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GROWTH, YIELD AND QUALITY OF CUCUMBER AS INFLUENCED BY FERTIGATION AND FOLIAR APPLICATION OF BORON

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ABSTRACT

The experiment was conducted to study the effect of fertigation and foliar application of boron on growth, yield and quality of cucumber Cv. Himangi 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 through boric acid viz. 0.0, 0.1, 0.2 per cent concentration. The spraying was undertaken at 30, 45 and 60 DAS to cucumber crop Cv. 'Himangi'. The results indicated 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), minimum days required for first female flower appearance (38.13 days) minimum male :female ratio (4.16) and maximum number of pickings (9.40), yield per vine (2.44 kg) yield (228.37 q/ha), maximum chlorophyll content (47.05 mg/g), fruit diameter (5.25 cm) and fruit length (16.30 cm) were obtained with the 120 % RDF through fertigation along with foliar application of boron at the concentration of 0.2 per cent. The vegetative growth, yield and quality parameters of cucumber were numerically higher when fertigated with 100 % RDF through fertigation along with foliar application of 0.2 % boron.

Keywords: cucumber, vine length, Himangi, fertigation, boron, foliar spray

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. There is a constant demand throughout the year for cucumber, especially the smooth skinned seedless fruit because of its popular use in salad dish, sandwich, pizza and other preparations (Bisht *et al*., 2011) and local market demands for specialized fruits. The precocity or earliness for fruit bearing and harvest is the desired characters for early summer production that fetches high price. Additionally, the cultivar may have high yield potential and good commercial quality that relates to consumers preference.

Therefore, before going for commercial cultivation of cucumber, it is imperative to assess the production potential based on growth, earliness, yield and quality for a particular location. Moreover, the commercial quality that relies on physical fruit appearance such as colour, form and size, texture and shelf life (Bertin and Genard, 2018) which determines consumers' acceptability of the hybrids in the local market. Therefore, a promising cultivar would be such that have a good compromise between fresh yield and commercial quality traits to satisfy the demands of local market with providing good returns to the farmers. Singh *et al*. (2012) have proposed that the cultivar selection to be based on certain parameters which include earliness, plant vigour, fruit yield and quality, besides consumers' preference for fruits in local market

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). 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). 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).

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 (Dell and Huang, 1997). Boron also ensures good shoot growth, maintain leaf growth, improve calcium uptake and it also influences storage quality on cucumber.

In view of the above issues and problems associated with the traditionally of fertilizer application and similarly to address the issue of boron deficiency in soil and plant, the experiment was conducted to study the effect of foliar spray of boron and fertigation on growth, yield and quality of cucumber Cv. Himangi.

Materials and Methods

The experiment was laid out in Split Plot Design with main factor of fertilizer application consisting of 100 % RDF through soil, 120 % RDF through fertigation, 100 % RDF through fertigation, 80 % RDF through fertigation and 60 % RDF through fertigation five levels of fertilizers and sub factor micronutrient as boron no foliar application of boron, 0.1 % concentration foliar spray of boron and 0.2 % concentration foliar spray of boron 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 N, P_2O_5 and K_2O kg^{-1}ha. There were fifteen treatment combinations under study, in which use of 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 DAS. 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 2 m x1 m 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. Nitrogen 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 first irrigation was given immediately after sowing of seeds. The beds were irrigated daily for 2 hours. Main line made of rigid PVC pipe having 2-inch diameter was connected to the well. The main line laterals made of LDPE having 16 mm internal diameter were connected at 2 m intervals in rows. Drippers were inbuilt in the main lateral at 0.5 m apart. From each dripper, the discharge rate was 4 liters per hour. After sowing, the crop was irrigated at four days interval in *Kharif.* Irrigation was given during morning hours. The pooled analysis was worked out for all the characters/parameters with the help of methods suggested by Panse and Sukhatme (1985).

Similar plant protection measures to control pests and diseases were followed in all the treatments. Plant growth and yield parameters were measured on five randomly selected plants from each treatment in each replication Fruit parameters such as fruit length, fruit girth and average fruit weight were measured during

peak harvest. The quality analyses of chlorophyll content of leaves of cucumber were performed on the selected sample leaf by chlorophyll meter. The mean data of each replication were subjected to analysis of variance in a Split Plot Design with three replications. Interaction effects for various characters were worked out and tested for significance.

