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Effect of foliar spray of macro and micro nutrients on growth and establishment of grape (*Vitis vinifera L.)* cv. Thompson Seedless under Prayagraj agro climatic condition

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Abstract

Grapes (*Vitis vinifera. L*) is one of the important commercial subtropical crops which is a good source of vitamins and minerals. It is grown throughout the world except the places with extreme temperature and high altitude. So, to find out Effect of foliar spray of macro and micro nutrients on growth and establishment of grapes cv. Thompson Seedless under Prayagraj agro climatic condition; a field experiment was conducted at Horticulture Research Farm, Department of Horticulture, Sam Higginbottom university of Agriculture, technology and science, Prayagraj, U.P-211007 during the year 2023-2024. The experiment comprised of 8 different treatment of three different micro nutrients comprising of Fe @ 0.2%, Zn @ 0.4% and Mg @ 0.02% respectively. The main objective of the experiment was to evaluate the root and vegetative growth of grapes plant with their success and survival in the Prayagraj agro-climatic zone. From the present investigation concluded, the application of T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) was found growth of grape plant in terms of plant height, survival percentage, root length, number of leaves and leaf area etc. It also showed the best root growth parameters with maximum root length 9.71cm @ 120 DAP and maximum root thickness 4.17 mm @120DAP. It also showed best vegetative growth parameters with maximum new shoot length 9.48 cm @ 120DAP, maximum Number of new sprouts 10.56 @ 120 DAP, highest number of leaves with 14.22 @ 120 DAP, maximum leaf area 66.17 cm^2, maximum plant height after transplanting 15.67 cm and highest survival percentage 73.44% of grapes plant.

Keywords: Grapes (*Vitis vinifera*), thompson seedless, foliar spray, macro and micro nutrients, agro-climatic conditions, Prayagraj

Introduction

Grapes *(Vitis vinifera L.*) is one of the important commercial subtropical crops which is a good source of vitamins and minerals. It is grown throughout the world except the places with extreme temperature and high altitude. It is one of the most delicious, nourishing and refreshing fruits of the world and is classified as a protective fruit. Grapes are grown in the world for a very long time. There are a number of varieties that were grown in the world with about 72 million tons of grapes annually. At the time of civilization the grapes production was started. It was started as early as 6500 B.C. as per information of archaeologists. By 4000 B.C. grapes growing extended to Asia minor and grapes production spread throughout Europe by the Romans. The wine production increased the demand for grapes and grapes culture was increased at a high rate from 16^{th} to the 20^{th} century (Wosteoves and Jimkamas, 2009) [15].

The primary uses for grapes at that time was the production of wine, dried fruit (raisins) and fresh table grapes. Fresh table grapes account for less than 12% of the world's total production of grapes. The fresh grapes consumption was highest in Europe and North America. Grapes can also produce product like jam, juice, jelly, vinegar, wine, grapes seed extracts and grapes seed oil. The different species of grapes were categorized in four different categories i.e. Native grapes, European grapes, French-American Hybrids and Muscadine grapes. (Singh *et al.*, 2002) [14].

In world fruit production, grapes are an important fruit with a good percent of global fruit production that is about 16% of the total production. The total world production of grapes is estimated to be about 68.9 million tonnes. The major grapes producing countries are Italy, France, Turkey, Iran, South Africa, Spain, Portugal, U.S.A and Chile. The annual production of fresh grapes in India is 1.21 million tonnes with fifth position among fruit crops. Maharashtra is the largest production state of grapes and Tamil Nadu has largest productivity. Other cultivation states of grapes are Andhra Pradesh, Karnataka, Punjab, and other states which contain about 90 percent of the total area of the grapes production. (Anonymous, 2018) [2].

Micronutrients and macronutrients are useful elements for plant growth and development. When these are made unavailable to the plant, the soil health gets deteriorated and toxicity levels increase in the soil, as a result the plant withers and dies. Macro and Micronutrients deficiency are verified by various soil and plant analysis. These nutrients are used for the enhancement in Plant growth and development. When Macronutrients are applied to the soil, it increases the fertility, fixes nitrogen bacteria in the root nodules and enhances the growth of the Plant, increase the vegetation and fruit development. When Micronutrients are applied to the foliage of the plant, various essential nutrients are absorbed which increase the Mobility of the nutrients in the foliage. These nutrients are essential as they maintain the stability and the production in plants. (Janaki *et al.*, 2004) [4] and Wassel *et al.*, (2007) [16].

Macro Nutrients
Nitrogen
Nitrogen is essential for the plant right from sowing to the growth and Development of the plant. Increases the vegetation of the crop, size of the leaves which enhances the photosynthetic activity of the plant. Increases the fruit growth and production of seeds. Excess application of nitrogen increases the vegetative growth which Prevents fruit growth due to overcrowding.

