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Effect of fertigation and foliar application of boron on growth and yield of cucumber

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Abstract
Effect of fertigation and foliar application of boron on growth and yield of cucumber Cv. Himangi was studied during two consecutive years 2018-19 and 2019-20. The experiment was consisting of fifteen treatment combinations of recommended doses of water soluble fertilizers, comprising of five levels of fertigation *viz*. 100% RDF through soil, 120% RDF, 100% RDF, 80% RDF and 60% RDF through fertigation in ten equal splits at 10 days interval starting from 8 days after sprouting of seeds along with three levels of boron *viz*. 0.0, 0.1, 0.2 per cent concentration. The results showed that, most of the traits under study were significantly influenced by various fertigation and boron levels. On the basis of pooled data, it has been observed that, among various treatment combinations, maximum vine length (235.68 cm), number of fruits per vine (6.26), yield per vine (2.44 kg) yield (228.37) q/ha were obtained due to the application of 120% RDF through fertigation along with foliar application of boron at the concentration of 0.2 per cent. The vegetative and yield parameters obtained by cucumber vine showed statistically at par results when fertigated with 100% RDF through fertigation along with foliar application of 0.2% boron. The spraying were undertaken at 30, 45 and 60 days after sowing to cucumber crop Cv. 'Himangi'.

Keywords: Fertigation, Drip irrigation, Foliar spray, Boric acid

Introduction
India is blessed with diverse agro-climate zones with distinct seasons, making it possible to grow wide range of vegetables. Vegetables are good sources of nutrients, dietary fiber, phytochemicals and vitamins. Vegetables with shorter duration, higher productivity have resulted in greater economic returns to the farmers. Vegetables are reported to be rich source of carbohydrates, proteins, fats, vitamins and minerals Bose *et al.,* (2002) [5]. The cucumber is originated in India (South foot of Himalaya) or Burma, cultivated extensively in India, China, Iran, Turkey, Russia, Mexico, Ukraine, Uzbekistan, United State. The production of cucumber in 2017-18 was 1217 thousand metric tonnes on an area of 76 thousand hector in India. (Annon. 2018) [1].

Cucumbers help in eliminating uric acid, which is beneficial for those who have arthritis, and its fiber-rich skin and high levels of potassium and magnesium, which would helps in regulating blood pressure and also to promote nutrient functions. Annon. (2018) [1]. To increase the production by adopting new techniques in cultivation, the present investigation was carried out to study the effect of fertigation levels and foliar application of boron on growth and yield of cucumber, under drip fertigation method.

Fertigation has the potential to supply a right mixture of water and nutrients to the root zone and thus, meeting plants water and nutrient requirements in most efficient possible manner during a growing season. With drip fertigation, nutrient use efficiency is increased and the loss of nutrients to the ground water is reduced. Hence, a precise scheduling of irrigation and fertilizer applications is essential for sustainable production of any crop (Thenmozhi *et al.*, 2017) [10]. Besides that, the split fertilizer applications help to avoid salt damages to the crop and improves germination rate. Applying smaller amounts of fertilizers at shorter intervals reduce salt stress.

The importance of micronutrients has been realized during the past four decades, when widespread micronutrient deficiencies were observed in most of the soils in our country, where intensive agriculture is practiced (Rattan *et al.,* 2012) [7].

Boron in anthers, stigmas and ovaries may be twice as high in stems of plants (Sywortokin, 1958), suggesting its role in pollen formation and quality of flowers and fruits. In plants, boron is required in the structure of cell wall (Neil *et al*., 2004) and this function is attributed to role of boron in cross-linking of cell wall proteins. Boron also ensures good shoot growth, maintain leaf growth, improve calcium uptake and it also influences storage quality on cucumber.

Material and Methods

The experiment was laid out in Split Plot Design with main factor of fertilizer application consisting of F_1, F_2, F_3 F_4 and F_5 five levels of fertilizers and sub factor micronutrient as boron M_0, M_1, M_2 three levels of boron through boric acid along with three replications at Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *kharif* 2018-19 and 2019-20. The variety Himangi was tested in these experiments.

