1) exhibited higher leaf B content of 15.03 ppm than under closer spacing (M_2). The leaf B content was lower with 14.34 ppm at flowering stage. Significant differences were noticed in all the drip fertigation treatments and spacings. The treatment S_1 (125% recommended dose of fertilizers as water soluble fertilizer plus Azophosmet and humic acid) registered the maximum boron content of 16.10 ppm. The minimum leaf boron content was observed at S_7 (75% recommended dose of fertilizers as straight fertilizer with Azophosmet and humic acid) with 13.45 ppm at flowering stage. Considering the treatments and stage of growth, the treatment application of 125% recommended dose of fertilizers as water soluble fertilizer plus Azophosmet and humic acid under wider spacing (M_1S_1) recorded the maximum leaf boron content of 16.70 ppm at flowering stage. . The increased manganese and boron contents in the leaf might be due to the effect of higher level of nutrients availability which resulting in increased intake of micronutrients from soil (Samson and Visser, 1989). Similar findings were recorded by Adani et al. (1998) in tomato.

It can be concluded from the foregoing discussion that drip fertigation at higher percentage of recommended dose of fertilizer as water soluble fertilizer along with Azophosmet and humic acid was higher nutrient content in leaves at all the stages of crop growth under wider spacing (60 x 45 cm).

Abbreviations: RDF, Recommended dose of fertilizer; **DAS,** Days after sowing; **NPK,** Nitrogen, Phosphorus and Potassium; **SF,** Straight fertilizer; **WSF,** Water soluble fertilizer; **SSP,** Single super phosphate; **MAP,** Mono ammonium phosphate; **SPD,** Split plot design; **MOP,** Muriate of potash.

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