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EFFECT OF NAPHTHALENE ACETIC ACID (NAA) AS GROWTH REGULATOR ALONG WITH CHELATED ZINC AND IRON ON THE AVAILABILITY OF MANGANESE, ZINC, COPPER AND IRON IN MENTHA PIPERITA LINN CULTIVAR KUKRAIL

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Abstract

A field experiment was displayed at the research plot of chemistry Department of Allahabad Agricultural Institute Deemed University, Allahabad to study the effect of NAA along with chelated Zinc and Iron on the availability of micronutrients of Mentha piperrita cultivar Kukrail during winter season. It is quite obvious that Mn was influenced significantly by application of NAA and Zn/Fe EDTA through foliar spray. The concentration of Mn increased with increasing levels of NAA with or without application of Zn/Fe EDTA and markedly higher in Mentha plants at 60 ppm NAA with 10ppm Zn/Fe EDTA. The higher concentration of NAA suppressed the uptake of nutrients above 60 ppm. However, the intake of Mn, Zn and Cu was much higher in second year trial with NAA and Zn while Fe obtained higher uptake in first year than that of second year experiment. The application of NAA was found to increase the Cu uptake with increasing doses till 60ppm with or without the incorporation of Zn/Fe and then gradually a fall at higher concentrations. The second cutting value in second year trial was higher than the corresponding year cutting affected by NAA with Zn. The result was found significant over control due to foliar application of NAA and Fe separately in second year experiment. Fe uptake in mint plants grown with different doses of NAA and Fe in second year trial was greater than first year trial. The Fe uptake in menta piperita plants in both trials were found higher over control. But the Fe uptake in mint plants narrowed down above 60ppm of NAA application with or without Zn/Fe EDTA spray.

Keywords: Naphthalene acetic acid, chelate Zinc/Iron, Mentha piperita, uptake nutrients

Introduction

Fragrance plays an important part in our life. They are one of the main factors in our food selection. Essential oil (as a group) is the most important flavoring agents which are used in food and beverages constitute our performance. Half of the world essential oil production is used in flavoring. Essential oil and their perfumery products have been used since time immemorial and have played an important role in ritual ceremonies. Menthol ($C_{10}H_{19}OH$) (molecular weight 156.26) is saturated alcohol obtained from mint oils or prepared synthetically. It's oil is used in pharmaceutical, confectionary preparations, alcoholic drinks, smoking, dental cream, mouth washes, scented tobacco etc. because of its diversified uses. Its demand is increasing throughout the world because of pleasant aromatic flavor.

Hormones are chemical messengers that regulate various physiological processes in an appreciable manner in plants when applied in low concentration. NAA is one of the most important plant growth regulators. Its activities include both stimulation and inhibition of growth. It is now commonly being used to manipulate the growth of plants with main aim to improve the yield. The studies have shown NAA may stimulate the growth of mentha. (Gowda et al., 1989) reported that NAA increases the number of lateral but reduced the short length, number, size of leaves and delayed flowering. NAA also increases herb and oil yields, Annual report; (CIMAP). (Moycho et al., 1954) also proved that sodium salt of NAA increases the oil and menthol content in menthe piperita. (Sitapara, et al., 2011) also reported the increase in yield and growth.

Zinc containing materials such as inorganic compounds chelates, multi micronutrients mixture etc are available in market. They have been evaluated for their relative efficiency under variable soil-plant conditions through field and green house experiments over years. It has been observed by various scientists that net photosynthetic rate, protein, chlorophyll contents and nitrate reductase (NA) activity were correlated with Zn nutrition in mint and its deficient and toxic levels decrease the mentha total oil contents and herb yield (Mishra, 1992, Chauhan et al., 1991 and Maheshwari et al., 1991). Iron is not readily mobile in plant tissues and its mobility is affected by several factors. Green plants deprived of Fe soon become chloratic in young plant parts while older tissue remains green. Therefore, younger tissues are dependent on continuous Fe supply in xylem or by a foliar application (Mishra et al., 1992). Considering this, the present investigation was taken up to find out most suitable treatment combination of growth regulators and micronutrients.

Materials and Methods

A field experiment was conducted at the research plot of chemistry department Allahabad Agricultural Institute (Deemed University) Allahabad with a view to study the effect of NAA as growth regulator with chelated Zinc and Iron on the availability of micronutrients (Mn, Zn, Cu and Fe) of Mentha Piperita Linn cv Kukrail during winter season. The microplots used for experimental work had soil pH 7.5 (1:2.5 water suspension), EC (dSm^{-1}) at 25^oC 1.10, % organic Carbon 0.33%, available N180 $Kgha^{-1}$, P2O5 14.0 $Kgha^{-1}$ K 245 $Kgha^{-1}$ and available Zinc