Treatment details:

Factor A - Fertigation levels

1. F1: 100 % RDF through soil as a straight fertilizer (100:50:50 kg/ha)
2. F2: 120 % RDF through fertigation
3. F3: 100 % RDF through fertigation
4. F4: 80 % RDF through fertigation
5. F5: 60% RDF through fertigation

Application of F1 i.e. 50 % N and full P_2O_5 and K_2O was applied at the time of sowing and remaining 50 % N 30 days after first application and F2, F3, F4, and F5 dose of NPK was applied in 10 equal splits.

Factor B – Micronutrient levels

1. M1 : 0.1 % concentration of boric acid
2. M2 : 0.2 % concentration of boric acid
3. M0 : 0.0 % concentration of boric acid

Boric acid of 0.1% and 0.2% concentration was used for spraying at 30, 45 and 60 DAS.

Results and Discussion

Vine length

There was a significant variation for different plant growth parameters among the fertilizers levels and foliar spray of boron. The maximum vegetative growth of the plant viz., significantly maximum vine length (236 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 and it was found at par with the treatment combination 100 % RDF through fertigation along with 0.2 % concentration of foliar spray of boron. (Table 1) Whereas, it was reported to be minimum (159 cm) fertilizers applied through traditional method along with no use of boron. Due to improvement in availability and uptake of mineral nutrients in the root zone.

Leaf area

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 and it was found at par with the treatment combination application of 100 % RDF through fertigation with 0.2 % concentration of foliar spray of boron. While, it was noticed significantly minimum (387.88 cm^2), when the cucumber crop was fertilized conventionally along with no boron.

These results are in confirmity with those obtained by Suresh and Pappiah (1991) in Bitter gourd and Agba and Enya (2006) in cucumber. Vegetative growth such as vine length and leaf area of cucumber plant have been influenced by application of fertilizers and foliar spray of boron might improved the availability and uptake of other macronutrients from soil. Similar thoughts had been reported by Bommesh *et al*. (2016) in cucumber.

Days required for appearance of first female flower

The 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. Whereas, the maximum (68.82 days) were needed.

Due to higher levels of fertilizers and boron levels might attributed to fast growth of vine which favours flower forming harmone by inducing production of more female flowers. These results were in accordance with Tekale *et al*. (2014) 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) in bitter gourd.

Yield and yield attributing parameters

Male : female sex ratio

The 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. (Table 2) While, significantly the maximum (12.01) male : female ratio of cucumber was obtained in treatment combination 100 % RDF through soil with water spray.

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. (Table 2) Whereas, it was reported minimum (154.33 g), when the crop was fertilized with 100 % RDF through soil

and sprayed with water spray. The positive interaction between irrigation, fertilizers and boron levels on enhancing the average fruit weight.

Significantly the maximum number of pickings (9.40) 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. (Table 3) Whereas, it was reported minimum (7.64), when the crop was fertilized with 100 % RDF through soil and sprayed with water. Increased fertilizer and boron levels produced maximum number of harvest might be due to more availability of nutrients to the plant which ultimately resulted in maximum number of pickings.

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 and it was found statistically at par with 100 % RDF through fertigation with 0.2 % concentration of foliar spray of boron.(Table 4) However, significantly the minimum yield per vine (1.03 kg) was observed with treatment combination 100 % RDF through soil with water spray in which fertilizers was given with conventional method and no boron was applied as foliar form. A balanced nutrition is utmost necessary to build up sufficient food material within the plant before entering into reproductive phase.

Fruit yield per hector (228.37 q) 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 and found statistically at par with the 100 % RDF through fertigation with 0.2% concentration of foliar spray of boron (Table 4). While, significantly the minimum (103.57 q) fruit yield per hector was obtained with the treatment combination 100 % RDF through soil with water spray. Increased yield could be largely attributed to the improvement in soil nutrients status due to application of macro and micronutrient which resulted in increase in yield. Similar results are also reported by Sikarwar and Hardaha (2016) in cucumber.

