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(RESEARCH ARTICLE)

Effect of fertigation and foliar application of boron on uptake and nutrient use efficiency and B:C ratio by cucumber

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Abstract

The effect of fertigation and foliar application of boron on yield, uptake of nutrients by cucumber Cv. Himangi was studied during two consecutive years 2018-19 and 2019-20. An experiment was carried out in open field conditions with five fertigation levels viz., 100 % RDF through soil, 120 %, 100 %, 80 % and 60 % RDF through fertigation in ten equal splits at 10 days interval along with three levels of foliar application of boron viz. 0.0, 0.1, and 0.2 per cent concentration at 30, 45 and 60 DAS to determine suitable fertigation and foliar spray of boron dose for cucumber cultivation. The experiment was consisting of fifteen treatment combinations of recommended doses of water-soluble fertilizers, comprising of five levels of fertigation. The results indicated that, yield, nutrient uptake of nitrogen, phosphorus and potassium under study were significantly influenced by various fertigation and boron levels. On the basis of pooled data, it was observed that, among various treatment combinations, the nitrogen, phosphorus and potassium by cucumber shoot and fruit was increased significantly with the application of 120 % RDF through fertigation. The B:C ratio and GMR are highest with the application of 120 % RDF through fertigation. The use efficiency of N, P and K was higher with the optimum level of NPK i.e. 60 % RDF through fertigation. The foliar application of boron at 0.2 % concentration resulted improvement in uptake of N, P and K and use efficiency of nutrients.

Keywords: Fertigation; Drip Irrigation; Foliar Spray; Boric Acid; Uptake of NPK Nutrients; Nutrient Use Efficiency; B:C Ratio

1. Introduction

Vegetable production in Indian Agriculture has wider scope for increasing the income of marginal and small farmers. Vegetables have vast potential in gaining foreign exchange through export. The vegetable growers are looking for new ways to achieve superior quality produce with higher yield. Among the vegetables, cucumber is a crop of commercial importance. As yield potential increases the need for nutrients also increases.

The challenge for agriculture over the coming decades will be to use the plant nutrients in a sustainable way. Sustainability of any system requires optimal utilization of resources such as water, fertilizer and soil. Fertilizer management is the most important agro-technique, which controls development, yield and quality of a crop. Every attempt is therefore necessary, in achieving this objective of higher water and uptake of nutrients. Under these circumstances, drip fertigation, which is known to be hi-tech and efficient way of applying fertilizers through irrigation

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system as a carrier and distributor of crop nutrients (Magen, 1995). Maximization of crop yield, quality and minimization of leaching loss of nutrients below the rooting zone could be achieved by managing fertilizer concentration in measured quantities of irrigation water using drip irrigation (Hagin and Lowengart, 1995). Fertigation is supplying fertilizers along with irrigation is one of the most effective convenient methods of supplying nutrients of water according to the specific requirements of the crop to maintain optimum soil fertility and to increase the quality of the produce (Shingure *et al*., 1999). Also, it ensures application of the fertilizers directly to the plant roots (Rajput and Patel, 2002). Boron is involved in the reproduction of plants and germination of pollen. Boron is associated with the pollen producing capacity of anther, viability of pollen tubes, pollen germination and growth of pollen tube. Boron ensures good shoot growth, maintain leaf growth, improve calcium uptake. Boron increases nectar production in flowers which attracts pollinating insects (Kumar *et al.,* 2014).

Even when there is no leaching of nitrate beyond the depth of rooting. The amount of nitrate recovered as nitrogen in the storage roots and leaves of the crop is always less than the loss of nitrate from the soil. Partly this apparent loss results from incorporation of NO_3-N into the fibrous roots and partly from microbial activity associated with root activity. It is generally assumed that uptake is a constant fraction of loss of N from the soil over wide range of levels and that N uptake by the crop increases approximately linearly with the total amount of mineral N in soil (to the depth of rooting) until a maximum uptake is reached which then remain constant with further increase in fertilizer N. Asyling and Hansen 1985; Addiscott and Whtemore 1987).

We need a new and effective technology which can improve continuously the productivity, profitability, sustainability of our major farming systems. Growing plants under cover improves the quality of their produce. This is helpful in getting higher price that becomes remunerative to the grower. It is also possible to make the produce available in the market, when it is in great demand, provided the grower. (Mangal et al.,2017).