The recommended dose of fertilizer for the cucumber was 100:50:50 NPK kg/ha. There were fifteen treatment combinations under study, in which use of conventional method in which basal dose of 100:50:50 kg NPK was applied conventionally i.e. full dose of P_2O_5 and K_2O along with half dose of nitrogen was given at the time of sowing and remaining half dose of nitrogen after 30 days of sowing. Fertilizers through drip irrigation system, as well as foliar application of boron at different concentrations were undertaken for comparative performance of growth, yield and quality.

The soil was well drained, sandy loam texture with medium black soil. The seeds dibbled at 2m x1m in broad bed furrow with drip irrigation method. Drip irrigation was given at 50 mm CPE on the basis of climatological condition on alternate days. Doses of NPK through urea and 19:19:19 was applied in 10 equal splits at 10 days interval. Boric acid of 0.1% and 0.2% concentration were used for spraying at 30, 45 and 60 DAS. Observations were recorded in respect of growth parameters such as vine length and number of branches at 30, 60, 90 DAS and at last harvest of crop and yield and yield attributing characters, in two successive years i.e. 2018-19 and 2019-20 on same site with same randomization. The pooled analysis was worked out for all the characters/parameters with the help of methods suggested by Panse and Sukhatme (1985).

Result and Discussion

Growth attributes

Vine length

Result represented from the table 1 in pooled mean, revealed that, the maximum vegetative growth of the plant *viz*., significantly maximum vine length (235.68 cm) was observed by crop fertilized at the fertigation level of 120 per cent RDF through fertigation along with the foliar application of boron at the concentration level of 0.2 per cent (F_2M_2), and it was found at par with F_3M_2. Whereas, it was reported to be minimum (158.85 cm) fertilizers applied through traditional method along with no use of boron (F_1M_0).

Leaf area (cm^2)

Results depicted from the table 1 observed that, maximum vegetative growth of the plant *viz*., leaf area (467.68 cm^2), was observed by crop fertilized at the fertigation level of 120 per cent RDF through fertigation along with the foliar application of boron at the concentration level of 0.2 per cent significantly maximum (F_2M_2) and it was found at par with F_3M_2. While, it was noticed significantly minimum (387.88 cm^2), when the cucumber crop was fertilized conventionally along with no boron (F_1M_0).

Days required for appearance of first female flower

In pooled mean, the result in Table 1 opined that, minimum (38.13 days), days were required for appearance of first female flower was observed by crop fertilized at the fertigation level of 120 per cent RDF through fertigation along with the foliar application of boron at the concentration level of 0.2 per cent (F_2M_2). Whereas, the maximum (68.82 days) were needed.

It might be due to frequent and increased application of fertilizers directly in the vicinity of the root zone increases the availability and uptake of nutrients which lead to increase the cell size and cell elongation resulted in healthy and vigorous plant growth. These results were in accordance with Tekale *et al*. (2014) [9] in cucumber crop. The improvement in vegetative growth would be due to fact that, boron play a crucial role in regulating auxin concentration in vines that enhanced the absorption of essential elements by increasing the cation exchange capacity of roots. Similar findings were reported by Karthick *et al*. (2018) [6] in bitter gourd.

Yield of cucumber and contributing factors

Male: female sex ratio

From the table 2, in pooled mean data revealed that, minimum male female sex ratio (4.16) was obtained by the cucumber crop fertilized with the fertigation level of 120 per cent RDF along with the foliar application of boron at the concentration level of 0.2 per cent. (F_2M_2). While, significantly the maximum (12.01) male: female ratio of cucumber was obtained in treatment combination (F_1M_0).

