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# Effect of Nitrogen, Zinc Sulphate and Boron on Growth and Yield of Cape Gooseberry *(Physalis peruviana* L.)

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**ABSTRACT**

*The present investigation was carried out during 2007-08 and 2008-09 at Horticultural Garden of the Department of Horticulture, Chandra Shekhar Azad university of Agriculture and Technology, Kanpur, U.P. The treatments consisted of three levels each of nitrogen (50, 75 and 100 kg/ha), $ZnSo_4$ (0.3%, 0.6% and 0.9%) and Borax (0.3%, 0.6% and 0.9%) along with a control. Thus there were in all 28 treatment combination replicated thrice in a Factorial Randomized Block Design. Half dose of nitrogen and full dose phosphorous and potassium as per treatment were mixed during last preparation of the field. Remaining half nitrogen was top dressing and total amount of zinc sulphate and borax were foliar spray in two split at 42 and 73 days after transplanting. Observation were recorded on vegetative growth (plant height, plant spread, number of leaves, number of branches, diameter' of stem), floral parameters days taking to first and last flowering, fruiting and fruit parameter (fruit set%, fruit retention %, number of fruit per plant, size of fruit, length and width and weight of fruit and pulp : seed ratio and yield/ha. Nitrogen, zinc sulphate and borax individually influencing all vegetative growth, flowering, fruiting parameters in cape gooseberry, Higher level of 100 kg N and 0.9% either $ZnSo_4$ or borax showed maximum vegetative growth, minimum days to first flowering, increased fruit yield and quality of fruit as compared to other nutrients levels. First and second order interaction, also increased vegetative growth, flowering, fruiting and 100 kg N + 0.9% Zn, 100 kg N + 0.9% B and 0.9% $ZnSo_4$ + 0.9% B and second order interaction 100 kg N + 0.9% Zn + 0.9% B promoted values further in all characters (vegetative growth, fruit quality and yield) as compared to control.*

***Key words:*** *Nitrogen, Zinc Sulphate, Boron, Borax.*

## INTRODUCTION

Cape gooseberry (*Physalis peruviana* L.) is one of the herbaceous, quick growing and high yielding minor fruit crops. The fruits are characterized by globose seed berry enclosed in inflated calyx[23].

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It is commonly known as *rashbhari makoi* and *tepari* in India and *poha* in Hawaii, golden berry in South Africa, huskcherry and Peruvian ground cherry in some other parts of the world[11]. The fruits have a good colour, texture and flavour. The ripe fruits are eaten as such and used in making excellent jelly, sauce and particularly jam for which it is called as "jam fruit' in India[17]. This crop is available in lean period (February-March) when a few fruits are available in the market. Having wide adaptability and high productivity, the crop has enormous potentiality to meet the demand of fruit, fruit and vegetable preservation industries[24]. From nutritional point of view, its importance is not less than any other major fruit as its 87 per cent edible portion contains carbohydrate 11.5 per cent, protein 1.8%, fat 0.2 per cent, fibre 3.2 per cent, mineral matter 0.6 per cent and ascorbic acid 49 mg/l00g edible portion[15]. The fruit also contains carotene (vitamin A) 2380IU[1], pectin 0.9%[18] and vitamin B (bioflaronoids)[13]. It also contains essential fatty acid, phytosterols and antioxidant vitamins[12].The cape gooseberry *{Physalis peruviana* L.) belongs to family solanaceae. The genus Physalis having approximately 80 species, originated from temperate and tropical America with a few species in Asia, Australia, Europe and Africa. The cape gooseberry is said to be originated in the western part of South America and is found to be native of Peru and northern part of Chile. Other species like *Physalis ixocarpa* and *P. pubescens* originated in tropical-Asia and India[6]. In genus *Physalis,* only three species are well known for their fruit value i.e. (i) *Physalis pubescens,* (ii) *Physalis peruviana* (iii) *Physalis ixocarpa.* The *P. pubescens* (strawberry tomato) have the best fruit but due to trailing habit harvesting is cumbersome. The Maxican variety *P. ixocarpa* (husk tomatillo) having the bigger size fruit is not good in taste, whereas *P. peruviana* (cape gooseberry) is better in taste, more common, quick growing and heavy yielding crop[11].