Phosphorus
This element is essential in Young plants for the development of various elements such as sugars, nucleic acids, ATP for energy production. Crop maturation, Flowering, fruiting, germination, ripening and Enhancing of grain quality is seen with this Nutrient. Phosphorus is a major nutrient which is used in the root development in plants.

Potassium
This is essential for the Photosynthesis, protein formation, sugar transportation, activation of enzymes. Encourages strong root system, Makes the crop resistance to diseases. Lodging of plants is prevented. Tubers are developed, regulation of water is seen, starch formation occurs and carbohydrates are formed.

Micro-Nutrients
Iron (Fe)
This is essential in the Photosynthetic reactions and respiratory Functions of the plant. Metabolic reactions, synthesis of porphyrin enzymes like catalyse, peroxidase cytochrome oxidase, production of Chlorophyll.

Zinc (Zn)
This is essential for internode elongation and hormone production in plants. Mobility is intermediate and symptoms arises in middle of leaf (Janaki *et al.*, 2004) [4].

Magnesium (Mg)
This is essential for the production of ATP which is essential for production of energy. It is the central molecule in chlorophyll as the plant constitutes around 15-20% of total Mg. Enzyme activity and formation of peptide chains is seen. Dark Green colour is present in the leaf due to Magnesium. Uptake of phosphorus occurs, formation of carbohydrates, fats and proteins. Magnesium acts as a mobile element. Translocation always occurs from older leaves to younger leaves.

Foliar application of macro and micro nutrients and fertilizers has been an approach followed by Researchers and growers to improve the quality and yield of different horticultural crops. For grape this approach has been quite popular and successful as it not only improves the Economic benefits in terms of savings towards excess fertilizer costs and higher market value for the produce but also improves the nutrient use efficiency and soil health by Direct absorption, utilization of nutrients and stabilizing nutrient balance in the soil which Consequently reduces environmental pollution (Christensen *et al.*, 2006) [3].

Materials and Methods
Geographical location of the experimental site
The experiment was conducted at the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, SHUATS Allahabad, (U.P.) India. The latitude of Prayagraj, Uttar Pradesh, India is 25.473034, and the longitude is 81.878357. Prayagraj, Uttar Pradesh, India is located in India in the *Cities* place category with the gps coordinates of 25° 28' 22.9224" N and 81° 52' 42.0852" E.

Climatic conditions of the experimental area
Prayagraj has a humid subtropical climate common to cities in the plains of North India. The annual mean temperature is 26.1 °C (79.0 °F); monthly mean temperatures are 18–29 °C (64–84 °F). In Allahabad, the average temperature of the coldest month (January) is of 16.6 °C (61.9 °F), that of the warmest month (May) is of 34.2 °C (93.6°F).The precipitation amounts to 745 millimeters (29.3 inches) per year: so, it is at an intermediate level. It ranges from 3 mm (0.1 in) in the driest month (November) to 210 mm (8.3 in) in the wettest ones (July, August).There are on average around 2775 sunshine hours per year.

Experimental details

Table 1: Treatment Combinations

Treatment	Treatment Details
T_1	NPK (RDF)
T_2	NPK + Fe @ 0.2%
T_3	NPK + Zn @ 0.4%
T_4	NPK + Mg @ 0.02%
T_5	NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%
T_6	NPK + Fe @ 0.2% + Zn @ 0.4%
T_7	NPK + Zn @ 0.4% + Mg @ 0.02%
T_8	NPK + Fe @ 0.2% + Mg @ 0.02%

Results and Discussion
Growth Parameter of grapes
The analysis of data enumerated in Table 4.1 varied significantly for foliar spray of macro and micro nutrients on growth and establishment of grapes in respect to plant root length (cm) in the study. The longest root length in Grape plant (9.21 cm) was observed in T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) and significantly similar with treatment T_4 (NPK + Mg @ 0.02%) (7.80 cm) and followed by treatments T_3 (NPK + Zn @ 0.4%) 7.76 cm, during the analysis. Minimum plant root length observed was the treatment T_7, (NPK + Zn @ 0.4% + Mg @ 0.02%), with 6.99 cm.

The longest root thickness in Grape plant (4.17 mm) was observed in T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) and significantly similar with treatment T_8 (NPK + Fe @ 0.2% + Mg @ 0.02%) (3.20 mm) and followed by treatments T_3 (NPK + Zn @ 0.4%) 3.07 cm, during the analysis. Minimum plant root thickness observed was the treatment $T_{6,}$ (NPK + Zn @ 0.4% + Mg @ 0.02%), with 2.94 mm.