Economic analysis permits to identify the strength and weakneses of technical and economic results, to take immediate and decisive action, at any time and to solve the problem affecting the agricultural activity, helping the grower to manage and use the available resources more efficiently, favoring their maximization and increasing the level of the production system with a simultaneous reduction in costs. Thus, an economics analysis of cucumber was carried out with the aim of increasing the grower's profitability (Naik et al. 2013).

The current problem with large scale cultivation of cucumber is that unreasonable water and fertilizer management system (high fertilizer application and inefficient irrigation) not only caused unnecessary waste of water and fertilizer resources, but also led to shallow groundwater nitrate pollution and other environmental problems. The present study was conducted to determine suitable dose of fertigation and foliar spray of boron for cucumber cultivation.

2. Material and methods

The experiment was laid out in Split Plot Design with main factor of fertilizer application consisting of five levels of fertilizers and sub factor micronutrient along with three levels of boron through boric acid and three replications at Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during *kharif* 2018-19 and 2019-20.

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 uptake of nutrients by various parts of cucumber shoot, fruit and whole vine. The soil was well drained, sandy loam texture with medium black soil. The initial soil always indicated that, available N, P_2O_5 and K_2O 146, 14.72 and 317 kg/ha, respectively.

The seeds were dibbled at 2m x 1m 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 was used for spraying at 30, 45 and 60 DAS and in drip on the basis of climatological condition on alternate days.

Full dose of P_2O_5 and K_2O was applied at 15 DAS and remaining 50 % nitrogen was applied 30 days after first application. 120 %, 100 %, 80 %, and 60 % RDF through fertigation levels of NPK was applied in 10 equal splits at 10 days interval. Boron through 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 yield, uptake of nutrients such as nitrogen, phosphorus and potassium by shoot, fruit and

whole cucumber vine and nutrient use efficiency in two successive years i.e. 2018-19 and 2019-20 on same site with same randomizations.

The liquid fertilizer (19:19:19 and urea) was applied by mixing them in Ventury and it was connected to the drip irrigation system as per the treatment. Observations were recorded in respect to yield, nutrient uptake by shoot, fruit and total cucumber vine and nutrient use efficiency. Similarly, plant analysis was also undertaken to know the nutrient content of the cucumber plant.

For this purpose, leaf samples from 5th active leaf from the top of shoot were taken at 80 days after sowing. Along with these, cutting from stem were taken. These samples were combined and representative samples were taken randomly, which was further dried powdered and used to prepare plant extract for estimation of nutrients. Statistical analysis of the data was performed using a Split Plot Design with three replications (Panse and Sukhatme, 1985). Nutrient uptake and nutrient use efficiency of each treatment was computed using the following equations:

Nutrient uptake (kg/ha) = nutrient content (%) x dry wt/yield (kg/ha)

Nutrient use efficiency (%) = uptake of nutrient in RDF (kg/ha) minus uptake of nutrient (kg/ha) in control / nutrient applied (kg/ha) x 100

3. Results and discussion

3.1. Uptake of nutrient by cucumber

3.1.1. Uptake of nitrogen by various parts of cucumber vine (kg/ha)

Significantly the maximum uptake of nitrogen (13.03 kg/ha) by shoot, (81.62 kg/ha) by fruit and (94.01 kg/ha) by whole cucumber vine were noted through the application of 120 % RDF through fertigation and it was at par with 100 % RDF through fertigation. However, the minimum uptake of nitrogen (10.33 kg/ha) by shoot, (51.74 kg/ha) by fruit and (38.29 kg/ha) by whole cucumber vine were observed in the 100 % RDF through soil.

Significantly the maximum (14.45 kg/ha) uptake of nitrogen by shoot, (79.22 kg/ha) by fruit and (89.05 kg/ha) by whole cucumber vine were noted in the foliar application of 0.2 % boron. However, the minimum (8.50 kg/ha) uptake of nitrogen by shoot (60.11 kg/ha) by fruit and (75.51 kg/ha) by whole cucumber vine were obtained in the foliar spray of water.

