REVIEWS OF LITERATURE

Bhat et al. (1990) reported that in a comparison of application methods for plants of cv. Bright Golden Anne, in 4.5-inch-diameter pots, granular Aqua-Gro was added pre-planting to a 1:1 sphagnum peat and vermiculite potting medium at 0, 0.56, 1.13, 2.25, 4.5 or 9 oz/ftsuperscript 3; liquid Aqua-Gro was applied in the irrigation water at 0, 5, 10, 20, 40 or 80 ppm. All plants were treated with 3 sprays of 5000 ppm. daminozide for height control. Overall, the growth and flowering of Aqua-Gro treated plants were not significantly different from those of untreated controls. However, the highest rate of granular treatment (10 times greater than the recommended standard) reduced final plant height by 4.2% and spread by 14.3%, delayed flowering by almost one day and reduced both flower number/plant and size by 3%. Increasing concentrations of the liquid formulation had no effect on these parameters. Foliar concentrations of P, Zn and Cu were increased and those of K, Mg, Fe, Mn and B were reduced in plants treated with the 9 oz rate of granules; with liquid Aqua-Gro the only change in nutrient status was a 7-10% increase in the Ca content (compared with controls) in plants which received < 40 p.p.m. At the end of the production period there was no difference in nutrient levels between the control medium and that containing Aqua-Gro granules; drenching with 80 p.p.m. of the liquid formulation raised the K level by 20%. The control medium had the highest soluble salts content. The shelf life of plants was reduced by 3.7 days with the 9-oz granular treatment. The lasting quality of the flowers was correlated with plant contents of N, P, K, Mg, Cu, Mn and Zn and with the levels of N, K, Ca and soluble salts in the medium. Under moisture stress conditions, both Aqua-Gro formulations delayed flower wilting and the onset of leaf necrosis. Application of 10 p.p.m. of the Aqua-Gro liquid was effective in improving flowering and shelf life without being phytotoxic.

Bhattacharjee and Singh (1996) reported that the three-year-old rose hybrid tea cv. Raktagandha plants were sprayed with ZnSO4 (0.5 or 1.0%), FeSO4 (1.0 or 2.0%), MnSO4 (0.5 or 1.0%) or CuSO4 (0.1 or 0.2%) in Nov. 1991 (1 month after pruning) and again in Jan. 1992. FeSO4 at 1.0% was the most effective in stimulating secondary shoot production and increasing bud length, flower diameter, number of petals/flower and
flower production. MnSO4 at both concentrations enhanced flower quality and ZnSO4 at 1.0% enhanced quality and increased yield. Micronutrient sprays did not affect vase life or flowering date.

Polster et al. (1992) reported that the effect was studied using the mean length of L. longiflorum pollen tubes as a semiquantitative parameter. Pollen tube growth was examined in relation to the presence of boric acid, ortho-silicic acid, nucleic bases, Ca²⁺ and Zn²⁺ in 10% sucrose solution. The highest mean pollen tube length was obtained with B at 2-20 ppm. Si had a synergistic effect on pollen tube growth in the presence of B and facilitated branching, but was ineffective alone. Adenine and guanosine were able to partially substitute for B in stimulating pollen germination and pollen tube growth. Ca²⁺ could also partially substitute for B. The stimulatory action of B was significantly inhibited by Zn²⁺ and by the herbicide Dicuran [Chlorotoluron].


Barman and Pal (1993) on Polianthes tuberosa, Gomaa (2001) on amaryllis and Prabhat and Arora (2000) on gladiolus, Manoly (1996) on Iris and Munikrishnappa et al., (2002) on Polionthes tuberosa, and Samia and Mahmoud (2009), on Tritonia crocata, they found that spraying zinc sulphate increased plant height, number of leaves as well as fresh and dry weight of leaves. Studied traits, parameters were significantly responded to boron foliar application. It appeared that the B foliar spraying on Iris plants significantly increased plant growth parameters, yield and yield components and flowering traits studied. The middle rate of B concentration gave the highest plant height, highest number of bulblet/plant, highest flower width and highest fresh and dry weight of flowers/plant. While the highest B concentration rate treatment resulted the highest values of the following parameters i.e., leaves number/plant leaves fresh and dry weight of plant, bulblet fresh and dry weight of plants, highest length of spike and inflorescence.

**SUMMARY AND CONCLUSION**
Roy and Sarker (1995) and Halder et al. (2007a,b) on gladiolus plant and corn and cormel production. The positive response on gladiolus plant growth, yield and yield components due to Zn foliar spray may be attributed to its deficiency in studied soil. In addition, the important role of Zn come from its apparent requirement for the synthesis of optimum tryptophan (Precursor of IAA) levels and for the activation of enzymes involved in the synthesis of IAA.

Bhattacharjee and Singh (1996) reported that the three-year-old hybrid tea rose cv. Raktagandha plants were sprayed with ZnSO₄ (0.5 or 1.0%), FeSO₄ (1.0 or 2.0%), MnSO₄ (0.5 or 1.0%) or CuSO₄ (0.1 or 0.2%) in Nov. 1991 (1 month after pruning) and again in Jan. 1992. FeSO₄ at 1.0% was the most effective in stimulating secondary shoot production and increasing bud length, flower diameter, number of petals/flower and flower production. MnSO₄ at both concentrations enhanced flower quality and ZnSO₄ at 1.0% enhanced quality and increased yield. Micronutrient sprays did not affect vase life or flowering date.