## MATERIALS AND METHODS

The present investigation was carried out at Horticultural Garden, Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) India, during 2007-08 and 2008-09. A brief description of climatic and edaphic conditions prevailing during the cropping period and materials used, experimental procedure and techniques adopted in field and laboratory. The experiment was laid out in Factorial Randomized Block Design with three replications and 28 treatment combinations as given-N, - 50 kg, $N_2$ - 75 kg, $N_3$ - 100 kg/ha, Zn, - 0.3%, $Zn_2$ - 0.6%, $Zn_3$ - 0.9%, B, - 0.3%, $B_2$ -0.6% and $B_3$ -0.9%. The plant height (cm) was recorded from the base of plant to terminal part of main stem with the help of a meter scale at last picking. The fully opened leaves from tagged plants of each plot were counted at harvesting stage and average number of leaves per plant was calculated. The diameter of stem was recorded at harvesting stage with the help of a 'Vernier Callipers* and average was expressed in cm. The plant spread was recorded in two directions i.e. East-West and North-South at the maximum width of plant with the help of a meter scale and mean values of both directions are given. The total number of branches was recorded at harvesting stage in which flowering and fruiting took place and average number of branches per plant was worked out in each treatment. The numbers of days from transplanting of crop to first full bloom of flower was recorded under each treatment and average days were calculated. It is a indeterminate type of crop which continue to grow and fruit upto favourable environmental conditions. The days, required for last bloomed flower which could set fruit was recorded under each treatment and the average was worked out. The total number of flowers on the tagged plants were recorded at alternate days and total number of fruit set were also recorded and calculated in per cent. To study the per cent retention, the number of fruits retained were recorded at the time of fruit harvesting and percentage was workout on the basis of fruit set. The total number of fruits/plant was recorded at 5 days interval under each treatment up to last harvesting of crop and

average number of fruits per plant was worked out. The days taken from flowering (anthesis) to picking stage of tagged flower was noted under each treatment and average was calculated. The length and width of five fruit from each treatment were recorded at the orange colour stage of fruit with the help of a 'Vernier Callipers' and average was expressed in cm. The fruit yield per hectare for each of the treatment was calculated with the help of fruit yield/plot and expressed as q/ha.

## RESULTS

**Effect of nitrogen on growth and yield:**

The flowering and fruiting in cape gooseberry plants was influenced by nitrogen doses during both the year of the study. Application of 100 kg N/ha delayed both the parameters i.e. days taken to first flowering as well as days to last flowering exhibiting the flowering span of 114.68 and 113.57 days. The last flowering took 198.08 and 196.77 days under N3. Smallest flowering span of 105.42 and 104.15 days was recorded under control during respective years of study and days taken to last flowering was 180.79 and 179.45 days. The findings are in agreement with the observations of Sharma and Mann[25] who reported delayed flowering in tomato due to nitrogen fertilization. The fruit set per cent, number of fruits per plant and fruits retention were recorded under 100 kg N/ha exhibiting 85.75 & 84.49 per cent 40.27 & 39.70 and 86.08 & 87.81 per cent values in respective parameters during corresponding years of trial- There was an improvement of fruit set by 10.12 and 10.51 per cent over control. The size and weight of fruit improved with advanced levels of nitrogen nutrition and 100 kg Nfla proved most effective followed by 75 kg B ha in producing larger and heavier traits daring both the years of study. Heaviest fruit of 8.01 and 7.82 g having greater length and width were recorded under the highest dose of nitrogen. Time ripening of Cape gooseberry fruit was delayed which was advanced with the nil ring, doses of Sunflower observations have been reported by Sahoo *et al*[21]., in tomato which is in conformity of the present findings. The seed pulp ratio and yield of cape gooseberry in the present investigation increased consistently which increasing levels of nitrogen. The maximum seed pulp ratio was 1:1.46 and 1:1.44 and yield 68.88 and 66.65 q/ha followed by 1:1.41 and 1:1.39, yield 58.99 and 57.75 q/ha in respective lower level of 75 kg N/ha during corresponding years of study. The yield increased by 75.95 and 78.21% over control. The beneficial role of nitrogen may be ascribed to the fact that its optimal level could improve the vegetative growth of the plants thereby improving the photosynthesis and ultimately producing vigorous plant which is obviously gave increased fruit set, better fruit retention and heavier fruit with increased size. The delay in fruit ripening is due to the delay caused in the reproductive phase under higher nitrogen doses.