The highest number of root of grape plant (20.83) found was observed in T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) and significantly similar with treatment T_8 (NPK + Fe @ 0.2% + Mg @ 0.02%) (20.16) and followed by treatments T_3 (NPK + Zn @ 0.4%) 19.16, during the analysis. Minimum number of root of grape plant observed was the treatment $T_{6,}$ (NPK + Zn @ 0.4% + Mg @ 0.02%), with 16.71.

The highest number of new sprouts of grape plant (10.56) found was observed in T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) and significantly similar with treatment T_4 (NPK + Mg @ 0.02%) (9.67) and followed by treatments T_8 (NPK + Fe @ 0.2% + Mg @ 0.02%) 9.56, during the analysis. Minimum number of new sprouts of grape plant observed was the treatment $T_{6,}$ (NPK + Zn @ 0.4%), with 8.78.

The highest length of new shoots of grape plant (9.48 cm) found was observed in T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) and significantly similar with treatment T_1 (NPK) (8.09 cm) and followed by treatments T_8 (NPK + Fe @ 0.2% + Mg @ 0.02%) 8.08 cm, during the analysis. Minimum length of new shoots of grape plant observed was the treatment $T_{6,}$ (NPK + Zn @ 0.4% + Mg @ 0.02%), with 6.99. This might be due to macro and micro nutrients was carried out on younger mother plants as they generally produce longer roots due to the presence of actively dividing cells and higher levels of growth hormones. The increase in the length might be due to the fact that exogenous application of fertilizer plays a vital role in inducing cell elongation as well as cell division which apparently dependent on the natural macro and micro nutrients and when applied exogenously it also enhanced the length of roots. Application of macro and micro nutrients folier spray was noted to have a significant effect on root length at different time intervals. Similar findings were also reported by Shadparvar *et al.*, (2011) in pomegranate, Kaur *et al.*, (2018) [6] in fig, Rolaniya *et al.*, (2018) [11] in grapes.

The concentration of carbohydrates in the roots affects the thickness and differentiation of the root system adequate nutrient availability in media and temperature might have promoted the length of the roots. These results are in collaboration with the results of Similar findings were also reported by Rolaniya *et al.*, (2018) [11], Kaur *et al.*, (2018) [6] and Singh *et al.* (2017) [17] in grapes.

The higher number of roots may be due to the fact that optimum foliar spray of macro and micro nutrients is the result of less time needed for callus formation and as a result consequent enhanced cambium dedifferentiation, producing numerous cells which will then differentiate to form root cells. It was possibly due to the fact that foliar spray of macro and micro nutrients along with Phloroglucinol accelerates the initiation of root meristem and consequently resulted in the production of the greater number of roots. These results are in close conformity with the reports of (Poornima *et al.* 2020) [18] air layering studies on *Citrus aurantifolia* with different concentrations of macro and micro nutrients.

Table 2: Effect of foliar spray of macro and micro nutrients on Root length (cm), Root Thickness (cm), No. of Roots, Number of new sprouts and Length of new shoots of grapes.

Treatment	Root length in Grape fruit (cm)	Root Thickness in Grape fruit (mm)	No. of Roots in Grape fruit	Number of new sprouts in Grape fruit	Length of new shoots in Grape fruit
T_1	7.95	3.07	18.71	9.67	8.09
T_2	7.25	3.04	18.49	9.11	7.64
T_3	7.76	3.07	19.16	8.78	7.72
T_4	7.80	3.04	17.49	9.67	7.86
T_5	9.71	4.17	20.83	10.56	9.48
T_6	7.27	2.94	16.71	9.56	7.80
T_7	6.99	2.70	17.94	7.89	6.99
T_8	7.60	3.20	20.16	9.56	8.08
F-Test	S	S	S	S	S
S.E. (m) (±)	0.29	0.25	0.66	0.39	0.31
CD (5%)	0.85	0.73	1.93	1.15	0.92
CV	6.57	14.56	6.17	7.36	6.74

Growth parameter of grape plant

The analysis of data enumerated in Table 4.3 varied significantly for foliar spray of macro and micro nutrients on growth and establishment of grape plant in respect to number of new leaves of grape plant in the study. Significantly, the highest number of new leaves of grape plant (14.22) found was observed in T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) and significantly similar with treatment T_1 (NPK) (13.11) and followed by treatments T_8 (NPK + Fe @ 0.2% + Mg @ 0.02%) 11.33, during the analysis. Minimum number of new leaves of grape plant observed was the treatment $T_{4,}$ (NPK + Mg @ 0.02%), with 10.33.

The highest leaf area in Grape plant (66.17 cm^2) was observed in T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) and significantly similar with treatment T_8 (NPK + Fe @ 0.2% + Mg @ 0.02%) (65.17 cm^2) and followed by treatments T_3 (NPK + Zn @ 0.4%) 3.07 cm, during the analysis. Minimum leaf area observed was the treatment $T_{6,}$ (NPK + Fe @ 0.2%), with 52.97 cm^2.