Mostafa et al. (1996) reported that the effects of P (0 or 300 ppm P₂O₅), B (0, 90 or 270 ppm boric acid) and method of B application (pre-planting application to corms, foliar spray or soil drench) on vegetative growth, flower quality, corm production and essential oil yield and components of Polianthes tuberosa (cv. Double) were investigated in Alexandria, Egypt, during 1993-94. Generally, B applied pre-planting increased the number of corms and cormlets/plant and essential oil content and increased the percentage of principal components in the essential oil. Foliar application of B increased the eugenol content of essential oils and floret number/spike. Application of B at 270 ppm to the soil decreased leaf dry weight (DW). B (90 ppm) + P₂O₅ (300 ppm) prolonged flowering and increased corm and cormlet number. Soaking the mother corms in a solution containing B (90 or 270 ppm) + P₂O₅ (300 ppm) increased floret and spike DW, corm and cormlet fresh weight/plant and the percentage of tuberon and farnesol in the essential oil. Foliar application of B in combination with 300 ppm P₂O₅ increased the number of florets/spike and the percentage of eugenol and farnesol in the essential oil.
Jhon et al. (1997a,b), Bhattacharjee and Misra. (1998) and Halder et al. (2007a,b) on gladiolus the positive effect of both zinc and boron on plant growth, yield and yield components and flowers characters may be attributed to the highly deficient of those nutrients of the experimental soils. The beneficial effect of boron may be due to its physiological role in plant. Boron facilitates transport of carbohydrates through cell membrane, i.e starch and sugars as well as plays an important role as an activator for many enzymes which promote plant growth and flower production.

Donald et al., 1998). Parr and Laughman (1983) postulated that boron is involved in a number of metabolic pathways, i.e sugar transport, respiration, carbohydrate, RNA, IAA and phenol metabolism.

Prabhat and Arora (2000) studied in gladiolus cv. White Prosperity effect of foliar application of 0.2 or 0.4% FeSO₄, ZnSO₄ or MnSO₄ singly or in various combination at 3-leaf or 6-leaf stages. The application of 0.2% FeSO₄ induced flowering earlier than the other treatments, as well as increasing plant height and number of leaves. Spike length, number of florets, weight of spike and size of florets were significantly increased with the application of 0.2% FeSO₄ + 0.2% ZnSO₄. Flowering duration was longest with 0.4% FeSO₄ + 0.2% ZnSO₄. Corm production/plant was highest with 0.4% FeSO₄ + 0.4%, MnSO₄ + 0.2% ZnSO₄.

Kumar et al. (2001) reported that the effect of foliar application of zinc (ZnSO₄.7H₂O), copper (CuSO₄.5H₂O) and iron (FeSO₄.7H₂O); at 0, 250, 500 and 1000 p.p.m. on the yield and quality of Gladiolus grandiflorus cv. Mirela was studied in a field experiment conducted in Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India, during 1998-99 and 1999-2000. Plants treated with micronutrients gave better results with respect to growth, flowering and yield compared to the control. Foliar application of Fe, Cu and Zn at 1000 p.p.m. showed better results with respect to growth, flowering and other yield parameters. In general, the most effective treatment for increasing the yield attributes and quality parameters of Gladiolus grandiflorus was foliar application of Zn at 1000 ppm.

Kumar and Chattopadhyay (2001) reported that the Gladiolus grandiflorus cv. Tropic Sea was supplied with different levels of N (40, 50 and 60 g/m²) at 2 splits (3 and
6 leaf stages) as side dressing, P₂O₅ (10, 20 and 30 g/m²) and K₂O at 20 g/m², in a field experiment in West Bengal, India, during 1990-93. The fertilizer combination of N at 50 g/m², P at 10 g/m² and K at 20 g/m² resulted in the highest spike weight, numbers of flowers per spike, flower diameter, number of open flowers at a time, size and weight of corms, and number of corms.

**Wabha and El-Din (2002)** reported that of plant spacing and foliar micronutrient on the growth of Chrysanthemum and noticed that the microelements viz., Mg, Cu, B, Mo, and Co with dense planting (25cm) and produced tallest plants.

**Jitendra et al. (2003)** reported that sprayed Mn (10, 20, 30 and 40ppm) and Zn (200, 400, 600 and 800ppm) on carnation. They noted highest number of flowers per plant (48.86), flower diameter (6.88cm) as well as earliest flowering (97.80) with the spray of Zn 800ppm.

**Joshi et al. (2003)** reported that Fe, Zn and Cu sprayed on Desi red rose (*Rosa damascene*) and noticed that all three micronutrients were effective for plant height, plant spread and flower yield over control.

**Kumar et al. (2003)** reported that the Gladiolus cv. Sylvia at the 3-leaf stage with borax, CaSO₄ and ZnSO₄ (0.2, 0.5, and 0.75%, respectively) sprayings revealed that ZnSO₄ at 0.75% induced earlier flowering (75.81 days) and increased the number of corms (1.33). Length of leaf (55.75 cm) and length of floret (8.96 cm) were significantly increased with 0.2% borax + 0.75% ZnSO₄ and 0.5% CaSO₄ + 0.75% ZnSO₄, respectively. Spike length (78.50 cm), number of florets per spike (15.83), width of floret (8.51 cm), size of corm (6.44 cm), and weight of cormels (39.67 g) were significantly increased under 0.2% borax + 0.5% CaSO₄. The corm weight (54.38 g) was recorded maximum under 0.5% CaSO₄.

**Yadav et al. (2003)** reported that effect of N and Zn on the growth and spike production of tuberose, cv “Double and noticed that an addition fo 15 kg N and 10 kg Zn per hectare increased the growth parameters viz., plant height, leaf number over control.

**Singh and Singh (2004)** reported that the effect of spacing (15x20, 20x20 and 25x20 cm) and zinc fertilizer (0, 10 and 20 kg ZnSO₄/ha) on the growth and flowering
of Gladiolus cv. Sylvia. The different spacings and levels of ZnSO₄ did not significantly affect sprouting percentage and number of sprouts per corm in both years. However, spacing had a significant effect on the number of leaves per hill, which was highest at 25x20 cm. Spacing at 25x20 cm and 20.0 kg ZnSO₄ produced the tallest plants with the longest and widest leaves. Flowering was significantly influenced by spacing, where 25x20 cm spacing resulted in the earliest spike emergence, opening of first flower, number of flowers per spike and size of spike. There was no perceptible effect of ZnSO₄, regardless of application rate, on spike emergence, opening of first flower and spike diameter. On the other hand, 20.0 kg ZnSO₄/ha increased the number of flowers per spike and spike length followed by 15.0 kg ZnSO₄/ha compared to the control.