**Effect of zinc sulphate growth and yield:**

Zinc sulphate is required for synthesis of tryptophane precursor of auxin. It is essential for carbon dioxide evaluation and utilization, carbohydrate and phosphorus metabolism and synthesis of protein. It is also a catalysis and activator for many enzymes. Zinc sulphate in the present study when applied @ 0.9% as foliar spray proved most effective and enhanced all the growth attributes, eg. plant height, number of leaves, plant diameter, plant spread and number of branches. But remained superior over control during both the years of investigation. The higher dose of zinc sulphate fertilizer recorded 75.94 and 71.41 cm plant height, 196.86 and 193.91 number of leaves per plant, plant diameter 2.26 and 2.20 cm, plant spread 52.23 and 51.10 cm, number of branches 3.09 and 3.05 per plant followed by 0.6% zinc sulphate, 74.42 & 70.00 cm, 194.18 & 191.60 cm, 2.22 & 2.16 cm, 51.26 & 56.12 cm, 3.04 & 3.00 and under control, the value for plant height were 63.60 and 61.12 cm. number of leaves 170.25 and 168.15, diameter of main plant 1.96 and 1.95 cm. plant spread 42.12 and 41.32 cm, number of branches 2.60 and 2.57 per plant during corresponding years of study. The increase in growth parameters under highest dose of Zn i.e. plant height

number of leaves/plant, diameter, spread and number of branches over control was recorded by 19.40 & 16.83%, 15.62% & 15.31%, 15.3 & 12.82%, 23.39 & 23.36% and 18.85 and 18.67%. The findings are in accordance with the reports of Chaturvedi *et al*[7]., and Kumar and Shukla[16], and Gupta and Gupta[10] who also reported increase in the number of branches and diameter of main branches with increase in the concentration of zinc sinjiMli and borax. The flowering and fruiting in cape gooseberry plant was hastened under the influence of zinc sulphate. When foliar application of 0.9% Z11SO4 was applied the flowering took 81.86 and 81.63 days against 75.55 and 75.15 days noted under control. The days taken to last flowering in Zn;, were 192.86 and 191.06 days under first and second years of observations respectively. The flowering under highest level was hastened by 12.05 and 11.61 days when compared with control. Zinc sulphate application in the present investigation responded favourably on all fruiting parameters such as fruit set, fruit retention, number of fruit per plant, days taken to ripening, fruit size, seed pulp ratio, fruit weight and fruit yield. Application of 0.9% $ZnS0_4$ brought about an increase of 6.42, 6.64% in fruit set, 6.44 and 6.5% fruit retention, 2.42 and 1.47 number of fruits per plant, 13.16 & 13.61% days to ripening, 27.52 & 26.85% fruit size 11.31 & 11.38% fruit weight, 66.82 & 68.82% yield over control during first and second years observation respectively. The findings are in accordance with Chaturvedi *et al*[7]*,*, Rani and Brahmachari[20], Kar *et al*[14]., Mishra *et al*[19]., Fischer *et al*[8]., in cape gooseberry, Borun and Kumar[3] obtained increased yield with Zn sulphate and boron treatment in strawberry.

**Effect of boron on growth and yield:**

All the vegetative growth attributes viz., height of plant, number of leaves, diameters and spread a of plant and number of branches were boosted significantly under the influence 0.9 per cent foliar application of borax when compared with control and its lower level of 0.6 pr cent. The fruit pants growing on soil which are deficient in boron however, response to boran application appreciably. Beneficial role of boron has been reported by Chaturvedi *et al*[7]., Gupta and Gupta[10] reported increase in the branches and diameter of main shoot with increase in the concentration of zine sulphate and borax. Foliar application of 0.9% B in respect of days taken to first flowering (81.49 and 81.27 day) and days taken to last flowering (192.82 and 191.56 days) did not differ with its lower concentration. But, proved significantly superior to control in hastening the flowering in cape goose berry. The longer flowering spans are obviously due to enhanced vegetative growth included by Boron fertilization. Boron in the present investigation promoted the fruiting, yield and yield components and the higher dose proved significantly superior in enhancing all the attributes eg. Per cent of fruit set and retention. Number of fruits per plant, days taken to repining, seed pulp ratio and yield improved during both the years of study. Fruit ripening took 59.66 and 58.69 days against 52.81 and 51.72 days under control during corresponding year of study. The yield of fruit increased by 64.30 and 7820% with 0.9% treatment of B when compared with control during first and second years of trial respectively. The finding are in according with the observations of Chaturvedi *et al*[7]., Kar *et al*[14]., Mishra *et al*[19]., and in cape gooseberry, Barun and Kumar[3]; and Brachmachari *et al*[4]., Ghosh and Bersa[9], Kar *et al*[14]., Mishra *et al*[19]., and Kumar and Shukla[16].