Average fruit weight

The result in table 2 in pooled mean data, represent that, significantly the maximum average weight of fruit (239.88 g) was obtained by the cucumber crop fertilized with the fertigation level of 120 per cent RDF through fertigation along with the foliar application of boron at the concentration level of 0.2 per cent. (F_2M_2). Whereas, it was reported minimum (154.33 g), when the crop was fertilized and sprayed with (F_1M_0) treatment combination.

Fruit yield per vine

The result shown in table 3 depicted that, maximum fruit yield per vine (2.44 kg) was obtained by the cucumber crop fertilized at the fertigation level of 120 per cent RDF through fertigation along with the foliar application of boron at the concentration level of 0.2 per cent. (F_2M_2) and it was found statistically at par with F_3M_2. However, significantly the minimum yield per vine (1.03 kg) was observed with treatment combination F_1M_0 in which fertilizers was given with conventional method and no boron was applied as foliar form.

Fruit yield per hector

In table 3, the result in pooled mean data, depicted that, fruit yield per hector (228.37 q/ha) was obtained by the cucumber crop fertilized with the fertigation level of 120 per cent RDF along with the foliar application of boron at the concentration

level of 0.2 per cent. (F_2M_2) and found statistically at par with the F_3M_2. While, significantly the minimum (103.57 q/ha) fruit yield per ha was obtained with F_1M_0.

The enhanced supply of nutrients through increased fertigation level in the root vicinity of vine maintained optimum nutrients concentration in the root zone throughout the crop growth period simultaneously the foliar application of boron which increases the uptake of moisture and nutrients and resulted in increasing all the growth attributes of cucumber, also it increases the photosynthetic rate and absorbed photosynthetically active radiation and resulted in more translocation of photosynthates towards reproductive organ (sink), which increases the yield per ha of cucumber. Similar results are also reported by Sikarwar and Hardaha (2016) [8] in cucumber.

Economics

Gross monetary return (Rs./ha)

Data on gross monetary return as influenced by various treatments are given in table 4. The response of cucumber under different treatment combinations of fertilizers and foliar spray of boron was found to have significant effect for gross monetary return in cucumber. Gross monetary return (Rs.407898/ha), Net monetary return (Rs.270986/ha) and B:C ratio (2.99) were obtained by the cucumber crop fertilized at the fertigation level of 120 per cent RDF through fertigation along with the foliar application of boron at the concentration level of 0.2 per cent. (F_2M_2) and it was found statistically at par with the treatment combination (F_3M_2). While, the minimum GMR (Rs.94700/ha), NMR (Rs.25790/ha) and B:C ratio (1.29) was obtained in F_1M_0.

Table 1: Effects of fertilizers and foliar spray of boron on vine length (cm), leaf area at 60 DAS and appearance of first female flower (days) in cucumber (Pooled mean)

Fertilizers	Vine length (cm)			Means	Leaf area (cm)2			Means	Appearance of first female flower (days)			Means
	Foliar application of boron											
	M0	M1	M2		M0	M1	M2					
F1	158.85	164.25	172.95	165.35	387.88	395.30	398.58	393.92	68.82	59.51	51.01	59.78
F2	206.56	215.56	235.68	219.27	403.70	446.88	467.68	439.42	54.90	42.06	38.13	45.03
F3	205.39	214.06	234.34	217.93	402.65	445.18	466.95	438.26	56.23	43.39	38.80	46.14
F4	198.00	211.33	226.91	212.08	392.19	441.06	455.90	429.71	60.84	49.67	44.46	51.65
F5	195.50	206.63	219.13	207.09	390.62	418.03	425.35	411.34	61.40	56.68	49.71	55.93
Mean	192.86	202.36	217.80		395.41	429.29	442.89		60.44	50.26	44.42	
F' test			Sig				Sig				Sig	
SE(m)±			11.95				17.34				3.30	
CD at 5%			34.62				51.22				9.58	

Table 2: Effect of fertilizers and foliar spray of boron on male: female ratio, average fruit weight (g) in cucumber (Pooled mean)