Katiyar et al. (2005) observed the effect of Zn, Cu and mixture of both as foliar spray (0.2%) applied twice, i.e. at vegetative growth and after emergence of spike on growth, floral characteristics and corm yield of Gladiolus (cultivars Aldebran, Friendship, Lady First and White Prosperity) grown in partially reclaimed sodic soils in Uttar Pradesh, India. Results showed that Zn, Cu or mixture of both sprays increased plant height of all cultivars except Lady First, which responded to the application of Cu compared to the control. The effect of the micronutrients was not significant on the number of tillers and spikes per plant. There was an increase of approximately 22-40% in spike length and 27-40% in the number of florets depending on the cultivar. Except Cu, the concentration of all micronutrients increased in the foliage accompanied by the increase in the content of only chlorophyll a in all the cultivars. The mixture of Zn and Cu increased the vegetative growth and enhanced the floral characteristics.

Katiyar et al. (2005) reported that the effect of Zn, Cu and mixture of both as foliar spray (0.2%) applied twice, i.e. at vegetative growth and after emergence of spike on growth, floral characteristics, Zn, Cu and mixture of both sprays increased plant height. The mixture of Zn and Cu increased the vegetative growth and enhanced the floral characteristics of Gladiolus.

Pratap et al. (2005) reported that the foliar spraying of FeSO₄ at 0.5% concentration significantly influenced iron content in the leaves. In contrast, leaf zinc content was least influenced by spraying of FeSO₄. Significantly
enhanced zinc content in the leaves was recorded by spraying with ZnSO₄ at 0.5%. The combined spraying of FeSO₄ and ZnSO₄ at varied concentrations was resulted in significant but inconsistent changes in leaf nutrient accumulation. Foliar spray of FeSO₄ at 0.75% significantly enhanced the cormel weight. The effect of ZnSO₄ alone or in combination with FeSO₄ had no significant effect on corm and cormel production parameters.

**Sharma and Devi (2005)** investigated the effect of different holding solutions on the quality and vase life of tuberose [*Polianthes tuberosa*] (cv. Single) and Gladiolus (cv. Thumbeliana). The different holding solutions were: sucrose (3%), hydroxyquinoline (200 ppm), cobalt chloride (500 ppm), silver thiosulfate (4 mM), boric acid (250 ppm), aluminium sulfate (400 ppm), gibberellic acid (100 ppm), citric acid (300 ppm), zinc sulfate (0.25 mM), calcium nitrate (0.05%), magnesium sulfate (1 mM) and silver nitrate (25 ppm). Observations were recorded on longevity of the first floret in vase, floret diameter, percentage of fully opened florets, maximum florets opened at a time, effective useful life and vase life. The silver nitrate was the best for improving the quality and lengthening the life of cut tuberose and Gladiolus spikes. The aluminium sulfate was also good for improving the postharvest life of the cut spikes.

**Bala et al. (2006)** conducted an experiment in Hyderabad, Telangana State, India, on Gladiolus (*Gladiolus grandiflorus*) cultivars Praha, Fiedelio and Jacksonvilla Gold to determine the effect of preharvest sprays of ZnSO₄ (0, 0.5 and 1%) and planting date (1 November, 16 November and 2 December) on flowering, flower quality and vase life. Fiedelio was late to open first floret and complete flowering and produced longer and heavier spikes with more number of florets per spike. Corms planted on 1 November were earliest to flower. Flowering was delayed with the increase of concentration of ZnSO₄. In vase life studies, Fiedelio recorded maximum fresh weight and minimum water loss to uptake ratio. Jacksonvilla Gold recorded maximum vase life and minimum number of florets opened per day. The number of florets opened per day were maximum in November plantings coupled with ZnSO₄ sprays.

**Halder (2007)** reported that the response of gladiolus to boron and zinc fertilizer and to find out the optimum dose of B and Zn for maximizing flower field of gladiolus.
Treatments comprising four levels of B (0, 1, 2 and 3 kg/ha) and four levels of Zn (0, 1.5, 3.0 and 4.5 kg/ha) along with combined blanket dose of N$_{375}$P$_{150}$K$_{250}$S$_{20}$ and cowdung 5 t/ha were used in the study. BARI Gladiolus-1 was taken as a test flower crop. However, it felt in the field data that B and Zn in their integration made a significant influence on flower yield and floral characters of gladiolus. It was also inferred in Tables that integrated use of B and Zn was appeared to be more pronounced as compared to their single applications. All the studied flower characters like length and weights of rachis and spike and number and weight of florets per spike and stick weights and size of the florets influenced with the increase of B and Zn but subsequent addition of B and Zn beyond that level (B$_{2.0}$Zn$_{3.0}$ kg/ha) depressed the flower yield. Besides, the highest mean stick weight (55.19 g) and the highest flower yield (14.70 t/ha) were recorded with the combined application of B$_{2.0}$Zn$_{3.0}$ kg/ha and 122% increase of flower yield was found to be contributed by afore said treatment (B$_{2.0}$Zn$_{3.0}$ kg/ha). This was significantly higher over other treatment combinations and B$_0$Zn$_0$. Similar result was also noticed in single applications of B and Zn but their effect was narrowed.

Halder et al. (2007) studied the effect of B (0, 1, 2 and 3.0 kg/ha) and Zn fertilizers (0, 1.5, 3.0 and 4.5 kg/ha) on corm and cormel production of Gladiolus. B at 2.0 kg/ha and Zn at 4.5 kg/ha along with a blanket dose of N$_{375}$P$_{150}$K$_{250}$S$_{20}$ and 5 t cow dung/ha was optimum for corm and cormel production.