**Interaction of treatments**

Careful consideration should be given to maintain a proper balance between various elements in fruit plant nutrition. Deficiency and excess of one or more nutrients result in one or more abnormalities leading to growth of plant and quality of fruits. Among the first order interaction. N3 x Zn3 i.e. 100 kg N/ha + 0.9% zinc sulphate promoted vegetative growth as well as flowering and fruiting parameters *viz*, plant height, number of leaves, diameter and spread of plant, number of branches, fruit set, fruit retention, number of fruits per plant. These parameters i.e.

vegetative growth of plant, flowering, fruiting and yield also improved under NxZn and and ZnxB interaction appreciably. Chaturvedi *et al*[7]., Gupta and Gupta[10] and Chadha[5] with results similar to present findings. Kumar and Shukla[16] in litchi cv, Saraswat *et al*[22]., in litchi cv. calcuttia also observed similar results. The second order interaction improved further all the parameters studied e.g. vegetative growth attributes, flowering, fruiting, quality and yield traits in cape goose berry during both the years of investigation. The vegetative growth attributes e.g. height of plant spread. Their and diameter, number of branches and were also improved significant & when 100 kg N/ha + 0.9 % zinc sulphate 0.9% Borax was applied delayed flowering (11.70 & 11.73 days) under Bi Zn Bi was noted while the longest flowering span was noted in $N_3$ 2n3 $B_3$ (123.73 and 112.42 days). The size and weight and number fruit recorded highest in plant fertilized with 100 Kg N/ha+0.9% ZnSo4 + 0.9 % Borax. The yield was maximized under this treatment registering 73.46 and 71.20 q/ha against (38.49 and 37.40 q/ha) under control during respective years of study. When all the three nutrients were applied together in highest concentration. The results are in support with Sarangi *et al*[24]., in cape goose berry, Mishra *et al*[19]., in kinnow fruit, Babu and Singh[2] and Kumar and Shukla[16] in litchi.

**Table 1: Interaction effect of N, Zn, B on plant height (cm) in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 63.60 |
| $B_1$ | 66.34 | 71.6 | 77.45 | 64.68 | 73.40 | 79.77 | 65.61 | 74.05 | 81.80 | |
| $B_2$ | 64.75 | 73.76 | 80.72 | 65.92 | 75.62 | 83.11 | 66.72 | 77.12 | 85.12 | |
| $B_3$ | 65.41 | 74.91 | 83.14 | 64.05 | 76.49 | 79.97 | 69.95 | 77.97 | 86.25 | |
| S.Ed. | | | | | 2.78 | | | | | |
| C.D. | | | | | 5.56 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 61.12 |
| $B_1$ | 58.55 | 65.55 | 73.15 | 59.88 | 68.88 | 74.85 | 60.95 | 69.98 | 76.83 | |
| $B_2$ | 59.30 | 69.91 | 76.25 | 61.90 | 7.93 | 78.25 | 62.35 | 72.35 | 80.49 | |
| $B_3$ | 61.95 | 69.79 | 78.22 | 63.24 | 72.12 | 73.98 | 73.98 | 73.98 | 82.24 | |
| S.Ed. | | | | | 2.50 | | | | | |
| C.D. | | | | | 5.00 | | | | | |