3.1.2. Uptake of phosphorus by various parts of cucumber vine (kg/ha)

Significantly the maximum (3.62 kg/ha) uptake of phosphorus by shoot, (21.52 kg/ha) by fruit and (25.13 kg/ha) by whole vine of cucumber crop were noted in plant received 120 % RDF through fertigation and it was at par by (3.61 kg/ha) by shoot, (20.49 kg/ha) by fruit and (24.10 kg/ha) by whole vine of cucumber crop with 100 % RDF through fertigation. However, the minimum uptake of phosphorus (2.88 kg/ha) by shoot, (8.98 kg/ha) by fruit and (11.86 kg/ha) by whole vine of cucumber were observed in the 100 % RDF through soil.

The maximum uptake of phosphorus (3.65 kg/ha) by shoot, (20.33 kg/ha) by fruit and (23.98 kg/ha) by whole cucumber vine were observed in treatment consisting of spray of 0.2 % boron. However, the minimum (3.13 kg/ha) uptake of phosphorus by shoot, (11.54 kg/ha) by fruit and (14.67 kg/ha) by the cucumber plant were recorded in the foliar spray of water.

3.1.3. Uptake of potassium by various parts of cucumber vine (kg/ha)

Significantly the maximum uptake of potassium (14.05 kg/ha) by shoot, (101.45 kg/ha) by fruit and (115.50 kg/ha) by whole cucumber plant were noted 120 % RDF through fertigation and it was at par by (13.53 kg/ha) by shoot, (100.46 kg/ha) by fruit and (113.99 kg/ha) by cucumber vine with 100 % RDF through fertigation -(Table 5). However, the minimum (9.32 kg/ha) uptake of potassium by shoot, (70.50 kg/ha) by fruit and (79.82 kg/ha) by cucumber vine were observed in the treatment wherein 100 % RDF through soil was supplied.

The maximum (15.30 kg/ha) uptake of potassium by shoot, (100.20 kg/ha) by fruit and (115.50 kg/ha) by cucumber vine with application of foliar spray of 0.2 % boron. However, the minimum (8.26 kg/ha) uptake of potassium by shoot, (69.96 kg/ha) by fruit and (78.21 kg/ha) by whole cucumber plant were recorded in the foliar spray of water.

Uptake of nitrogen, phosphorus and potassium by various parts of cucumber vine as influenced by drip fertigation and foliar spray of boron were in conformity with the findings of Okonwn *et al*. (2012) in pumpkin, Bhosale *et al.* (2017) in watermelon, Sanap *et al.* (2010) in bitter gourd and Sadia *et al.* (2017) in cucumber.

3.1.4. Nutrient use efficiency

The application of 120 % RDF through fertigation was recorded the minimum (27.73 and 25.71 %, respectively) nutrient use efficiency of nitrogen, (17.2 and 16.85 %, respectively) phosphorus and (55.28 and 50.28 %, respectively) potassium by cucumber, respectively during 2018-19 and 2019-20. Significantly the maximum (36.70 and 34.70 %, respectively) nutrient use efficiency of nitrogen, (25.38 and 21.90 %, respectively) phosphorus and (65.81 and 63.43 %, respectively) potassium were recorded with the application of 60 % RDF through fertigation.

The foliar application of 0.2 % boron was recorded the maximum (22.59 and 20.61 %, respectively) nutrient use efficiency of nitrogen, (6.99 and 7.70 %, respectively) phosphorus and (27.30 and 30.47 %, respectively) potassium by cucumber. Whereas, the use of foliar spray of water was recorded the minimum (3.60 and 3.44 %, respectively) nutrient use efficiency of nitrogen, (0.56 and 0.52 %, respectively) phosphorus and (3.72 and 4.05 %, respectively) potassium by cucumber, respectively during the years 2018-19 and 2019-20 due to directly foliar spray on leaf, bark, stem and losses not occurred through leaching, devolatization.

More application of nutrient in soil might have maximum loss of it through leaching, devoltilization and consequently, it reflects in less nutrient use efficiency in the present study indicating optimum levels of nutrient efficiency taken up by plants especially nitogen, phosphorus and potassium. Nutrient use efficiency of nitrogen, phosphorus and potassium by cucumber crop was influenced the maximum by the foliar spray of boron during both the years of experimentation.

Nutrient use efficiency of nitrogen, phosphorus and potassium increased approximately linearly with the increase in concentration of spray of boron. More the application of micro-nutrient spray directly on leaves, stomata, bark or the succulent plant like cucumber, its absorption has been increased comparatively more as per the requirement of cucumber crop than its lower concentration and naturally it increases nutrient use efficiency. Duncan *et al.* (1989).