Halder et al. (2007) studied the effect of B and Zn on Gladiolus sp. at the Floriculture Farm of HRC, Gazipur and RARS, Jessore, Bangladesh, during 2005-06. The objective was to evaluate the response of B (at 0, 1.0, 2.0 and 3.0 kg/ha) and Zn (0, 1.5, 3.0 and 4.5 kg/ha) and to find out the optimum dose of the same for production of Gladiolus sp. The data revealed that B and Zn made promising response to the growth and floral characters of Gladiolus sp. It was also noticed that B and Zn both either in single or in combination exerted tremendous effect on the yield and quality of Gladiolus sp. However, as the subsequent addition of higher rates of B and Zn progressively increased the selective growth and flower characters to some extent, beyond further increment of the dosage the results declined noticeably. It has also been reported that Gladiolus sp. is highly responsive to chemical fertilizers. The 16 treatment combinations included in the study noted that B and Zn at the rate of 2.0 and 4.5 kg/ha,
respectively, along with the blanket dose of 375:150:250:20 kg/ha of N:P:K:S and 5 t CD/ha exhibited the best performance in flower production and stretched the vase life of flower. The studied parameters like plant height (79.83 and 87.61 cm), length of spike (71.2 and 67.33 cm), length of rachis (48.86 and 45.08 cm) and leaves number (10.77 and 9.87/plant) significantly responded to the combined application of boron and zinc at the rate of 2.0 and 4.54 kg/ha, respectively, as compared with the other treatment combinations. Floral characters like floret number (12.85 and 12.45/spike), floret size (9.76x8.93 and 10.28x9.77 cm) and weight of stick (36.73 and 45.12 g) also significantly influenced by the same treatment which was markedly differed over rest of treatments combination. Similar trend was noticed as well in single application of B and Zn with increased rates.

Khoshgoftarmanesh et al. (2008) reported the effect of additional supply of iron (Fe), zinc (Zn), manganese (Mn), and copper (Cu) on three rose cultivars. Five fertilizer treatments were utilized: 0 (control), 150 micro mol Fe L⁻¹, 150 micro mol Fe+10 micro mol Mn L⁻¹, 150 micro mol Fe+10 micro mol Mn+12 micro mol Zn L⁻¹, 150 micro mol Fe+10 micro mol Mn+12 micro mol Zn+5 micro mol Cu L⁻¹. The results demonstrated significant variation among rose cultivars in developing Zn, Fe, and Mn deficiency symptoms and response to micronutrient supplies. For cvs. Modern Girl and Orange Juice, all micronutrient treatments resulted in higher stem length and thickness as compared to the control. Non significant increase in stem length was observed in cv. Aqua Fresh. All cultivars had the greatest flower vase life in the added Zn treatments. All fertilizer treatments significantly increased Fe concentration in the leaves of cvs. Modern Girl and Aqua Fresh as compared to the control. The Fe-Mn-Zn-Cu treatment significantly increased leaf concentration of Mn, Zn, and Cu in all cultivars. Leaf sodium (Na) concentration was lower in the micronutrient treatments that included Zn addition as compared to the treatments that did not include added Zn. No visible mildew symptom was observed in the treatments with Zn addition. The results showed that genotypic variation and sufficient micronutrient supply are two key factors in successful production of rose in the soilless culture. Furthermore, the results indicated the importance of Zn in enhancing the quality of the rose flower.

**SUMMARY AND CONCLUSION**
Pratap et al. (2008) conducted experiment in Andhra Pradesh, India, for two consecutive years (1998 and 1999) to study the influence of preharvest micronutrient foliar sprays on postharvest keeping quality of Gladiolus (cv. Trader Horn) using postharvest vase chemicals. The experiment comprised preharvest micronutrient foliar sprays of FeSO₄ (0%, 0.5%, 0.75% and 1%) and ZnSO₄ (0%, 0.25%, 0.5% and 0.75%) with 16 treatment combinations sprayed at the 3- and 6-leaf stage of the crop. Various postharvest vase chemicals used were NaOCl at 25, 50 and 100 ppm, STS at 100 ppm, Al₂(SO₄)₃ at 400 ppm and a combination of these vase chemicals. Sucrose was added as a source of base material in all the vase chemical treatments. Preharvest spraying of FeSO₄ at 0.75% or 1% along with ZnSO₄ at 0.5% was found promising in delaying the days taken for basal floret opening and the number of floret opening at a time. Preharvest spraying of these micronutrients and dipping the cut ends of Gladiolus spikes in vase solution of sucrose at 2%+NaOCl at 50 or 100 ppm, sucrose at 2%+STS at 50 or 100 ppm or Al₂(SO₄)₃ at 400 ppm significantly influenced in extending the days taken for basal flower opening and number of flowers opening at a time.

Ravi et al. (2008) studied the effect of sulphur, zinc and iron nutrition on growth, yield, nutrient uptake and quality of safflower on Vertisol at the Main Agricultural Research Station, (MARS) University of Agricultural Sciences, (UAS) Dharwad, Karnataka India, during rabi season 2002-03. The results indicated that application of 30 kg S per ha improved the growth parameters like plant height, number of leaves, number of branches and dry matter, yield components viz., number of capsules, seed weight per head, 1000-seed weight and nutrient uptake of N, P, K, S, Zn and Fe as compared to other treatments. Combined application of sulfur along with micronutrients (Zn and Fe) had significant influenced on the growth, yield and nutrient uptake by safflower. The treatment receiving 30 kg S per ha+Fe+Zn foliar recorded the highest growth, yield and nutrient uptake as compared to 30 kg S per ha, 20 kg S per ha+Fe+Zn foliar, 10 kg S per ha+Fe+Zn foliar spray and control.