**Table 2: Interaction effect of N, Zn, B on number of leaves in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 170.25 |
| $B_1$ | 173.24 | 189.15 | 197.33 | 175.65 | 193.25 | 201.68 | 177.25 | 195.66 | 206.25 | |
| $B_2$ | 177.95 | 193.20 | 202.15 | 180.11 | 196.68 | 207.25 | 185.21 | 198.71 | 206.25 | |
| $B_3$ | 180.68 | 196.65 | 207.11 | 183.11 | 184.71 | 211.15 | 184.90 | 200.25 | 214.95 | |
| S.Ed. | | | | | 6.18 | | | | | |
| C.D. | | | | | 12.37 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 168.15 |
| $B_1$ | 171.33 | 187.29 | 194.21 | 173.11 | 191.00 | 199.11 | 175.19 | 193.26 | 202.50 | |
| $B_2$ | 175.33 | 191.28 | 199.31 | 178.25 | 194.25 | 194.25 | 180.90 | 194.25 | 207.21 | |
| $B_3$ | 177.95 | 194.65 | 203.19 | 181.11 | 196.11 | 196.11 | 182.81 | 198.15 | 210.19 | |
| S.Ed. | | | | | 6.18 | | | | | |
| C.D. | | | | | 12.37 | | | | | |

**Table 3: Interaction effect of N, Zn, B on the diameter of main plant (cm) in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 1.96 |
| $B_1$ | 1.98 | 2.14 | 2.25 | 2.04 | 2.18 | 2.27 | 2.09 | 2.22 | 2.30 | |
| $B_2$ | 2.06 | 2.19 | 2.33 | 2.10 | 2.25 | 2.36 | 2.16 | 2.28 | 2.39 | |
| $B_3$ | 2.11 | 2.21 | 2.35 | 2.15 | 2.27 | 2.38 | 2.19 | 2.30 | 2.42 | |
| S.Ed. | | | | | 0.067 | | | | | |
| C.D. | | | | | 0.134 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 1.91 |
| $B_1$ | 1.92 | 2.08 | 2.19 | 1.98 | 2.12 | 2.21 | 2.04 | 2.17 | 2.24 | |
| $B_2$ | 2.00 | 2.13 | 2.27 | 2.04 | 2.19 | 2.29 | 2.09 | 2.22 | 2.36 | |
| $B_3$ | 2.05 | 2.15 | 2.29 | 2.09 | 2.22 | 2.31 | 2.13 | 2.24 | 2.38 | |
| S.Ed. | | | | | 0.61 | | | | | |
| C.D. | | | | | 0.121 | | | | | |

**Table 4: Interaction effect of N, Zn, B on plant spread (cm) in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 42.12 |
| $B_1$ | 42.20 | 46.96 | 52.75 | 44.48 | 48.75 | 53.81 | 45.95 | 49.95 | 54.25 | |
| $B_2$ | 46.12 | 49.25 | 54.51 | 48.65 | 54.19 | 55.33 | 49.98 | 52.39 | 56.12 | |
| $B_3$ | 48.15 | 51.54 | 51.15 | 50.15 | 52.97 | 56.11 | 51.19 | 53.65 | 56.75 | |
| S.Ed. | | | | | 2.13 | | | | | |
| C.D. | | | | | 4.26 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 41.32 |
| $B_1$ | 41.55 | 45.79 | 51.65 | 43.38 | 47.67 | 52.65 | 44.81 | 48.88 | 53.13 | |
| $B_2$ | 45.10 | 48.21 | 5325 | 47.36 | 50.09 | 54.15 | 48.77 | 51.**33** | 55.00 | |
| $B_3$ | 47.15 | 50.83 | 54.11 | 48.95 | 51.81 | 55.00 | 50.12 | 52.25 | 55.61 | |
| S.Ed. | | | | | 1.99 | | | | | |
| C.D. | | | | | 3.99 | | | | | |

**Table 5: Interaction effect of N, Zn, B on number of branch in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 2.60 |
| $B_1$ | 2.70 | 2.90 | 3.15 | 2.75 | 2.99 | 3.21 | 2.79 | 3.05 | 3.26 | |
| $B_2$ | 2.72 | 2.96 | 3.18 | 2.82 | 3.05 | 3.26 | 2.86 | 3.12 | 330 | |
| $B_3$ | 2.81 | 2.99 | 2.81 | 2.86 | 3.10 | 3.29 | 2.95 | 3.15 | 3.35 | |
| S.Ed. | | | | | 0.098 | | | | | |
| C.D. | | | | | 0.196 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 2.57 |
| $B_1$ | 2.66 | 2.88 | 3.09 | 2.72 | 2.46 | 3.18 | 2.76 | 3.01 | 3.21 | |
| $B_2$ | 2.74 | 2.93 | 3.14 | 2.79 | 3.00 | 3.21 | 2.87 | 3.08 | 3.21 | |
| $B_3$ | 2.77 | 2.96 | 3.17 | 2.84 | 3.07 | 3.25 | 2.92 | 3.10 | 3.29 | |
| S.Ed. | | | | | 0.91 | | | | | |
| C.D. | | | | | 0.182 | | | | | |