Significantly the maximum (5.25 cm) fruit diameter of cucumber was observed in 120 % RDF through fertigation and the foliar application of 0.2 % boron. It was at par with the application of 100 % RDF through fertigation and the foliar spray of 0.2 % boron. Minimum (4.11 cm) fruit diameter of cucumber was observed in the 100 % RDF through soil and foliar spray of water.

More the use of macro nutrients as well as boron at flowering stage of cucumber more will be the availability of micronutrients and ultimately resulted in production of fruits with higher diameter. The results obtained in the present investigation are in close agreement with the findings of earlier workers Bommesh *et al*. (2016) in cucumber.

Significantly the maximum (16.30 cm) fruit length of cucumber was observed in 120 % RDF through fertigation and the foliar application of 0.2 % boron. It was at par with the application of 100 % RDF through fertigation and foliar spray of 0.2 % boron (15.77 cm). Minimum (7.13 cm) fruit length of cucumber was observed in the 100 % RDF through soil and foliar spray of water.

Maximum fruit length of cucumber might be due to the better mineral utilization of plant accompanied with enhancement of photosynthesis, other metabolic activity and greater diversion of food material to fruits. Similar findings had reported by Dursun *et al*. (2010) in cucumber and Patil *et al.* (2013) in bitter gourd.

Quality parameters of cucumber

Chlorophyll content of leaves

Significantly the maximum (47.05 mg/g respectively) chlorophyll content in leaves of cucumber was observed in 120 % RDF through fertigation and the foliar application of 0.2 % boron. It was at par with the application of 100 % RDF through fertigation and foliar spray of 0.2 % boron. (Table 5) Minimum (18.87 mg/g) chlorophyll content in leaves of cucumber crop was observed in the 100 % RDF through soil and foliar spray of water. It leads to increases photosynthetic process in plant and ultimately reflected into increased chlorophyll content in cucumber leaves. The results obtained in the present investigation are in close agreement with the findings of Um *et al.* (1994) and Papadopoulos (1992) in cucumber.

Conclusions

From the study it can be concluded that, vegetative growth of cucumber viz. vine length, leaf area, days required for appearance of first female flower etc. were appeared best due to application of 120 % RDF through fertigation along with 0.2 % foliar application of boron. The yield contributing characters like days required for first Male : female sex ratio, number of pickings, average weight of fruit, yield per vine and per hector and quality parameters of cucumber such as chlorophyll content in leaves, fruit diameter, fruit length were concerned, they were also expressed better performance due to application of 120 % RDF through fertigation along with foliar use of boron @ 0.2 %.

Table 1: Effects of fertilizers and foliar spray of boron on vine attributes in cucumber

Fertilizers	Vine length (cm)			Means	Leaf area (cm)^2			Means
	Levels of 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
F2	206.56	215.56	235.68	**219.27**	403.70	446.88	467.68	439.42
F3	205.39	214.06	234.34	**217.93**	402.65	445.18	466.95	438.26
F4	198.00	211.33	226.91	**212.08**	392.19	441.06	455.90	429.71
F5	195.50	206.63	219.13	**207.09**	390.62	418.03	425.35	411.34
Mean	**192.86**	**202.36**	**217.80**		395.41	429.29	442.89	
F' test			Sig				Sig	
SE(m)±			11.95				17.34	
CD at 5 %			34.62				51.22	

Note: F_1-100% RDF through soil application, F_2: 120 % RDF through fertigation, F_3: 100 % RDF through fertigation , F_4: 80 % RDF through fertigation, F_5: 60 % RDF through fertigation.