Ganga et al. (2009) reported that Dendroubium cv. Sonia -17 plants were supplied with the recommended dose of fertilizers Which is 0.2% of NPK @ 20:10:10 given as foliar spray at fortnightly intervals. Among the micronutrient treatments, 1000
ppm ferrous ammonium sulphate was found superior in respect of the vegetative parameters viz., plant height (39.31 cm), number of leaves/plant (7.51), number of pseudobulbs/plant (7.12) and number of roots/plant (23.41) as well as flowering parameters viz., number of spikes/plant (6.73), number of florets/spike (9.21), spike length (35.24 cm), flower pedicel length (4.91 cm) and vase life (16.72 days).

**Reddy and Chaturvedi (2009)** studied the effect of zinc (ZnSO₄) at 0.5%, calcium (CaSO₄) at 0.5% and boron (borax) at 0.25% on growth and flowering in Gladiolus cv. at C. S. A. University of Agriculture and Technology, Kanpur, Uttar Pradesh, India, during 2005-06. Foliar application of ZnSO₄ at 0.5% found to be significant on different parameters like plant height (73.11 cm), leaf length (52.81 cm), days to flowering (66.11 days), length of spike (54.01 cm), length of rachis (46.26 cm), number of florets per spike (14.00) and floret length (9.08 cm). While borax and CaSO₄ have shown non significant results for most of the characters except days to flowering (66.13 days) and number of florets (13.93) per spike with boron at 0.25%. However, the interaction between boron (0.25%), ZnSO₄ (0.5%) and CaSO₄ (0.5%), ZnSO₄ (0.5%) revealed significant results for plant height (73.27 and 73.33 cm, respectively). While the interaction between boron and ZnSO₄ was significantly affected by days to flowering (66.13 days) and rest of the interactions were non-significant.

**Sivaparakasam et al. (2009)** reported that the spermine at 5 micro M delayed flower senescence in ethylene-insensitive Gladiolus by three days, along with increased fresh weight which was retained for longer period and increased vase solution uptake as compared to control. Activities of total SOD as well as that of its copper/zinc and iron isoforms were significantly enhanced by spermine. Qualitative analysis revealed one Fe SOD and two Cu/Zn isozymes, Cu/Zn SOD₁ and Cu/Zn SOD₂. Cu/Zn SOD₁ appeared to be constitutively expressed but at a higher level than Cu/Zn SOD₂, though the later is more responsive to spermine treatment. Spermine reduced the expression of GgCyP while upregulating GgSOD. Spermine is thus effective in delaying senescence. It increased the activity of all the isoforms of SOD thereby, reducing oxidative stress and prolonging the vase life. Spermine affected gene expression of GgCyP and GgSOD without any impact on GgERS1a, while slightly affecting the
expression of GgERS1b. The differential impact of spermine is related to the differential role of these genes in senescence.

Karakurt and Aslantas (2010) conducted and experiment to evaluate the effects of four strains of plant growth promoting rhizobacteria (Agrobacterium rubi A-18, Bacillus subtilis OSU-142, Burkholderia gladioliOSU-7 and Pseudomonas putida BA-8) on growth and leaf nutrient content of apple cvs viz. 'Starking Delicious', 'Granny Smith', 'Starkrimson Delicious', 'Starkspur Golden Delicious' and 'Golden Delicious' grafted on semi-dwarf rootstock MM-106. The application of bacterial strains increased the leaf number and area as well as number of annual shoots and their diameter, although OSU-7 application suppressed annual shoot length. BA-8 application resulted in the highest annual shoot number (52.4) and OSU-142 in the largest leaf area (16.12 cm²). The applications of A-18 bacteria decreased the concentration of N, K and Cu and increased the concentration of P and Zn in the leaves. OSU-142 application resulted in the highest Mg (0.13%) and Fe (32.7 ppm) contents and OSU-7 in the highest Mn content (40.3 ppm). None of the applications affected the concentration of Na and Ca in the leaves.

Khan et al. (2010) studied the effect of foliar application of different micronutrients (B, Zn & Fe; 0.5%, 1.5% and 1%, respectively) on plant growth and flowering of three rose (Rosa hybrida L.) cultivars viz. Kardinal, Amalia and Rosy Cheeks. Nutrients were applied alone and with different combinations after 6, 8 and 10 weeks of pruning. Plant height, number of leaves/branch, leaf area, number of flowers/plant, flower stalk length and leaf Zn contents were maximum with B+Zn application followed by only B application which also resulted early flower production as compared to rest of the treatments while bud diameter, flower diameter, as well as fresh & dry weight of flowers were maximum with B application alone followed by combination of B+Zn application. Leaf chlorophyll contents, flower quality, flower stalk diameter and leaf B & Fe contents were highest when plants were sprayed with combination of all micronutrients. Plants without micronutrients application produced poor quality vegetative growth and less number of flowers. Regarding cultivars, Rosy Cheeks responded well to micronutrients as compared to Amalia and Kardinal. It is

**SUMMARY AND CONCLUSION**
concluded that application of micronutrients could help better to improve flower yield and quality of roses.

Kumar and Haripriya (2010) reported that the effect of foliar application of iron and zinc on growth, flowering and yield of Nerium (Nerium odorum L.) cv Pink Double in treatments using monthly spray of 0.25%, 0.50% and 0.75% of FeSO₄, ZnSO₄ and their combination with a control (water spray) at Floriculture Research Complex in the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalainagar Tamil Nadu, India. Among different treatments, FeSO₄ @ 0.75%+ZnSO₄ @ 0.50% spray gave significantly maximum value on all the growth attributes like plant height, no. of secondary branches, no. of leaves per plant, plant spread and leaf area. But, number of primary branches per plant was non significant in this study. However, significant and superior results on early flowering, duration of flowering and yield attributes like flower diameter, hundred flower weight, flower yield per plant, flower yield per plot and estimated flower yield per hectare were observed with FeSO₄ @ 0.75%+ZnSO₄ @ 0.50% spray, followed by FeSO₄ @ 0.75%+ZnSO₄ @ 0.75% spray.