**Table 6: Interaction effect of N, Zn, B on day taken to first flowering in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 75.55 |
| $B_1$ | 75.17 | 78.55 | 80.77 | 76.94 | 79.25 | 81.95 | 77.45 | 80.68 | 80.65 | 83.75 |
| $B_2$ | 76.12 | 79.75 | 81.95 | 72.85 | 80.60 | 83.15 | 78.88 | 81.74 | 81.74 | 85.10 |
| $B_3$ | 76.95 | 80.67 | 82.75 | 78.65 | 81.25 | 83.95 | 79.34 | 79.34 | 82.59 | 87.25 |
| S.Ed. | | | | | 1.60 | | | | | |
| C.D. | | | | | 3.20 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 75.15 |
| $B_1$ | 74.97 | 78.38 | 80.60 | 76.62 | 79.03 | 81.77 | 77.25 | 80.33 | 83.60 | |
| $B_2$ | 75.88 | 79.51 | 81.79 | 77.63 | 80.33 | 82.97 | 78.67 | 81.59 | 84.88 | |
| $B_3$ | 76.70 | 80.53 | 82.57 | 78.41 | 81.00 | 83.78 | 79.15 | 82.40 | 86.88 | |
| S.Ed. | | | | | 1.76 | | | | | |
| C.D. | | | | | 2.52 | | | | | |

**Table 7: Interaction effect of N, Zn, B on days taken to last flowering in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 180.79 |
| $B_1$ | 179.24 | 186.77 | 194.15 | 182.24 | 188.78 | 196.70 | 184.79 | 190.90 | 198.80 | |
| $B_2$ | 183.75 | 188.95 | 196.65 | 184.95 | 190.15 | 198.82 | 188.15 | 192.75 | 199.75 | |
| $B_3$ | 186.70 | 190.05 | 197.72 | 187.65 | 191.65 | 199.15 | 187.88 | 193.82 | 200.98 | |
| S.Ed. | | | | | 3.48 | | | | | |
| C.D. | | | | | 6.96 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 179.45 |
| $B_1$ | 178.15 | 185.33 | 193.00 | 181.09 | 18735 | 195.29 | 183.55 | 189.49 | 197.41 | |
| $B_2$ | 182J5 | 187.79 | 19534 | 183.71 | 189.00 | 197.45 | 195.00 | 19130 | 198.50 | |
| $B_3$ | 185.51 | 189.00 | 196.41 | 18625 | 19037 | 198.00 | 186.44 | 192.40 | 199.60 | |
| S.Ed. | | | | | 3.22 | | | | | |
| C.D. | | | | | 6.44 | | | | | |

**Table 8: Interaction effect of N, Zn, B on fruit set (%) in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 77.87 |
| $B_1$ | 85.53 | 73.15 | 77.90 | 84.95 | 74.25 | 86.73 | 86.15 | 74.90 | 86.00 | |
| $B_2$ | 71.48 | 76.7 | 84.59 | 86.45 | 77.90 | 85.88 | 84.79 | 78.75 | 73.20 | |
| $B_3$ | 88.91 | 77.89 | 85.93 | 87.25 | 78.75 | 87.15 | 88.25 | 79.20 | 88.05 | |
| S.Ed. | | | | | 2.67 | | | | | |
| C.D. | | | | | 5.34 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 76.45 |
| $B_1$ | 82.40 | 72.00 | 76.51 | 83.49 | 73.05 | 85.40 | 83.09 | 73.09 | 87.09 | |
| $B_2$ | 81.03 | 75.39 | 93.25 | 85.21 | 76.49 | 86.65 | 86.65 | 86.05 | 86.05 | |
| $B_3$ | 87.14 | 76.48 | 84.52 | 86.10 | 77.35 | 86.00 | 87.10 | 87.00 | 87.00 | |
| S.Ed. | | | | | 2.39 | | | | | |
| C.D. | | | | | 4.78 | | | | | |