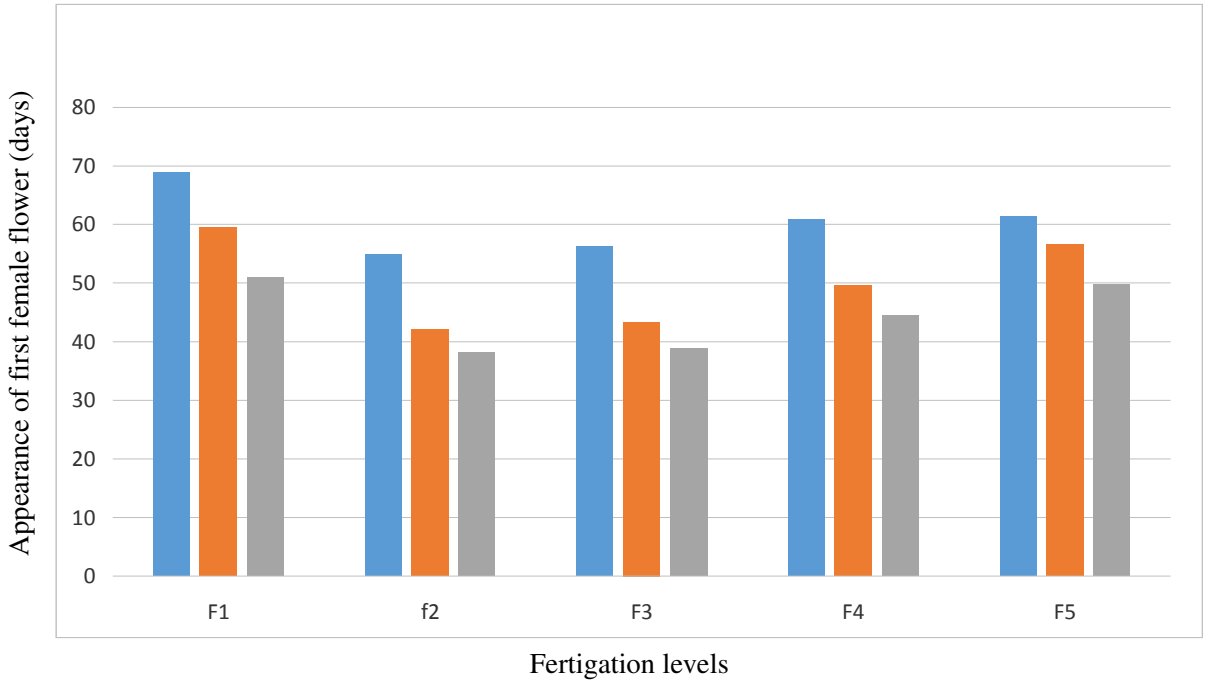

Fig. 1: Effect of fertigation and foliar application of boron on appearance of first female flower in cucumber (days)

Note: M_0: No foliar application of boron, M_1: 0.1 % foliar application of boron, M_2: 0.2 % foliar application of boron.

