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# Influence of Drip Fertigation and Foliar Spray of Boron on Yield and Nutrient Uptake by Cucumber cv. Himangi

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The effect of fertigation and foliar application of boron on yield, uptake of nutrients and nutrient use efficiency 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 and nutrient use efficiency 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, minimum male : female sex ratio (1:4), maximum average weight of fruit (239.88 g), yield per vine ( 2.44 kg), yield (

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228.37 q/ha), uptake of nitrogen by shoot, ( 13.03 kg/ha), ( 81.62 kg/ha) by fruit and (94.01 kg/ha) by whole cucumber vine, maximum uptake of phosphorus by shoot (3.62 kg/ha), (21.52 kg/ha) by fruit and ( 25.13 kg/ha) by whole cucumber vine and the maximum uptake of potassium by shoot ( 14.05 kg/ha), by fruit (101.45 kg/ha) and ( 115.20 kg/ha) by whole cucumber vine, B:C ratio (2.99) and minimum (27.73, 25.71 and 17.2, 16.85 and 55.28, 50.28 %, respectively) nutrient use efficiency of NPK were recorded with the application of 120 % RDF through fertigation due to nutrient losses through leaching, devolatilization. While, maximum (36.70, 34.70 and 25.38, 21.90 and 65.81, 63.43 respectively) nutrient use efficiency of NPK was recorded with the application of 60 % RDF through fertigation. The maximum (22.59, 20.61 and 6.99, 7.70 and 27.30, 30.47 %, respectively) nutrient use efficiency with foliar application of boron at concentration of 0.2 per cent and minimum (3.60, 3.44 and 0.56, 0.52 and 3.72, 4.05 %, respectively) nutrient use efficiency with foliar application of boron at concentration of 0.1 per cent.

*Keywords: Fertigation; drip irrigation; foliar spray; boric acid uptake; nutrient use efficiency.*

## 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 system as a carrier and distributor of crop nutrients [1]. 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 [2]. 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 [3]. Also it ensures application of the fertilizers directly to the plant roots [4]. 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 increase nectar production in flowers which attracts pollinating insects [5].

Nitrogen application to cucumber crop markedly influence the vegetative growth, bearing habit, yield and quality of fruits and also helpful for the production of female flowers. John et al*.,* [6]. Phosphorus is a structural element of certain coenzyme, which is involved in energy transfer thus, improves photosynthetic process and increased the growth of the crop [7]. Phosphorus also plays an important role in energy transformation and metabolic process of plant and stimulate early root formation and growth, give a rapid and vigorous growth to the plants. Potassium is the nutrient having the strongest influence on plant growth, yield and quality attributes that determine fruit marketability [8]. The role of potassium in plant metabolism, growth and development and it's significance in production of marketable fruit and on fruit firmness, quality and visual appearance are published and well known [9].

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. MATERIALS 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 were 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 5$^{th}$ 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 and was suggested by Panse and Sukhatme [10]. 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) -- uptake of nutrient (kg/ha) in control / nutrient applied (kg/ha)

## 3. RESULTS AND DISCUSSION

### 3.1 Yield and Yield Contributing Characters

#### 3.1.1 Male: female sex ratio

Data presented in Table 1 expressed that, crop yield is always an important effective and economic index consideration in the crop development. Male: female sex ratio is an important determinant of yield in cucumber and minimum male :female sex ratio would be ideal character in cucumber. The minimum male : female sex ratio (1:4.16) 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.. While, significantly the maximum (1: 12.01 ) male : female sex ratio of cucumber was obtained in the fertigation level of 100 per cent RDF through soil along with the no application of boron in the present investigation. These results are in line with the findings of Umamaheswarappa et al. [11] in cucumber and Annonymous, [12].

#### 3.1.2 Average fruit weight (g)

From the Table 1 it is observed 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. Whereas, it was reported minimum (154.33 g), when the crop was fertilized and sprayed with the fertigation level of 100 per cent RDF through soil along with no boron application. Similar results were discussed by Oloyede et al. [13] in pumpkin and Narayanamma et al. [14] in cucumber.

### 3.1.3 Fruit yield per vine (kg)

From the Table 2 it is observed that, maximum cucumber fruit yield per vine (2.44 kg) was obtained by the cucumber crop fertilized at 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 application of 100 % RDF through fertigation along with 0.2 % foliar spray of boron (2.43 kg). However, significantly the minimum yield per vine (1.03 kg) was obtained with application of 100 % RDF through soil along with water spray in which nutrients were given with conventional method and no boron was applied as foliar form. Significantly increased yield of cucumber might be due to foliar application of boron causes higher uptake of NPK ultimately resulted into maximum fruit yield per vine. These findings are in harmony with Ameta et al. [15] and Dursun *et al* .(2010) in cucumber.