**Table 9: Interaction effect of N, Zn, B on fruit retention (%) in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 78.17 |
| $B_1$ | 83.86 | 73.44 | 78.20 | 85.28 | 74.54 | 87.07 | 86.49 | 75.49 | 88.64 | |
| $B_2$ | 82.31 | 77.05 | 84.93 | 86.79 | 78.20 | 86.21 | 88.13 | 88.13 | 87.54 | |
| $B_3$ | 89.25 | 78.19 | 86.27 | 87.59 | 79.06 | 87.49 | 88.59 | 88.59 | 88.39 | |
| S.Ed. | | | | | 2.56 | | | | | |
| C.D. | | | | | 5.13 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 76.91 |
| $B_1$ | 82.71 | 72.27 | 76.80 | 83.81 | 73.33 | 85.72 | 85.32 | 73.77 | 87.42 | |
| $B_2$ | 81.51 | 75.68 | 83.57 | 85.53 | 76.78 | 84.81 | 86.98 | 86.98 | 86.38 | |
| $B_3$ | 87.27 | 76.77 | 84.84 | 86.43 | 77.64 | 86.23 | 87.41 | 78.38 | 87.33 | |
| S.Ed. | | | | | 2.39 | | | | | |
| C.D. | | | | | 4.58 | | | | | |

**Table 10: Interaction effect of N, Zn, B on number of fruit/plant in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 78.17 |
| $B_1$ | 28.77 | 34.03 | 37.11 | 36.03 | 36.45 | 40.95 | 37.55 | 39.75 | 41.00 | |
| $B_2$ | 33.22 | 33.86 | 39.15 | 35.41 | 38.05 | 40.79 | 36.95 | 33.85 | 40.97 | |
| $B_3$ | 35.12 | 35.95 | 40.25 | 36.95 | 39.15 | 40.95 | 38.15 | 36.25 | 41.03 | |
| S.Ed. | | | | | 1.30 | | | | | |
| C.D. | | | | | 2.60 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 76.91 |
| $B_1$ | 32.13 | 32.30 | 38.00 | 34.32 | 3422 | 37.00 | 39.45 | 32.71 | 39.80 | |
| $B_2$ | 34.00 | 34.81 | 39.11 | 35.88 | 35.88 | 38.00 | 39.82 | 34.11 | 40.00 | |
| $B_3$ | 34.45 | 35.22 | 39.75 | 38.55 | 3639 | 38.55 | 38.12 | 36.00 | 41.15 | |
| S.Ed. | | | | | 1.26 | | | | | |
| C.D. | | | | | 2.52 | | | | | |

**Table 11: Interaction effect of N, Zn, B on number of fruit/plant in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 7.07 |
| $B_1$ | 7.46 | 7.70 | 7.90 | 7.51 | 7.76 | 7.97 | 7.55 | 7.83 | 8.00 | |
| $B_2$ | 7.54 | 7.83 | 7.97 | 7.59 | 7.88 | 8.02 | 7.66 | 7.93 | 8.06 | |
| $B_3$ | 7.61 | 7.88 | 8.00 | 7.65 | 7.90 | 8.05 | 7.71 | 7.95 | 8.10 | |
| S.Ed. | | | | | 0.104 | | | | | |
| C.D. | | | | | 0.208 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 7.03 |
| $B_1$ | 7.44 | 7.67 | 7.87 | 7.48 | 7.73 | 7.96 | 7.53 | 7.80 | 8.00 | |
| $B_2$ | 7.50 | 7.90 | 7.94 | 7.55 | 7.83 | 7.99 | 7.62 | 7.90 | 8.02 | |
| $B_3$ | 7.58 | 7.84 | 7.97 | 7.81 | 7.87 | 8.01 | 7.68 | 7.92 | 8.05 | |
| S.Ed. | | | | | 0.083 | | | | | |
| C.D. | | | | | 0.166 | | | | | |

