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Effect of micronutrients on plant growth, Flowering and corm production of Gladiolus (*Gladiolus grandiflorus*) cv. white Prosperity

Sajina Beevi S, Vijay Bahadur, Tarence Thomas, Samir E Topno, Neelam Khare and Anupriya Paul

Abstract
A field experiment was carried out at the Research Farm Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj during the year 2020-2021 to find out the "Effect of micronutrients on plant growth, flowering and corm production of gladiolus (*Gladiolus grandiflorus*) cv. White Prosperity".
The study was laid out in RBD, having four levels each of Iron (0.1%,0.2%,0.3% and 0.4%), Boron (0.1%,0.2%,0.3% and 0.4%) and Zinc (0.1%,0.2%,0.3% and 0.4%),making a total of 13 treatment combinations, each replicated three times.The allocation of treatments to the individual plants was done using random numbers in each replication. Corms were planted in third week of October 2020 on 30 cm apart ridges with 30cm distance allowed with rows.Nine corms were planted in each treatment. Micronutrient sprays were applied at three and six leaf stages of gladiolus.Application of the micronutrients significantly increased plant height, flower stalk length, flower fresh weight, spike length, florets per spike, florets' fresh weight and diameter, flower vase-life, flower diameter as well as fresh weight of corms. Based on the findings of the experiment, it is concluded that the treatment T_9 (Boron 0.4%) gave the maximum plant height (97.83) (cm). The treatment T_9 (Boron 0.4%) gave the maximum number of leaves per plant (24.84). The treatment T_9 (Boron 0.4%) gave the maximum number of shoots per corm (2.23). The treatment T_9 (Boron 0.4%) gave the minimum days to spike initiation (62.61).The treatment T_9 (Boron 0.4%) gave the maximum number of spikes per plant (1.83). The treatment T_9 Boron 0.4% gave the maximum number of corms per plant (2.38).The treatment T_9 (Boron 0.4%) gave the maximum Floret size (9.79) (cm).It is concluded from the present investigation that, application of micronutrient positively influenced plant growth, spike yield, and flower quality of gladiolus. In economics maximum benefit cost ratio (1:3.59) was also found in T_9 (Boron 0.4%).Among all the treatment, T_9 Boron 0.4% was found superior in relation to plant growth, spike yield, corm and cormels yield and flower quality of gladiolus.

Keywords: Gladiolus, zinc, boron, iron, number of spike, length of spike, number of plant height, number of leaves, number of florets, number of corms

Introduction
The modern gladiolus hybrids are botanically known as *Gladiolus grandiflorus*. Gladiolus is one of the important monocotyledonous flowering perennial bulbous plant belongs to family Iridaceae and widely grown as a cut flower in the world and referred to as the "Queen of Bulbous" flowers. It has basic chromosome number n=15 (Gold blatt *et al*., 1993) and majority of South African species are diploid (2n=30).Gladiolus (*Gladiolus grandiflorus* L.) is a bulbous ornamental plant because of attractive spike, having florets of huge forms, dazzling colours and longer keeping quality. which belongs to family Iridiaceae and sub family Ixiodeae, is native to tropical South Africa. It is the most important bulbous flower of India and it is next to tulip in Holland and other countries. The gladiolus belongs to the genus Gladiolus which consists of more than 250 species. Micronutrients are essential for plant growth are categorized as macronutrient (such as nitrogen, phosphorus and potassium) and micronutrients. There are eight essentials micronutrient: Copper (Cu), Zinc (Zn), Iron (Fe), Manganese (Mn), Boron (B), Chloride (Cl), Molybedenum (Mo) and Nickel (Ni). Micronutrients had great effect on plant growth and development such as boron, iron and zinc nutrients. The main function of boron is related to cell wall strength and development, cell division, sugar transport, and hormones development, RNA metabolism, respiration, Indole acetic acid (IAA) metabolism and as part of the cell membranes Marchner (1995). In Gladiolus plant Halder *et al.* (2007a, b) [4] found that application of boron at 2.5Kg/ha-1could be suitable for maximizing yield and flower quality.