Khalifa et al. (2011) studied the influence of the foliar spraying of zinc (as zinc sulphate) and boron (as boric acid) on growth parameters, bulblet, flower characteristics, chemical constituents and nutrients content of leaves and flowers in iris. Zinc sulphate (Zn) at concentrations of 0.0, 1.5g/l, 3.0g/l and 4.5g/l and boric acid (B) at concentrations of 0.0, 5ppm, 10 ppm and 20 ppm were applied alone and in combinations twice as foliar spray, where the first was after 45 days and the second was after 60 days of planting. Results showed that the foliar spraying of zinc sulphate or boric acid alone at all rates and as combinations significantly increased growth parameters, flowers characteristics and bulblet number and yield/plant as compared with the control treatment. The treatments also significantly increased leaves carbohydrate, pigment, nutrients, i.e. N, P, K, Fe, Mn, Zn and B content, as well as carbohydrate and oil of flowers (%) and its nutrients content as compared with the control. The most promising results were obtained from plants treated with Zn at 4.5g/l combined with 20 ppm B.
Khosa et al. (2011) observed the effect of foliar application of macro (NPK) and micro nutrients (Zn, B, Fe and Mn) on gerbera growth and flowering production. The fertilizer solution of macro nutrients containing 1 g, 1.5 g and 2 g of nitrogen, potassium and phosphorus, respectively and micro power contain 5000+ or-200, 4000+ or-200 and 5000+ or-200 mg/100 ml solution of Zn, B, Fe and Mn. Different concentration of macro nutrients i.e. 12.5 ml+987.5 ml water, 18.75 ml+981.25 ml water and 25 ml+975 ml water taken and sprayed fifteen days intervals on potted gerbera. Spray of micro power (solution of different micronutrients) was also being applied at constant rate of 5 ml/1000 ml solution of water. Plant height, number of branches per plant, length of branches per plant, number of leave per plant, leaf area, stock length, days to first flower emergence, flower diameter and flower quality increased with increasing fertilization level and began to turn down when fertilization level exceed beyond the above given levels of macro and micro nutrients. Foliar fertilization influenced the days to first flower emergence as compared to control where no foliar spray of macro and micro nutrients was applied.

Jagtap et al. (2012) studied the effect of foliar application of micronutrients on growth and flowering of rose under polyhouse conditions at Satpuda Botanic Garden, College of Agriculture, Nagpur, Maharashtra, India during the year July 2008 to Dec. 2008. The treatment comprised of 0.1 to 0.3 per cent alone ZnSO₄, MnSO₄, FeSO₄ and combination treatments. The results indicated that, the vegetative growth in term of number of primary branches, number of secondary branches, number of leaves per shoot, number of leaves per plant and number of blind shoots were found superior under 0.3 per cent ZnSO₄+0.3 per cent MnSO₄+0.3 per cent FeSO₄ followed by 0.2 per cent ZnSO₄+0.2 per cent MnSO₄+0.2 per cent FeSO₄. The flowering attribute like days required for first flower bud initiation was found minimum in treatment 0.3 per cent ZnSO₄+0.3 per cent MnSO₄+0.3 per cent FeSO₄ Foliar spray of 0.3 per cent ZnSO₄+0.3 per cent MnSO₄+0.3 per cent FeSO₄ increased the flower yield and quality of flower.

Katiyar et al. (2012) reported that the foliar spray of zinc at 0.5% to Gladiolus plant was most effective to influence the vegetative growth and size of spike.
Lahijie (2012) conducted field experiment for two consecutive years to study the effect of foliar spray of Feso₄ and ZnSO₄ on the growth and floral characteristics of gladiolus cv. Oscar. The results disclosed that solutions of Feso₄ and ZnSO₄ significantly affected plant growth and floral characteristics of Gladiolus. Higher contents of both Feso₄ and ZnSO₄ speed the plant growth and increased flowering characteristics. Application of 1% Feso₄ accelerated flowering earlier than ZnSO₄, as well as elongated days to spike emergence (21.49 days) and first florets opening (38.28). The results showed that 2% of both Feso₄ and ZnSO₄ solutions and their mixture delayed the days from basal floret opening and number of florets open at a time. The flowering properties like plant height (83.47 cm), length of spike (66.03 cm), number of leaves (9.52/plant) floret number (11.55/spike) and diameter of floret (8.53 cm) were significantly different with other treatments when a mixed solution of 2% Feso₄ and ZnSO₄ was applied. It is concluded that no application of micronutrients on Gladiolus ornamental at the commercial scale will produce poor quality of vegetative growth and low number of florets. However, It is suggested that micronutrients play a vital role on the growth and development of Gladiolus plants, because of its stimulatory and catalytic effects on flower yield and metabolic processes.

Prashant et al. (2012) reported that the foliar spray of zinc at 0.5% to Gladiolus plant was most effective to influence the vegetative growth and size of spike.

Reddy and Nageshwar (2012) conducted and experiment to find out precision foliar application of zinc on Gladiolus. The experiment was spraying of zinc at different concentrations (2, 1 and 0%) at different days after planting (4, 6 and 8 weeks). The treatment 2% zinc has significantly increased plant height, number of leaves, leaf length, leaf width and leaf area at 40, 60 and 80 DAP, with highest values when sprayed at 6 weeks after planting compared to 4 and 8 weeks after planting, minimum values were observed with control. Among the floral parameters, the treatment 2% zinc recorded more number of days (97.63) to first floret appearance and 50% flowering (103.32) over other treatments whereas, control recorded minimum number of days to first floret appearance and 50% flowering. Similarly, the treatment 2% zinc recorded more number of spikes (1.33), spike length (112.19 cm), number of florets per spike and highest spike
growth rate (0.68 cm/day). While the interaction of 2% zinc and 6 weeks after planting recorded maximum spike length (118.36 cm) and number of florets (13.40). The treatment 2% zinc sprayed at 6 weeks after planting recorded maximum values for corm size (4.47 cm), corm weight (37.97 g), number of cormels (32.90) and cormel weight per corm (10.72 g), while minimum values were observed with control.