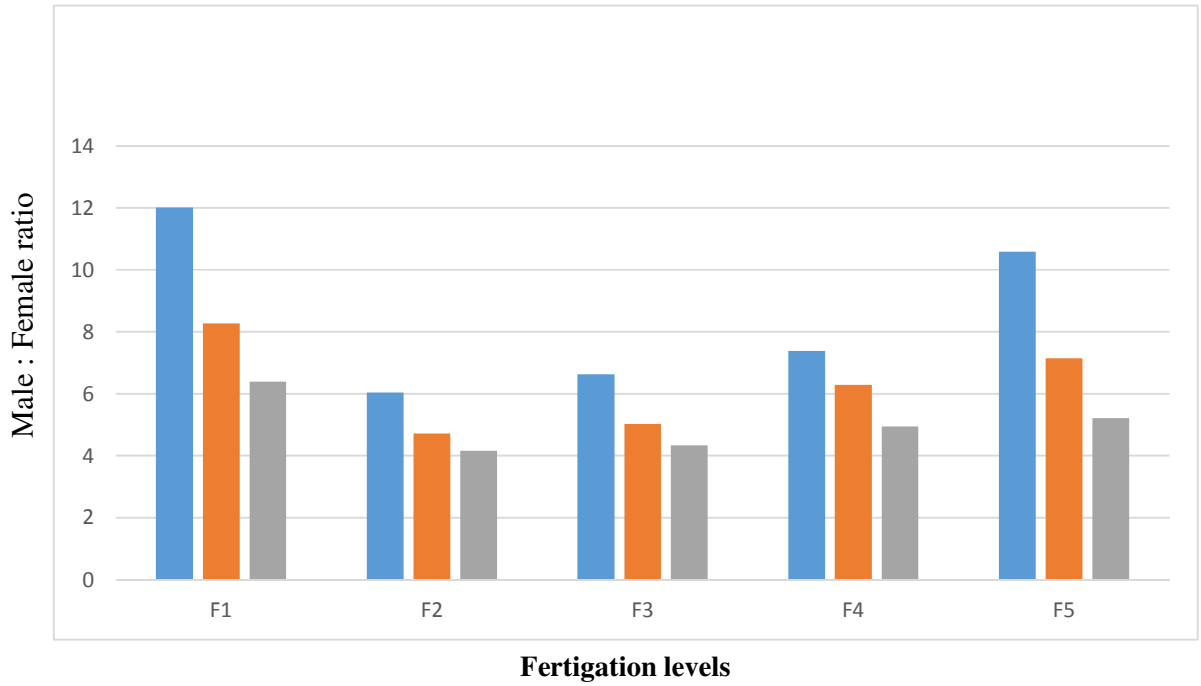

Fig. 2: Effect of fertigation and foliar application of boron on male: female ratio in cucumber

Table 2: Effect of fertilizers and foliar spray of boron on average fruit weight and number of pickings in cucumber

	Average fruit weight (g)				Number of pickings			
	Levels of foliar application of boron							
Fertilizers	**M0**	**M1**	**M2**	**Means**	**M0**	**M1**	**M2**	**Means**
F1	154.33	170.45	183.42	**169.40**	7.64	8.16	9.06	**8.29**
F2	170.28	205.92	239.88	**205.36**	8.09	8.38	9.40	**8.62**
F3	169.15	204.87	238.85	**204.29**	8.09	8.37	9.39	**8.60**
F4	162.25	200.53	225.72	**196.17**	7.87	8.46	9.28	**8.54**
F5	157.58	182.94	218.83	**186.45**	7.82	8.42	9.14	**8.46**
Mean	**162.71**	**192.94**	**221.34**		**7.90**	**8.36**	**9.25**	
F' test			Sig				Sig	
SE(m)±			9.04				0.40	
CD at 5 %			27.19				1.17	

Table 3: Effects of fertilizers and foliar spray of boron on fruit yield per vine and fruit yield per hector in cucumber

	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 chlorophyll content in leaves, fruit diameter and fruit length in cucumber

Fertilizers	Chlorophyll content in leaves (mg/g)				Fruit diameter (cm)				Fruit length (cm)			
	Foliar spray of boron											
	M0	M1	M2	Means	M0	M1	M2	Means	M0	M1	M2	Means
F1	18.87	24.70	27.90	**23.82**	4.11	4.29	4.68	**4.36**	7.13	8.77	9.65	**8.52**
F2	33.37	43.10	47.05	**41.17**	5.00	5.20	5.25	**5.15**	13.23	15.85	16.30	**15.13**
F3	32.20	42.10	46.05	**40.12**	4.98	5.17	5.24	**5.13**	12.73	15.28	15.77	**14.59**
F4	26.82	36.90	42.08	**35.27**	4.87	5.08	5.12	**5.02**	10.48	13.13	14.52	**12.71**
F5	21.93	30.57	36.92	**29.81**	4.80	4.97	5.02	**4.93**	8.67	10.55	12.43	**10.55**
Means	**26.64**	**35.47**	**40.00**		**4.75**	**4.94**	**5.06**		**10.45**	**12.72**	**13.73**	
F' test			**Sig**				**Sig**				**Sig**	
SE(m)±			2.33				0.29				0.78	
CD at 5 %			6.76				0.87				2.34	