Zinc plays an essential role in plant physiology where it activates some of enzymes related to metabolism of carbohydrates, auxins, and RNA and ribosome functions. The main function of iron is the synthesis of chlorophyll, and it is essential for the maintenance of chloroplast structure and function. The micronutrients are responsible in activating several enzymes (catalase, peroxidase, alcohol dehydrogenase, carbonic dehydrogenase, etc.) and involve them self in chlorophyll synthesis and various physiological activities by which plant growth and development are encouraged (Kumar and Arora, 2000), Zinc also controls the metabolism of plant by stimulating the hydrogenase and carbonic anhydrase activities, stabilization of ribosomal fractions and synthesis of cytochrome. It was also reported by many researchers (Singh 1996 and Das, 1998) [2] that boron and zinc had a significant effect on corm and cormel production.

Materials and Methods

A field experiment entitled "Effect of micronutrients on plant growth, flowering and corm production of gladiolus (*Gladiolus grandiflorus*) cv. White Prosperity" was carried out at Horticultural Experimental Field, Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom. The experiment was laid out with 13 treatments and 3 replications, each treatment contain 9 plants with 30 x 30 spacing. Irrigation was done in alternate days. Treatment combinations were different levels of micronutrients are, T_1 (control), T_2 (Fe-0.1%), T_3 (Fe-0.2%), T_4 (Fe-0.3%), T_5 (Fe-0.4%) T6 (B- 0.1%), T_7 (B- 0.2%), T_8 (B- 0.3%), T_9 (B-0.4%), T $_{10}$ (Zn- 0.1%) T_{11} (Zn- 0.2%), T_{12} (Zn- 0.3%), T_{13} (Zn- 0.4%)

Result and Discussion

Table 1: Effect of micronutrients on vegetative parameters of gladiolus (*Gladiolus grandiflorus*) cv. White Prosperity

Treatment notation	Plant height(cm)	No of leaves	No of shoots/corm	Days to spike intiation	Days to first floret opening
T_1	80.61	18.43	1.21	72.98	85.33
T_2	81.74	20.51	1.30	70.72	82.48
T_3	82.62	21.41	1.42	68.44	81.45
T_4	84.44	20.40	1.53	69.43	80.40
T_5	88.42	21.28	1.45	68.03	80.55
T_6	94.52	23.56	1.84	64.71	78.56
T_7	93.29	23.16	1.74	65.24	77.42
T_8	92.78	21.58	1.67	65.89	75.77
T_9	97.83	24.84	2.23	62.61	74.51
T_{10}	91.60	22.64	1.95	64.70	75.31
T_{11}	94.53	22.11	1.75	64.32	76.48
T_{12}	94.52	22.67	1.86	64.09	78.27
T_{13}	95.76	24.53	2.23	63.33	73.72
F-Test	S	S	S	S	S
S.Ed (+)	0.120	0.353	0.051	0.309	0.196
C.D. at 0.5%	0.247	0.728	0.105	0.637	0.405