Singh et al. (2012) conducted an experiment consisted of two levels each of Zn (Zn₀ and Zn₁), Fe(Fe₀ and Fe₁) and Cu (Cu₀ and Cu₁) which were sprayed on Gladiolus plants. The dose of foliar spray of zinc, iron and copper were 0.5%, 0.25% and 0.25%, respectively. Results revealed that all the vegetative parameters increased significantly by Zn and Cu sprays. Similarly, iron enhanced significantly the height of plant and length only. Combined effect of Zn and Cu increased the height of plant, length of leaves and width of leaves significantly. Whereas, interaction of Zn x Fe and Fe x Cu increased length and width of leaves. Interaction effect of Zn x Fe x Cu also influenced significantly to these attributes. All floral characters influenced significantly by Zn except days to heading. Similarly, Cu increased all floral parameters. Fe also influenced all floral parameters barring the length of spike only. Days to heading significantly increased by Fe x Cu.

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Singh et al. (2012) tried dose of foliar spray of zinc, iron and copper @0.50%, 0.25% and 0.25%, respectively in gladiolus cv. Sapn. Weight of corms significantly increased with the application of Zn and Cu (94.38 and 94.82 g, respectively). Diameter of corms influenced significantly with the application of Zn, Fe and Cu (5.71, 5.77 and
5.81 cm diameter, respectively). Foliar spray of Zn, Fe and Cu, significantly increased the number of corms per plant. Interaction between Zn x Fe and Zn x Cu, significantly enhanced number of corms per plant whereas, the number of corms per plant revealed by Zn (1.74), Fe (1.66) and Cu (1.68) over their respective controls. Maximum increase in cormels production per plant was influenced due to application of zinc (44.97) followed by spray of copper (43.18) and iron (42.11) over their respective controls.

Adnan et al. (2013) reported that the quality and flower yield of roses are directly dependent on the balanced application of macro and micronutrients. In the present study, foliar application of macro- and micronutrients was done after every 15 days when new emerging leaves had sprouted after pruning. The results revealed that plants treated with foliar application of micronutrients along with NPK showed significant increase in the growth characteristic like plant height, number of flowers plant$^{-1}$, bud diameter, flower diameter, fresh and dry weight of flower, flower quality, flower stalk length when compared to the application of NPK alone and untreated plants (control). Application of foliar fertilizer (NPK=15:32:7+micro power) and NPK (15:32:7)+chelated mix micronutrients gave the highest values compared to the other treatments in both cultivars. Cultivar Cardinal responded well to micronutrients as compared to cv. Whisky Mac in case of cultivars. Leaf total chlorophyll contents, vase life and the mineral contents (NPK) of leaves were significantly increased as a result of foliar application of micronutrients compared to the control treatment. It was concluded that application of micronutrients along with NPK could improve flower yield and quality of roses.

Memon et al. (2013) reported the effect of zinc sulphate (ZnSO$_4$) and iron sulphate (FeSO$_4$) on the growth and flower production of Gladiolus. Treatments included T1=Control, T2=20 g ZnSO$_4$, T3=40 g ZnSO$_4$, T4=20 g FeSO$_4$, T5=20 g ZnSO$_4$ +20 g FeSO$_4$ and T6=40 g ZnSO$_4$ +20 g FeSO$_4$. The effect of zinc sulphate (ZnSO$_4$) and iron sulphate (FeSO$_4$) on the growth and flower production of Gladiolus was examined. The results showed that application of 40 g ZnSO$_4$ +20 g FeSO$_4$ resulted in significantly better performance than rest of the treatments with 12.44 leaves/plant, 115.70 cm length of leaves, The control treatment resulted in lowest values for almost all the studied traits. It was concluded that overall growth and flower production performance of Gladiolus were remarkable when the plants were supplied with combined application of

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40 g ZnSO$_4$ + 20 g FeSO$_4$ and lowest performance was noted in control. Hence, for achieving high performance in Gladiolus, the plants may be fertilized with 40 g ZnSO$_4$ + 20 g FeSO$_4$.

**Sharma et al. (2013)** tried the dose of foliar spray of Zn, Ca and B of 0.75%, 0.50% and 0.20%, respectively. The height of plant significantly increased by foliar application of Zn, B, and Ca (79.55 cm, 79.39 cm and 78.75, respectively) interaction effect was also significant between those. The yield of spike increased significantly with foliar application of zinc and calcium, maximum yield of spike (16904.50) was recorded with application of zinc 0.75%. The length of floret was significantly enhanced by the use of B (8.29) and Zn (8.23) while, effect of Ca was non-significant. Spray of calcium was found most effective in prolonging the longevity of spike (17.61 days) as compare to control (14.79 days) and more corms (3.30) were produced in the plants fertilized with zinc. Results obtained among, from the application of Zn, B and Ca and its interaction Zn exhibited most significant effect on various parameters studied under the investigation.