	Male: female ratio				Average fruit weight (g)			
	Foliar application of boron							
Fertilizers	M0	M1	M2	Means	M0	M1	M2	Means
F1	12.01	8.28	6.40	8.90	154.33	170.45	183.42	169.40
F2	6.04	4.72	4.16	4.97	170.28	205.92	239.88	205.36
F3	6.63	5.03	4.33	5.33	169.15	204.87	238.85	204.29
F4	7.38	6.28	4.95	6.20	162.25	200.53	225.72	196.17
F5	10.59	7.15	5.22	7.65	157.58	182.94	218.83	186.45
Mean	8.53	6.29	5.01		162.71	192.94	221.34	
F' test			Sig				Sig	
SE(m)±			0.68				9.04	
CD at 5%			1.96				27.19	

Table 3: Effects of fertilizers and foliar spray of boron on fruit yield per vine (kg) and fruit yield per hector (q) in cucumber (Pooled mean)

	Fruit yield per vine (kg)				Fruit yield per hector (q)			
	Foliar application of boron							
Fertilizers	M0	M1	M2	Means	M0	M1	M2	Means
F1	1.03	1.52	1.93	1.49	103.57	162.50	170.50	145.52
F2	1.13	1.99	2.44	1.85	108.33	214.80	228.37	183.83
F3	1.11	1.70	2.43	1.75	109.03	214.13	225.70	182.96
F4	1.07	1.61	2.35	1.68	107.40	186.33	221.30	171.68
F5	1.04	1.53	2.27	1.61	104.90	171.67	208.10	161.56
Mean	1.07	1.67	2.28		106.64	189.88	210.79	
F' test			Sig				Sig	
SE(m)±			0.05				6.55	
CD at 5%			0.16				18.97	

Table 4: Effects of fertilizers and foliar application of boron on Gross monetary return, Net monetary return (Rs./ha) and B:C ratio in cucumber (Pooled mean)

	Gross monetary return (Rs. /ha)				Net monetary return (Rs. /ha)				B:C ratio			
	Foliar application of boron											
Fertilizers	**M0**	**M1**	**M2**	**Mean**	**M0**	**M1**	**M2**	**Mean**	**M0**	**M1**	**M2**	**Mean**
F1	94700	123000	147300	121667	25790	37184	48229	37067	1.29	1.43	1.49	1.40
F2	208700	319665	407898	312088	135418	209099	270986	205167	2.85	2.91	2.99	2.92
F3	199250	308365	396298	301304	129120	204651	266327	200033	2.83	2.86	2.89	2.86
F4	178817	266715	300131	248554	118374	187956	226337	177556	2.71	2.78	2.83	2.78
F5	159650	214165	240576	204797	113967	167923	205390	162426	2.65	2.72	2.79	2.72
Mean	168223	246382	298440		113967	167923	205390		2.46	2.54	2.60	
F' test			Sig				NS				-	
SE(m)±			15282.84				16574.22				-	
CD at 5%			44263.85				-					

Conclusion

From the above results, it could be concluded that, From the results obtained of pooled means of two years i.e. 2018-19 and 2019-20 data it could be concluded that, vegetative growth of cucumber *viz*. vine length, leaf area, days required for appearance of first female flower etc. was appeared best due to application of 120% RDF through fertigation along with 0.2% foliar application of boron and it was found statistically at par with the application of 100% RDF through fertigation along with 0.2% foliar application of boron (F_3M_2).

As far as the yield and yield contributing characters like Male: Female ratio, Av. weight of fruit, yield per vine and per ha were concerned, they were also expressed better performance due to application of 120% RDF through fertigation along with foliar use of boron @ 0.2% (F_2M_2) and found statistically at par results with (F_3M_2).

Finally, the treatment combination (F_2M_2) exhibits at par economical and statistical values with (F_3M_2) i.e. application of 100% RDF through fertigation along with 0.2% foliar application of boron for immediate benefit from the cucumber crop in present study.

These conclusions, are based on the results of only two successive years and hence needs more study for the confirmation.

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