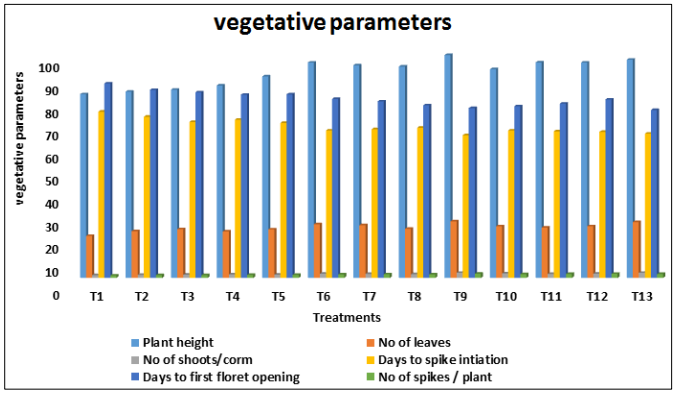

Fig 1: Vegetative parameters

A. Morphological parameters

The data on morphological parameters like plant height, number of leaves, number of shoots, days to spike intiation, floret opening are given in Table 1 and geographical observation in Fig.1.It is clear that, The treatment T_9 (Boron 0.4%) gave the maximum plant height (34.84, 72.57 and 97.83)cm at 30,60 and 90DAT, Whereas the minimum plant height at 30, 60 and 90 DAT (23.85, 58.28 and 80.61)(cm) was found in control. The treatment with Boron 0.4% have reported significant plant height. The results are in support with Halder *et al.*, (2007) [4], Mir *et al.*, (2007) [12], Kakade *et al.*, (2009) in gladiolus. The treatment T_9 (Boron 0.4%) gave the maximum number of leaves per plant (7.45,16.62 and 24.84). Whereas the minimum number of leaves per plant at 30, 60 and 90 DAT (4.17, 11.12 and 18.43) was found control. The treatment with Boron 0.4%, have reported significant. The results are in support with Halder *et al.*, (2007) [4], Mir *et al.*, (2007) [12], and Kakade *et al.*, (2009) in gladiolus. The treatment T_9 (Boron 0.4%) gave the maximum number of shoots per corm (2.23), Whereas the minimum number of shoots per corm (1.21) was found in control. The treatment with Boron 0.4% have reported best for number of shoots per corm. The results are in support with Prasad *et al.*, (2014) [14] and Jagtap *et al.*, (2012) [3]. The treatment T_9 (Boron 0.4%) gave the minimum days to spike initiation (62.61), Whereas the maximum days to spike initiation (72.98) was found in control. The treatment with Boron 0.4%,have reported best for early spike intiation. The results are in support with Singh *et al.*, (2014) Chattopadhayay *et al.*, (2001) [2] and Mir *et al.*, (2007) [12]. The treatment T_9 (Boron 0.4%) gave the minimum days to opening of first floret (74.51). Whereas the maximum days to opening of first floret (85.33) was found in treatments control (T_1).The results are in support with khan *et al.*, (2007) [8] and Mir *et al.*, (2007) [12].

Table 2: Effect of micronutrients on floral parameters of gladiolus (*Gladiolus grandiflorus*) cv. White Prosperity

Treatment notation	No of spikes / plant	Floret size	First floret durability	Spike length(cm)	No of floret/ spike	Spike yield/ha(lakh)
T_1	1.05	6.89	8.17	65.77	12.99	1.10
T_2	1.23	8.19	8.50	70.28	13.61	1.29
T_3	1.21	7.90	8.63	71.49	13.40	1.28
T_4	1.31	8.31	8.22	72.86	13.77	1.39
T_5	1.34	7.22	9.23	72.08	13.30	1.42
T_6	1.52	8.30	9.47	76.72	14.49	1.60
T_7	1.59	8.52	9.61	76.86	15.30	1.68
T_8	1.55	8.24	9.59	77.47	14.36	1.63
T_9	1.83	9.79	10.81	78.33	17.86	1.93
T_{10}	1.65	8.52	10.35	76.84	14.64	1.74
T_{11}	1.76	8.52	9.55	76.31	15.71	1.86
T_{12}	1.80	8.22	9.67	76.84	17.31	1.90
T_{13}	1.75	9.78	10.68	75.13	17.71	1.85
F-Test	S	S	S	S	S	S
S.Ed (+)	0.042	0.280	0.158	1.105	0.148	0.045
C.D. at 0.5%	0.087	0.578	0.326	2.282	0.306	0.092