**Sonmez et al. (2013)** reported the effects of organic fertilizers on nutrient contents in leaves and corms of *gladiolus*. Chicken manure, farmyard manure, peat and waste mushroom compost were used as organic fertilizers. As a result, while the highest mean contents of nitrogen (1.97%), iron (160 ppm) and manganese (128 ppm) in leaves were obtained in chicken manure application, the highest mean contents of potassium (2.01%), calcium (1.80%) and magnesium (0.25 ppm) were determined in waste mushroom compost application. The highest mean contents of phosphorus (0.30%), zinc (25.3 ppm) and copper (9.29 ppm) in leaves were found with peat, control and farmyard manure applications, respectively. The highest mean contents of phosphorus (0.83%), potassium (1.47%), calcium (0.57%), manganese (73 ppm) and zinc (67.3 ppm) in corms were obtained in farmyard manure applications. While the highest mean contents of nitrogen (4.86%) and copper (20.9 ppm) in corms were determined in chicken manure application, the highest mean contents of iron (17.6 ppm) and magnesium (0.20%) in corms were obtained in peat and waste mushroom compost applications, respectively. Application of organic fertilizers increased macro and micro nutrient contents in leaves and corms of gladiolus.
Tariq et al. (2013) reported that the Zinc being an activator of certain enzymes, regulates antioxidant activity; therefore, it could enhance the shelf life of cut flowers. This study on zinc (Zn) nutrition of Gladiolus was conducted for two years (2010-2011) in the greenhouse. Graded levels of zinc, viz., 0, 2, 4, 6, 8 and 10 mg Zn/kg were applied in soil media. Results in both the years revealed significant positive response to zinc application on growth and vase life attributes of gladiolus. Zinc at 6 mg/kg rendered the highest impact for increasing the leaf area, spike length, flower size, fresh and dry biomass weight. Less number of days to flowering and higher count of florets per spike was recorded with 8 mg Zn/kg. Chlorophyll and protein contents were highest at 6 mg Zn/kg; whereas, Zn contents were highest with 10 mg Zn/kg. Vase quality parameters like percent florets opened, vase life and fresh weight change were greater with 8 mg Zn/kg, and the least membrane leakage was also ensured at this rate. Antioxidant enzymes, viz., SOD, CAT, POD and free radical scavenging activities in cut flowers remained at the highest with 6 mg Zn/kg. This study concludes that Zn applied at 6-8 mg/kg imparts greater beneficial effects on growth, production, vase life quality, and antioxidative activities in Gladiolus cut flower, and further higher application rates render non-significant improvement.

Amin et al. (2014) reported the effect level of zinc on growth, flowering and production of corms and cormels of Gladiolus. Experiment consisted of four different levels of zinc viz. Z0= 0 kg Zn/ha, Z1= 1 kg Zn/ha (1.28 Kg ZnO), Z2= 2 kg Zn/ha (2.56 Kg ZnO), Z3= 3 kg Zn/ha (3.84 Kg ZnO) and Z4= 4 kg Zn/ha (5.12 Kg ZnO). Maximum number of spike (22.3/plot), number of floret/spike (16.1), corm yield (1.23 kg/plot) and cormel yield (1.06 kg/plot) was found from Z3 while lowest number of spike (17.9/plot), number of floret/spike (11.1), corm yield (0.86 kg/plot) and cormel yield (0.80 kg/plot) was found from Z0.

Fahad et al. (2014) investigated the effect of micronutrients (B, Zn and Fe) on growth, flower yield and quality of Gladiolus cv. Traderhorn. Eight treatments comprised of either each micronutrient alone or a combination of Fe, B and Zn were applied. Corms were planted within the first week of November 2010, and 2011 on 60 cm apart ridges with 20 cm distance allowed within rows. Micronutrient sprays were applied at 30 and 60 Days After Planting (DAP). Application of micronutrients significantly increased plant

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height, leaf chlorophyll content, 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. Leaf number and days to spike emergence were only influenced by a combined application of all the three micronutrients. Among the micronutrient treatments, the treatment containing FeSO4.7H2O, H3BO3 and ZnSO4.7H2O (all at 2% level) performed the best for all the parameters except for number of corm per plant, which was not affected significantly by the foliar application of the micronutrients.

Karuppaiah et al. (2014) studied the effect of zinc and iron on growth, yield and quality of chrysanthemum during 2009-2010 at the Department of Horticulture, Annamalai University, Annamalainagar, Tamil Nadu, India. Sixteen treatments were formulated with three levels (0.25, 0.5 and 0.75%) each of zinc sulphate and ferrous sulphate individually and in combination. The control was the usual practice of the farmers. Various biometric observations on growth and physiological viz., plant height, stem girth, number of branches and leaves per plant, leaf area and chlorophyll content, flowering and yield attributes viz., number of flowers per plant, flower stalk length, flower head diameter, flower head weight, flower yield per plant and hectare and quality attributes viz., xanthophyll and carotenoid content, visual rating and shelf life were recorded. The results revealed that the treatment combination of 0.5% zinc sulphate +0.5% ferrous sulphate ) was found to be the best in growth, yield and quality attributes followed by 0.5% zinc sulphate +0.75% ferrous sulphate and 0.5% zinc sulphate +0.25% ferrous sulphate.

Niedz et al. (2014) conducted four types of experiments to quantify the effects of mineral nutrients on four in vitro growth responses (quality, shoot number, leaf number, and shoot height) of gerbera and included groups of mineral nutrients (macros/mesos, micros, and Fe), individual salts (CuSO4.5H2O, MnSO4.4H2O, ZnSO4.7H2O, and Fe/EDTA), and the specific ions NO3−, NH4+, and K+. Experiments included mixture-amount designs that are essential for separating the effects of proportion and concentration. Highly significant effects were observed in all experiments, but the mineral nutrients with the largest effects varied among the four growth responses. For example, leaf number was strongly affected by the macronutrient group in one
experiment and by $\text{NH}_4^+$ and $K^+$, which were in the macronutrient group, in the NO$_3^-$/$\text{NH}_4^+$/K$^+$ ion-specific experiment, whereas quality was strongly affected by the micronutrients ZnSO$_4$ and Fe/EDTA. Because mineral nutrient effects varied significantly with the response measured, defining an appropriate formulation requires a clear definition of "optimal" growth.