Among the different doses of foliar spray of macro and micro nutrients, T_5 recorded the maximum plant height at 15.67 cm followed by T_8 with plant height of 14.78 cm. The minimum plant height was recorded in T_2 i.e. 10.87 cm. The data for the same is presented in Table-4.3.

The highest survival percentage of grape plant (73.44) was observed in T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) and significantly similar with treatment T_1 (NPK) (71.67) and followed by treatments T_3 (NPK + Zn @ 0.4% + Mg @ 0.02%) 70.33, during the analysis. Minimum survival percentage of grape plant observed was the treatment T_3, with 66.33.

The highest Chlorophyll content (spad value) of grape plant (16.67) was observed in T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) and significantly similar with treatment T_8 (NPK) (NPK + Fe @ 0.2% + Mg @ 0.02%) and followed by treatments T_7 (NPK + Zn @ 0.4% + Mg @ 0.02%) 14.67, during the analysis. Minimum Chlorophyll content (spad value) of grape plant observed was the treatment T_2, (NPK + Fe @ 0.2%) with 9.67.

IBA can stimulate the growth and development of new roots and shoots, which can lead to the production of new leaves. Phloroglucinol can induce the formation of adventitious buds, which can potentially grow into new leaves. Seaweed extract contains a variety of plant growth regulators, including auxins, cytokinins, and gibberellins, as well as essential nutrients, such as nitrogen, phosphorus, potassium, iron, and magnesium, which can all contribute to the growth and development of new leaves in plants. Overall, the application of these supplements might have potentially enhanced the overall health and vigour of the plants, promoted the growth of new leaves and ultimately contributed to the overall growth and development of the plant. Similar result was reported by Singh *et al.* (2017) [17] on his air layering studies on Guava and Bhumika *et al.* (2022) [19] on her studies on air layering in acid lime. The use of different foliar spray of macro and micro nutrients has a substantial impact on leaf area. Similar, results found by Kaur *et al*. (2018) [6], Shahzad *et al.* (2019) [13] in grapes.

The survivability of grape plant in combined foliar spray of macro and micro nutrients treatments is maximum and this might be due to a greater number of roots and root length in these treatments which could have caused the absorption of nutrients and water from the soil, ultimately resulting in high survival rate. It also might be probably due to the fact that rooting co factors and their balance with macro and micro substances. The response of above growing media might be due to a greater number of roots and subsequently, increased root length at this concentration which could have caused the better absorption of nutrients, food material and moisture from the soil, ultimately resulted in high survival rate. These results are in concurrence with reports of Lalramhluna *et al.* (2016) [20] on their studies on air layering in *Citrus limon* with different concentrations of IBA under Prayagraj agro-climatic conditions and are in an agreement with the findings of Sharma *et al.* (2022) [21] on air layering in *Citrus aurantifolia*.

Table 3: Effect of foliar spray of macro and micro nutrients on Number of new leaves, Root Leaf area (cm^2), Plant height (cm), Survival percentage and Chlorophyll content (Spad value) of grapes.

Treatment	Number of new leaves	Leaf area (cm^2)	Plant height (cm)	Survival percentage in Grape fruit	Chlorophyll content (Spad value)
T_1	13.11	61.97	14.78	69.67	12.33
T_2	12.00	52.97	10.87	65.22	9.67
T_3	10.56	58.07	12.47	64.33	10.67
T_4	10.33	62.97	12.87	66.89	12.33
T_5	14.22	66.17	15.67	71.44	15.67
T_6	11.56	63.87	12.57	68.33	13.33
T_7	10.56	62.77	12.37	76.33	14.67
T_8	11.33	65.17	13.67	66.33	15.33
F-Test	S	S	S	S	S
S.E. (m) (±)	0.50	2.33	0.31	1.64	0.31
CD (5%)	1.48	1.97	0.90	4.81	0.90
CV	7.53	5.62	6.83	4.15	6.83

Conclusion

From the present investigation, it is concluded that the application of T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) was found survival percentage of grape plant the satisfactory. The highest survival percentage found was 73.44% of grapes plant. In the study the effect of nutrients vegetative growth of grape plant also good effect on all the characters in the study. Also the study, macro and micro nutrients on growth and development of Plants such like plant height (15.67 cm), survival percentage, root length (9.71cm), number of leaves (14.22), root thickness (4.17 mm), length of new shoot (9.48 cm), Number of new Spouts (10.56) and leaf area (66.17 cm^2) was good in all characters at final day of the research. It may concluded that, the application of T_5 (NPK + Fe @ 0.2% + Zn @ 0.4% + Mg @ 0.02%) was the best treatment in the study.

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