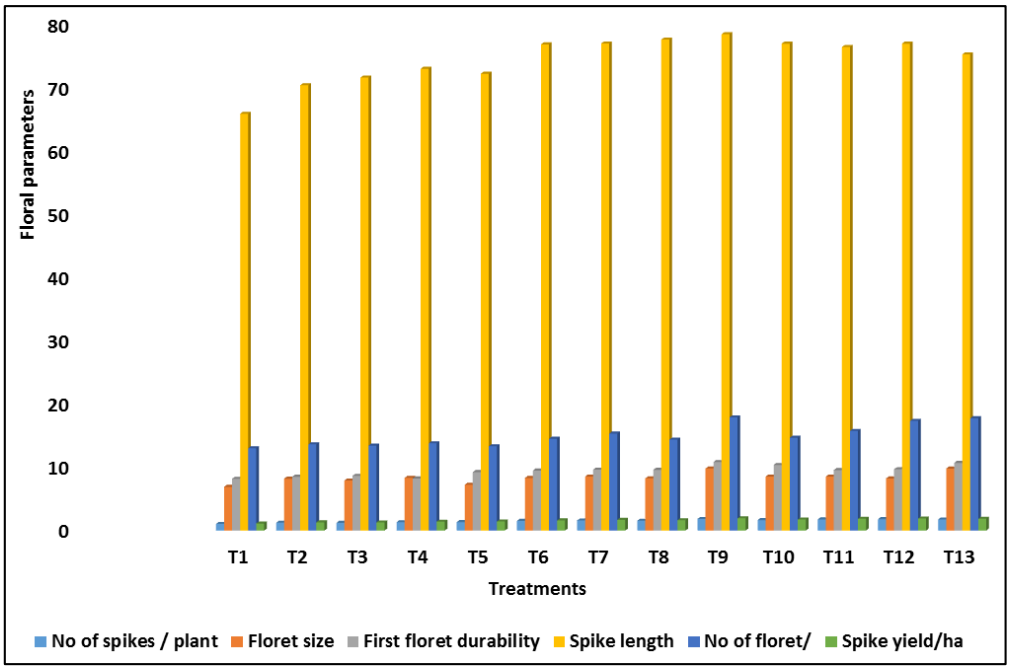

Fig 2: Floral parameters

B. Floral parameters

The data on floral parameters like number of spikes per plant, floret size, first floret durability, spike length, number of florets and spikes yield per hectare are given in Table.2 and geographical observation in Fig.2. It is clear that, The treatment T_9 (Boron 0.4%) gave the maximum number of spikes per plant (1.83), Whereas the minimum number of spikes per plant (1.05) was found in control. The treatment with Boron 0.4% have reported significant number of spikes per plant. The results are in support with Prasad *et al.*, (2014) [14]. The treatment (T_9 Boron 0.4%) gave the maximum floret size (9.79) (cm). Whereas the minimum floret size (6.89) (cm) was found in control. All the micronutrient treatments were significantly superior in their Floret size (cm) over control (T_1).The treatment with Boron 0.4%,have reported significant for floret size. The results are in support with Singh *et al.*, (2014) and Halder (2007) [4]. The treatment T_9 (Boron 0.4%) gave the maximum First floret durability (10.81) (days). Whereas the minimum first floret durability (8.17) (days) was found in treatments Control (T_1). The treatment with Boron 0.4%, have reported significant for floret durability. The results are in support with Khan *et al.*, (2010) [8]. The treatment T_9 (Boron 0.4%) gave the maximum spike length (78.33) (cm), whereas the minimum spike length (65.77) (cm) was found in control. The treatment with Boron 0.4%, have reported significant in large spikes. The results are in support with Singh *et al.* (2014). The treatment T_9 (Boron 0.4%) gave the maximum number of florets per spike (17.86), whereas the minimum number of florets per spike (12.99) was found in control. All the micronutrient treatments were significantly superior in their number of florets per spike over control (T_1).The treatment with Boron 0.4%, have reported significant in number of spikes per plant. The results are in support with Prasad *et al.*, (2014) [14] and Chopde *et al.*, (2015) in gladiolus. The treatment T_9 (Boron 0.4%) gave the maximum spike yield per hectare(1.93) (Lakh),Whereas the minimum spike yield per hectare (1.10) (Lakh) was found in control. It help to increase number of spikes. The treatment with Boron 0.4%, have reported significant in number of spikes per hectare. The results are in support with Singh *et al.* ((2014) and Chopde *et al.*, (2015) in gladiolus.

Table 3: Effect of micronutrients on corm and cormel parameters of gladiolus (*Gladiolus grandiflorus*) cv. White Prosperity

Treatment notation	Cormels Yield/ha (lakh)	No of corms /plant	Corm Yield/ha(lakh)
T_1	9.00	1.19	1.26
T_2	11.11	1.70	1.79
T_3	10.92	1.61	1.70
T_4	10.24	1.56	1.65
T_5	10.33	1.55	1.63
T_6	11.82	1.75	1.85
T_7	11.92	1.66	1.75
T_8	11.39	1.75	1.85
T_9	14.37	2.38	2.51
T_{10}	13.25	1.78	1.88
T_{11}	12.37	1.80	1.90
T_{12}	12.94	1.66	1.76
T_{13}	13.96	2.21	2.33
F-Test	S	S	S
S.Ed (+)	0.306	0.065	0.068
C.D. at 0.5%	0.631	0.133	0.141