3.1.5. Cost economics

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 and it was found statistically at par with the treatment combination with the application of 100 % RDF through fertigation with 0.2 % foliar spray of boron. While, the minimum GMR (Rs.94700/ha), NMR (Rs.25790/ha) and B:C ratio (1.29) was obtained in the treatment combination 100 % RDF through soil with water spray.

Table 1 Influence of drip fertigation and foliar spray of boron on nutrient uptake of NPK by shoot, fruit and whole cucumber vine per hector (Kg/ha) pooled mean

Treatments	**Nutrient uptake (kg/ha)**								
	Nitrogen			**Phosphorus**			**Potassium**		
	Shoots of cucumber	**Fruits of cucumber**	**Total vine**	**Shoots of cucumber**	**Fruits of cucumber**	**Total vine**	**Shoots of cucumber**	**Fruits of cucumber**	**Total vine**
Fertilizers (F)									
F1: 100 % RDF through soil	10.33	51.74	38.29	2.88	8.98	11.86	9.32	70.50	79.82
F2: 120 % RDF through fertigation	13.03	81.62	94.01	3.62	21.52	25.13	14.05	101.45	115.20
F3: 100 % RDF through fertigation	13.01	80.62	93.00	3.61	20.49	24.10	13.53	100.46	113.99
F4: 80 % RDF through fertigation	11.76	74.53	89.91	3.44	15.04	18.48	12.00	86.05	98.04
F5: 60% RDF through fertigation	11.16	71.09	83.46	3.37	12.09	15.46	10.34	76.44	86.78
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.35	2.52	2.75	0.10	0.75	0.81	0.46	3.43	3.46
CD at 5%	1.02	7.30	7.97	0.29	2.17	2.35	1.33	9.94	10.02
Micronutrient (M)									
M0: water spray	8.50	60.11	75.51	3.13	11.54	14.67	8.26	69.96	78.21
M1: foliar spray of boron 0.1 %	12.62	76.44	68.61	3.37	15.00	18.37	11.98	90.78	102.77
M2: foliar spray of boron 0.2 %	14.45	79.22	89.05	3.65	20.33	23.98	15.30	100.20	115.50
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m) ±	0.27	1.95	2.13	0.08	0.58	0.63	0.36	2.66	2.68
CD at 5%	0.79	5.65	6.18	0.23	1.68	1.82	1.03	7.70	7.76
Interaction (F X M)									
'F' test	NS	NS	NS	NS	NS	NS	NS	NS	NS
SE(m) ±	0.61	4.36	4.77	0.18	1.30	1.41	0.80	5.94	5.99
CD at 5%	-	-	-	-	-	-	-	-	-

Table 2 Effect of fertigation levels and foliar spray of boron on nutrient use efficiency

Treatments	Nutrient use efficiency (%)					
	Nitrogen		Phosphorus		Potassium	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Fertilizers (F)						
F1- 100 % RDF through soil as a straight fertilizer	-	-	-	-	-	-
F2- 120 % RDF through fertigation	27.73	25.71	17.2	16.85	55.28	50.28
F3- 100 % RDF through fertigation	31.34	29.31	19.45	18.38	62.23	54.18
F4- 80 % RDF through fertigation	32.31	30.34	22.85	19.45	64.18	59.15
F5- 60 % RDF through fertigation	36.70	34.70	25.38	21.90	65.81	63.43
Micronutrient (M)						
M0- water spray	-	-	-	-	-	-
M1- foliar spray of boron 0.1 %	3.60	3.44	0.56	0.52	3.72	4.05
M2- foliar spray of boron 0.2 %	22.59	20.61	6.99	7.70	27.30	30.47

Table 3 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)

	Foliar application of boron											
	Gross monetary return (Rs. /ha)				Net monetary return (Rs. /ha)				B:C ratio			
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				-					

4. Conclusion

From the present investigation, it could be concluded that, the response of highest dose of fertilizers through fertigation and application of foliar spray of boron exhibited significantly maximum uptake of nitrogen, phosphorus and potassium. Among all the treatments combination under study, application of 120 % RDF through fertigation with ten equal splits upto 110 days of growing period of cucumber crop along with foliar spray of 0.2 % concentration of boron gave better results in terms of uptake parameters of cucumber crop. However, the application of 100 % RDF through fertigation with ten equal splits up to 110 days of growing period in cucumber along with 0.2 % concentration of boron also found equally beneficial results in obtaining maximum uptake of nutrients.