**Table 12: Interaction effect of N, Zn, B on number of fruit/plant in cape gooseberry**

| Treatment | $N_1Zn_1$ | $N_2Zn_1$ | $N_3Zn_1$ | $N_1Zn_2$ | $N_2Zn_2$ | $N_3Zn_2$ | $N_1Zn_3$ | $N_2Zn_3$ | $N_3Zn_3$ | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2007-08** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 38.49 |
| $B_1$ | 47.24 | 53.28 | 60.22 | 53.24 | 55.95 | 65.24 | 56.25 | 58.37 | 69.25 | |
| $B_2$ | 49.90 | 56.75 | 64.33 | 55.97 | 58.80 | 68.48 | 59.68 | 61.33 | 72.10 | |
| $B_3$ | 51.68 | 59.60 | 66.95 | 57.15 | 61.95 | 70.93 | 62.51 | 64.90 | 73.46 | |
| S.Ed. | | | | | 2.46 | | | | | |
| C.D. | | | | | 4.92 | | | | | |
| | **2008-09** | | | | | | | | | |
| Control | - | - | - | - | - | - | - | - | - | 37.40 |
| $B_1$ | 46.12 | 52.15 | 59.13 | 52.12 | 54.78 | 64.12 | 55.09 | 57.15 | 68.12 | |
| $B_2$ | 48.75 | 56.19 | 63.11 | 54.65 | 57.49 | 67.49 | 58.33 | 60.11 | 71.00 | |
| $B_3$ | 50.45 | 58.31 | 65.70 | 55.95 | 60.73 | 69.73 | 61.31 | 63.60 | 71.20 | |
| S.Ed. | | | | | 2.03 | | | | | |
| C.D. | | | | | 4.06 | | | | | |

## CONCLUSION

As regards second order interactions N3Zn3B3 required minimum period for flowering 87.25 and 86.88 days after transplanting with a flowering span period of 113.63 and 112.72 days during corresponding years of trial. Nitrogen significantly increased the fruiting and fruit parameters with increasing doses. The maximum fruit set (85.75 and 84.49%). fruit retention (86.08 and 87.81%). number of fruit plant (4027 and 39.70), weight of fruit (8.01 and 7.82 g) length and width of fruit (1.39. 1.37 and 1.50. 147 cm) and seed pulp ratio of 1: 1.46 and 1: 1.44) was noted under 100 kg nitrogen followed by 75 kg N ha during respective years of study. $ZnSO_4$ influenced the fruiting and fruit parameters with advancing levels. $ZnS0_4$ @ 0.9% gave maximum values in respect of all the fruiting and fruit parameters and fruit set and weight of fruit were recorded as 84.29, 83.09 and 7.87, 7.83 g during respective years of study. Foliar application of borax @ 0.9% also improved and fruit set and weight of fruit were recorded as 84.59, 85.30 and 7.87, 7.84 g respectively during corresponding years of study. Among the first order interaction nitrogen @ 100 kg/ha with 0.9% $ZnSO_4$ improved all the fruiting parameters during both the years of investigation. N3Zn3 showed the maximum fruit set (87.55 and 86.74%) their retention (88.19 and 87.04%), number of fruits/plant (41.08 and 45.35), length & width (1.44, 1.46 and 1.42, 1.51 cm) and fruit weight (8.05 and 8.02 g during both the years. However, N3B3 proved slightly less effective as compared to N3Zn3 in promoting all the above parameters. Among the first order interactions of Zn x B, the maximum effective to boost the fruiting parameter was found Zn3B2, though was relatively lesser effective than other first order interaction i.e. N x Zn and N x B. As regards the second order interaction N3Zn3B3 exhibited maximum fruit set (88.05, 87.00%) their retention (88.39, 87.33%), number of fruit (41.03 & 41.15), fruit length (1.48 & 1.46 cm) and weight (8.10 and 8.05 g) during both the years. On the basis of two years field trial it is concluded that the highest dose each of nitrogen 100 kg N/ha and foliar sprays of zinc sulphate @ 0.9% and borax @ 0.9% individually enhanced the vegetative growth, flowering, fruiting and yield parameters of cape gooseberry fruits. Nitrogen in conjunction with zinc, zinc in conjunction with B and zinc conjunction with boron also promoted these parameters effectives. However, application of 100 kg N + 0.9% ZnS04 + 0.9% borax proved most effective treatment for boosting vegetative, flowering, fruiting and yield attributes under the agro-climatic of North Gangetic plains of India.

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