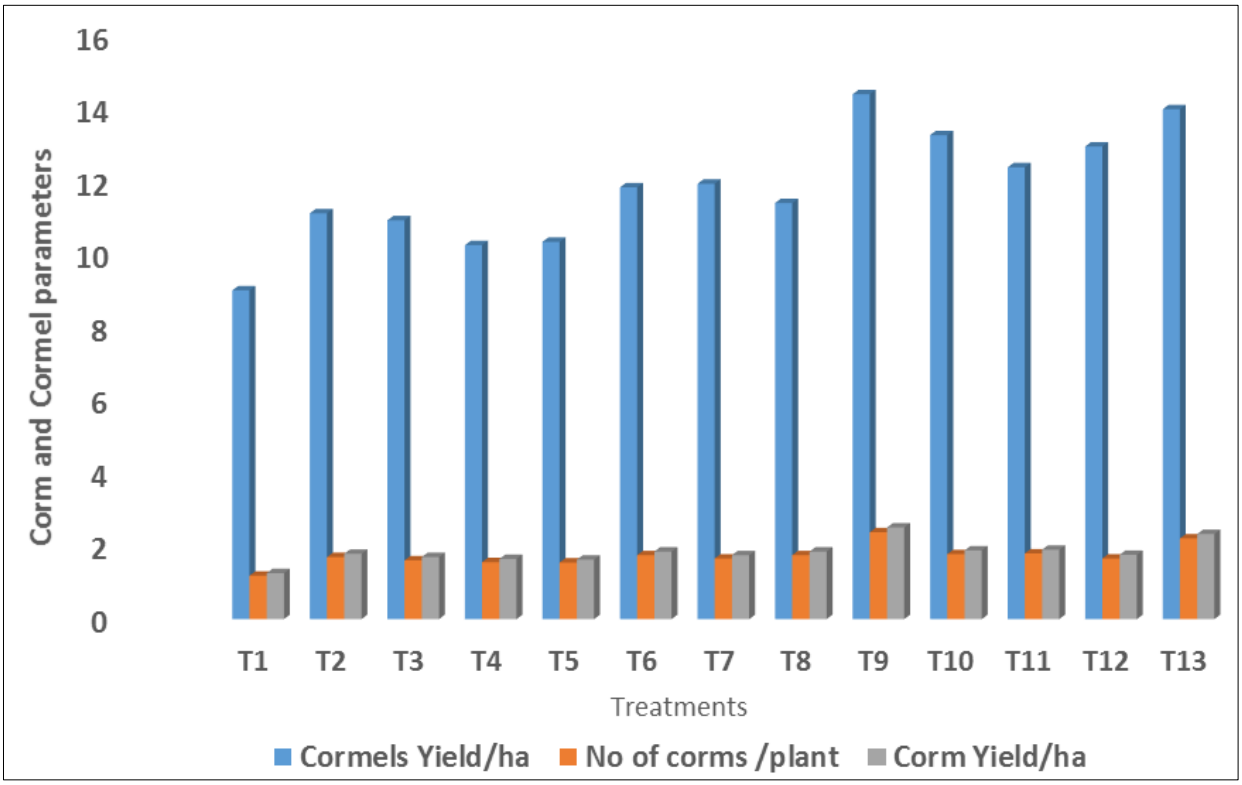

Fig 3: Corm and Cormel parameters

C. Corm and Cormel yield

The data on floral parameters like number of corms per plant, corm yield per hectare and cormels yield per hectare are given in Table.3 and geographical observation in Fig.3. It is clear that. The treatment T_9 Boron 0.4% gave the maximum number of corms per plant (2.38), The treatment with Boron 0.4% have reported significant number of corms per plant. The results whereas the minimum number of corms per plant (1.19) was found in control. are in support with khlifa *et al.*, (2011) and Halder *et al.*,(2007) [4].The treatment T_9 Boron 0.4% gave the maximum number of cormels per plant (13.61),Whereas the minimum number of cormels per planted corm (8.53) was found in control. The treatment with Boron 0.4%, have reported best for number of cormels per plant. The results are in support with Khalifa *et al.*, (2011) [7] and Ravi *et al.*, (2008). The treatment T_9 Boron 0.4% gave the maximum Corm yield per hectare (2.51) (Lakh), Whereas the minimum corm yield per hectare (1.26) (Lakh) was found in control. The treatment with Boron 0.4%, have reported significant in number of cormels per hectare. The results are in support with Mukherjee *et al.*, The treatment T_9 Boron 0.4% gave the maximum Cormels yield per hectare (14.37) (Lakh), Whereas the minimum cormels yield per hectare (9.00) (Lakh) was found in control. The treatment with Boron 0.4%, have reported significant in number of cormels per hectare. The results are in support with Khalifa *et al.*, (2011) [7].