Furthermore, the maximum nutrient uptake in respect of nitrogen, phosphorus and potassium by shoot, fruit and whole vine of cucumber were obtained with the application of 120 % RDF through fertigation at ten equal splits. Similar findings were found with foliar application of boron at the concentration of 0.2 % on cucumber crop.

The minimum nitrogen, phosphorus and potassium use efficiency were obtained with the application of 120 % RDF through fertigation along with foliar application of boron at the concentration of 0.1 % in the present investigation.

Compliance with ethical standards

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References

[1] Addiscott, T.M. and Whitemore, A.P. 1987: Computer simulation of changes in soil mineral nitrogen and crop nitrogen during autumn, winter and spring. J.Agric. Sci. Camb., 109, 141-157.

[2] Asyling, H.C. and Hansen, S. 1985: Radiation, water and nitrogen balance in crop production. In field experiments and Simulation models WATCROS and NITCROS, Royal Veterinary and Agricultural University, Copenhagen.

[3] Bhosale, A.R., Puranik, U.Y. Kapse, V.D., Dodake, S.B., Kasture, M.C., Gangavane, S.B.2017. Effect of graded levels of nitrogen and potassium on yield and nutrient content of watermelon in lateritic soils of Konkan. Int. J. of Chemical studies. 5(2): 467-470.

[4] Dursun atilla, Metin Turan,Melek Ekinci, Adem Gunes, Nizamettin Ataoglu, Aslihan Esringu and Ertan Yildirim. 2010. Effect of boron fertilizers on tomato, pepper and cucumber yields and chemical composition. J. of Communication in Soil Science and Plant Analysis. Vol. 40, (13) pp: 1576-1593.

[5] Hagin, J. and A. Lowengart (1995). Fertigation for minimizing environmental pollution by fertilizers. FertilizerResearch, 43((1). pp 127-130.

[6] Magen, H. (1995). Fertigation: An overview of some practical aspects. Fert. News, 40 (12), pp.97-100.

[7] Panse, V.G. and P.V. Sukhatme, 1985. Statistical Method for Agricultural Workers. Indian Council of Agril. Res., New Delhi.

[8] Patil, M.P. Gadge, S.B. and S.D. Gorantiwar (2017). Economics of cucumber grown under shade net house with different fertigation levels International J. Agric. Engg; 10(1): 1-9.

[9] Rajput, T.B.S.and Neelam Patel (2002). Yield response of okra to different levels of fertigation. Annals of Agricultural Research, 23(1) pp 164-165.

[10] Shirgure, P.S. Lallan Ram, R.A. Marathe and R.P.Yadav.(1999). Effect of nitrogen fertigation on vegetative growth and leaf nutrient content of acid lime in central India. Indian J. Soil Conservation, 27(1),pp. 45-49.

[11] Kumar, C., A.K. Gupta and S.P. Uniyal, 2014. Influence of boron and lime on growth and seed yield of snowball cauliflower (Brassica Oleracea var. botrytis L.) Cv. Pusa Snowball K-1. Prog. Horti. 46(1): 107-110.

[12] Karthick, R, G.V. Rajalingam, S. Praneetha, K.B. Sujatha and T. Arumugam, 2018. Effect of micronutrients on growth, flowering and yield of bitter gourd (Momordica charantia) Cv. CO1. Int. J. of Chemical Studies, 6(1): 845-848.

[13] Naik, P.S., M. Singh and P. Karmaker (2013). Adaptation options for sustainable production of cucurbitaceous vegetable under climate change situation.ISBN 978-81-322-0973-7 (e-Book). Springer New Delhi Heidelberg New York Dordrencht London.

[14] Okonwn, K. and S.I. Mensah, 2012. Effects of NPK (15:15:15) fertilizer on some growth indices of pumpkin. Asian J. of Agril. Res. 6(3): 137-143.

[15] Sanap, K.S., S.D. Warade, P.B. Sanap, S.R. Barkule and G.R. Pandhre, 2010. Effect of N, P and K on growth and yield of bitter gourd (Momordica charantia L.). Bioinfole. 7(2):184-185.