### 3.1.4 Fruit yield per hactor (q)

Data presented in Table 2, depicted that, fruit yield per hector (228.37 q/ha) was procured 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 application of 100 % RDF through fertigation with 0.2 % foliar spray of boron. While, significantly the minimum (103.57 q/ha) fruit yield of cucumber per hector was obtained due to the application of 100 % RDF through soil with water spray. 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 increased the uptake of moisture and nutrients and resulted in increasing all the growth attributes of cucumber. Similar results are also reported by Tekale et al. [16] in cucumber and Karthick et al. [17] in bitter gourd.

## 3.2 Uptake of Nitrogen by Various Parts of Cucumber Vine (kg/ha)

The data expressed in Table 3 presented that, 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 with no boron application. The results are in conformity with the findings of Okonwn et al. [18] in pumpkin and Sadia et al. [19] in cucumber.

**Table 1. Effect of fertilizers and foliar spray of boron on male: female ratio, average fruit weight (g) in cucumber**

| | 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 2. Effect of fertilizers and foliar spray of boron on fruit yield per vine (kg) and per hector (q) 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 | |

### 3.3 Uptake of Phosphorus by Various Parts of Cucumber Vine (kg/ha)

The data depicted in Table 3 expressed that, 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 with no boron application. These findings are in conformity with the result obtained by Okonwn et al. [18] in pumpkin.

### 3.4 Uptake of Potassium by Various Parts of Cucumber Vine (kg/ha)

The data presented in Table 3 observed that, in pooled mean of both the years of experimentation, 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 with no boron application.

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. [18] in pumpkin, Bhosale et al. (2017) in watermelon, Sanap et al. [20] in bitter gourd.

### 3.5 Nutrient use Efficiency

The data presented in Table 4 revealed that, nutrient use efficiency of nitrogen, phosphorus and potassium by cucumber crop was influenced by the foliar spray of boron during both the years of experimentation. 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.

**Table 3. 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 4. Nutrient use efficiency by cucumber crop during 2018-2019 and 2019-2020 (%)**

| Treatments | Nutrient use efficiency (%) | | | | | |
|---|---|---|---|---|---|---|
| | Nitrogen | | Phosphorus | | Potassium | |
| | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| **Fertilizers (F)** | | | | | | |
| $F_1$- 100 % RDF through soil as a straight fertilizer | - | - | - | - | - | - |
| $F_2$- 120 % RDF through fertigation | 27.73 | 25.71 | 17.2 | 16.85 | 55.28 | 50.28 |
| $F_3$- 100 % RDF through fertigation | 31.34 | 29.31 | 19.45 | 18.38 | 62.23 | 54.18 |
| $F_4$- 80 % RDF through fertigation | 32.31 | 30.34 | 22.85 | 19.45 | 64.18 | 59.15 |
| $F_5$- 60 % RDF through fertigation | 36.70 | 34.70 | 25.38 | 21.90 | 65.81 | 63.43 |
| **Micronutrient (M)** | | | | | | |
| $M_0$- water spray | - | - | - | - | - | - |
| $M_1$- foliar spray of boron 0.1 % | 3.60 | 3.44 | 0.56 | 0.52 | 3.72 | 4.05 |
| $M_2$- foliar spray of boron 0.2 % | 22.59 | 20.61 | 6.99 | 7.70 | 27.30 | 30.47 |

**Table 5. 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 | | | | - | | | | | |

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 exhibited and 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 during the years 2018-19 and 2019-20.

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 nitrogen, phosphorus and potassium. This results are in close agreement with the findings of Jisha Chand [21] in cucumber.

As suggested by Duncan et al. [22] the 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 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 [23].

### 3.6 Cost Economics

Data presented in Table 5 showed that, the response of cucumber crop under different treatment combinations of fertilizers and foliar spray of boron was found to have maximum for gross monetary return. (Rs.407898/ha), Net monetary return (Rs.270986/ha) and B:C ratio (2.99) 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 ($F_2M_2$). Whereas, it was found statistically at par with the ($F_3M_2$) with the application of 100 % RDF through fertigation with 0.2 % foliar spray of boron. While, the minimum gross monetary return (Rs.94700/ha), net monetary return (Rs.25790/ha) and B:C ratio (1.29 ) was obtained in the treatment combination 100 % RDF through soil with water spray ($F_1M_0$).

## 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 yield and yield attributing characters, uptake of nitrogen, phosphorus and potassium and the minimum nutrient use efficiency in cucumber crop. 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 yield 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 higher yield and yield attributing characters and also 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 due to the application of 120 % RDF through fertigation along with foliar application of boron at the concentration of 0.1 % in the present investigation.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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