Table 4: Effect of micronutrients on economics parameters of gladiolus (*Gladiolus grandiflorus*) cv. White prosperity

Treatment combination	Treatment			Cost of cultivation	Spike yield		Corm yield		Cormlet yield		Gross return	Net return	Benefit cost ratio
	Iron	Boron	Zinc	Rs ha^{-1}	No. ha^{-1} (Lakh)	Sale rate (Rs.)	No. ha^{-1} (Lakh)	Sale rate (Rs.)	No. ha^{-1} (Lakh)	Sale rate (Rs.)	Rs ha^{-1}	Rs ha^{-1}	
T_1	Control	Control	Control	595593.00	1.10	5	1.26	2	9.00	0.50	1254521.18	658928.18	2.11
T_2	0.1	-	-	595829.7	1.29	5	1.79	2	11.11	0.50	1562038.08	966208.38	2.62
T_3	0.2	-	-	596066.4	1.28	5	1.70	2	10.92	0.50	1525445.68	929379.28	2.56
T_4	0.3	-	-	596303.1	1.39	5	1.65	2	10.24	0.50	1534241.93	937938.83	2.57
T_5	0.4	-	-	596540.3	1.42	5	1.63	2	10.33	0.50	1552538.13	955997.83	2.60
T_6	-	0.1	-	596335.6	1.60	5	1.85	2	11.82	0.50	1760481.48	1164145.88	2.95
T_7	-	0.2	-	597078.1	1.68	5	1.75	2	11.92	0.50	1786870.23	1189792.13	2.99
T_8	-	0.3	-	597820.7	1.63	5	1.85	2	11.39	0.50	1755027.80	1157207.10	2.94
T_9	-	0.4	-	598563.2	1.93	5	2.51	2	14.37	0.50	2186747.75	1588184.55	3.65
T_{10}	-	-	0.1	595726.3	1.74	5	1.88	2	13.25	0.50	1909525.14	1313798.84	3.21
T_{11}	-	-	0.2	595859.6	1.86	5	1.90	2	12.37	0.50	1927434.30	1331574.70	3.23
T_{12}	-	-	0.3	595992.8	1.90	5	1.76	2	12.94	0.50	1946434.20	1350441.40	3.27
T_{13}	-	-	0.4	596126.1	1.85	5	2.33	2	13.96	0.50	2089109.38	1492983.28	3.50

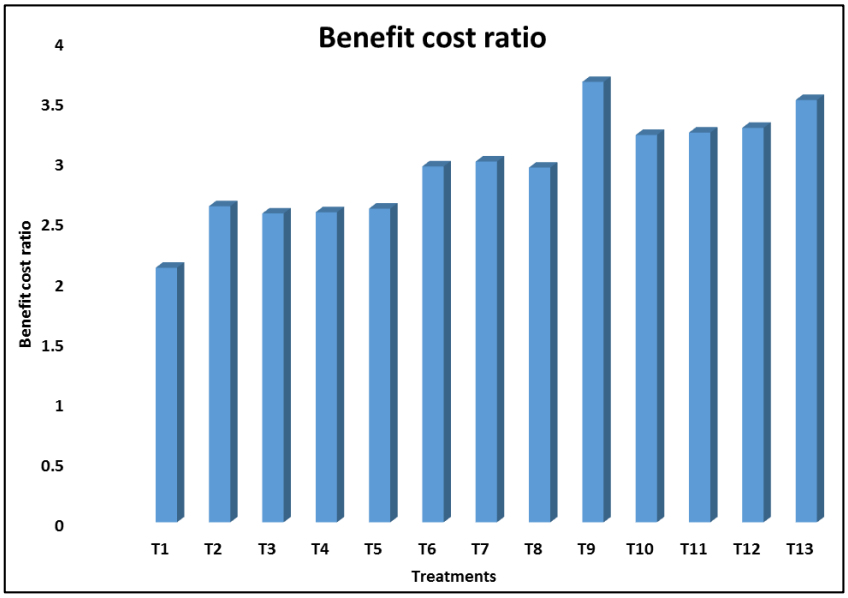

Fig 4: Benefit cost ratio

D. Economic parameters

The economic parameters are given in Table.4 and geographical observation in Fig.4. It is clear that, in economics maximum benefit cost ratio (1:3.59) was also found in T_9 (Boron 0.4%)**.**

Conclusion

It is concluded from the present investigation that application of micronutrient positively influenced plant growth, spike yield, and flower quality of gladiolus. Among all the treatment, T9 (Boron 0.4%) was found superior in relation to plant growth, spike yield, corm and cormels yield and flower quality of gladiolus. The maximum benefit cost ratio of (1:3.59) was also found in T9 (Boron 0.4%).

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