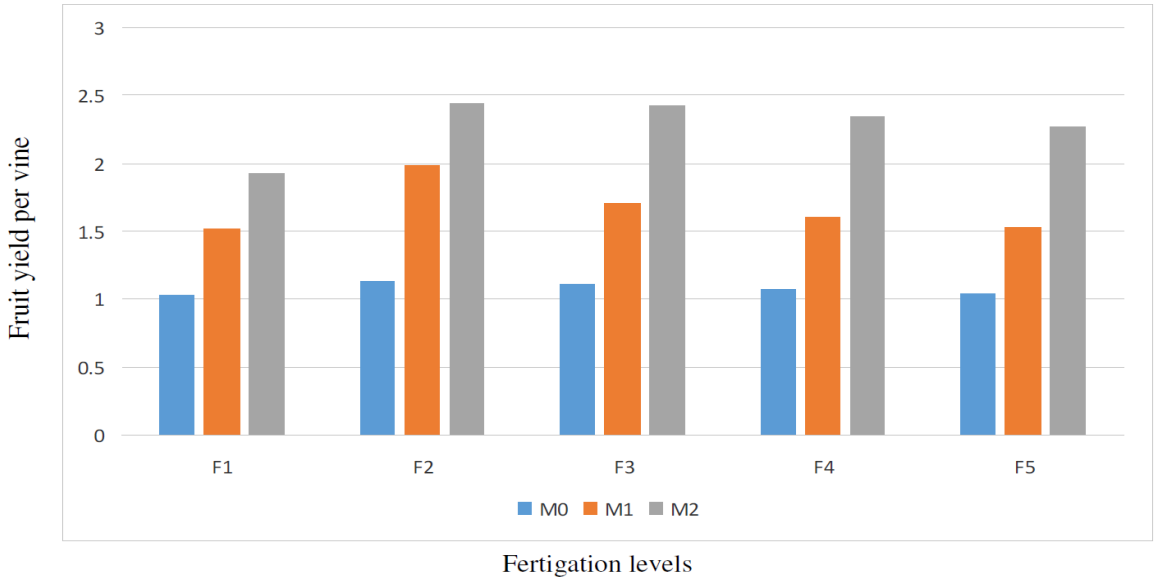

Fig. 3: Effect of fertigation and foliar application of boron on fruit yield per vine in cucumber

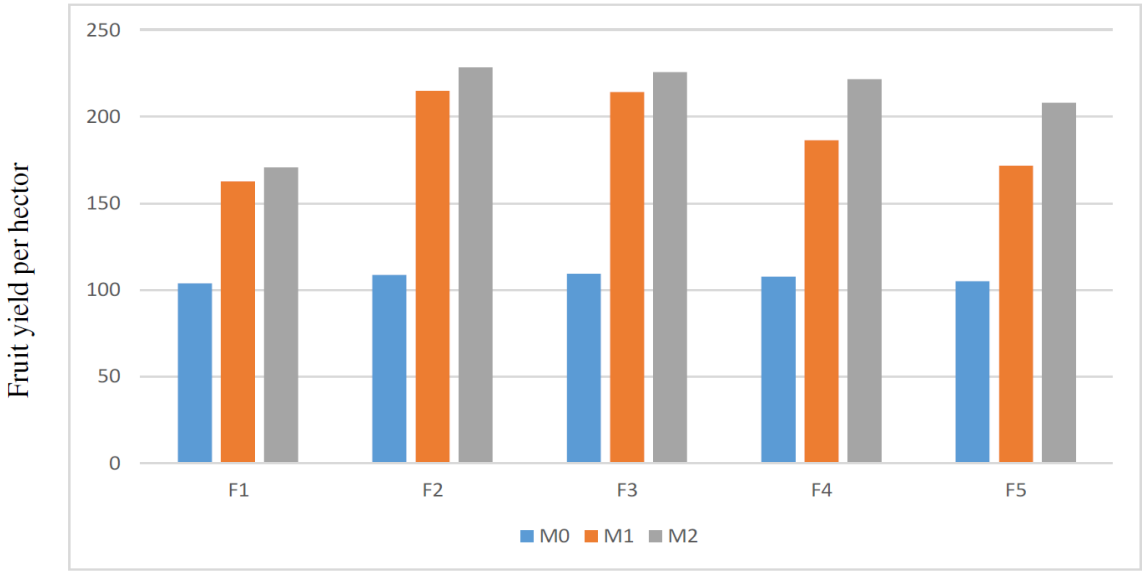

Fig. 4: Effect of fertigation and foliar application of boron on fruit yield per hector in cucumber

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