0.35mgKg^{-1}. The soil used for conducting the experimental trial was sandy loam in texture. The experiments were laid out in 1X1m^2 microplots in pattern of two factorial randomized block design with three replications. The NAA with chelated zinc (Zn EDTA) were applied in the first year trial and NAA with chelated iron (Fe EDTA in solution form) in the second year trial of the session. Treatments were replicated thrice in both the year experiments. The five levels of NAA (Naphthalene acetic acid) 0.0 (No), 20ppm (N1), 40ppm (N2), 60ppm (N3), 80ppm (N4) and 100ppm (N5) and two levels of Zinc/Iron i.e. (Z0) control, (Z1) 10ppm and (F0) control, (F1) 10ppm were used separately with NAA. After dividing the plots the recommended doses of fertilizers were incorporated in microplots. The half dose of nitrogen through urea @120Kgha^{-1} and total dose of P2O5 @60Kgha^{-1} through single super phosphate and K2O @40Kgha^{-1} through muriate of potash were applied before transplanting the slips or seedlings. All stolus/suckers of Mentha plants were irrigated. Rest half dose of nitrogen was applied through top dressing after 4 to 6 weeks of planting. The stolons/suckers of Mentha were transplanted at a distance of 15X15 cm^2. The stolons/suckers were obtained from the central Institute of Medicinal and Aromatic Plants CIMAP RSM Nagar Lucknow, U.P. The growth regulator NAA was sprayed on the planted stolons/suckers at the interval of 30 and 45 DAT (days after transplanting) @0.0, 20,40,60,80 and 100ppm of each and every microplots of the experiments in both the trials of the year. The chelated zinc and iron as Zn EDTA and Fe EDTA were also sprayed on the plants after 40 DAT @0.0 and 10ppm in the first and second trial respectively. The irrigation was done as per the requirement of the crop. All the physical observations regarding height of plants, number of branches, dry matter percentage and fresh and dry weight of plants etc were done as per the need.After harvesting the crop, five random plant samples were dried and analyzed for various micronutrients. All the micronutrients (Mn, Zn, Fe and Cu) in menthe plants were determined with the help of Perkin elmer Atomic spectrometer-3100. No any serious insect-pest or natural hazard adversely affected the crop growth as well as yield.

Results and Discussion

Data recorded in Table-1 and 2 pertaining to Mn uptake in menthe plants as influenced by varying levels of NAA with or without Zn/Fe EDTA clearly indicated that the highest Mn uptake in mint plants recorded at 60ppm NAA application with Zn/Fe EDTA. Higher concentration of NAA application gradually decreased the uptake but it was still higher than the control. The increased uptake was observed 42% higher than control at level N3F1 followed by N2F1, N3F0 levels with 38% and 35% increased respectively. It has been also analyzed from the data presented in tables that mechanism of uptake was seemed to be higher in the second year cutting (harvest) treated with NAA and Fe which may be due to rationing of plants and residual effect of nutrient present in soils as was supplied in first year trial. The conclusion can be drawn from the observations that Zn application improved the quality in term of less uptake of Mn. These results are in close agreement with the findings of (Subramanyan et al., 1991; Stephen and Grun, 1989; Jitendra Mohan et al., 1993 and Zheljazkov and Nielson, 1996).

Table-1:Effect of different doses of NAA and chelated Zn on Mn uptake(ppm) by Mentha piperita Linn						
Treatments	NAA					
Zinc EDTA	N0	N1	N2	N3	N4	N5
Z0	1.86(0.62)	1.94(0.64)	2(0.66)	2.1(0.7)	2.03(0.67)	1.98(0.66)
Z1	1.87(0.62)	1.97(0.65)	2.06(0.68)	2.15(0.71)	2.05(0.68)	2.03(0.67)

Figure in parenthesis denotes replication mean

Table-1 A:Effect of different doses of NAA and chelated Fe on Mn uptake(ppm) by Mentha piperita Linn						
Treatments	NAA					
Iron EDTA	N0	N1	N2	N3	N4	N5
F0	2.4(0.8)	2.7(0.9)	3.2(1.06)	3.7(1.23)	3.1(1.03)	2.7(0.9)
F1	2.9(0.96)	3.1(1.03)	3.9(1.3)	4.2(1.4)	3.4(1.13)	2.8(0.93)

CD (5%) for Iron =0.085; NAA= 0.148

Table-2:Effect of different doses of NAA and chelated Zn on Zn uptake(ppm) by Mentha piperita Linn						
Treatments	NAA					
Zinc EDTA	N0	N1	N2	N3	N4	N5
Z0	1.19(0.39)	1.46(.48)	1.91(.63)	2.53(.84)	2.18(.72)	1.35(.45)
Z1	1.3(.43)	1.47(.49)	2.23(.74)	3.58(1.19)	2.71(.9)	2.32(.77)

CD (5%) for Zinc = 0.156   NAA= 0.27

Table-2b:Effect of different doses of NAA and chelated Fe on Zn uptake(ppm) by Mentha piperita Linn						
Treatments	NAA					
Iron EDTA	N0	N1	N2	N3	N4	N5
F0	2.4(0.80)	3.6(1.20)	4.9(1.63)	5.6(1.86)	5(1.86)	4.5(1.50)
F1	3.9(1.30)	5.1(1.7)	5.7(1.90)	6.3(2.10)	6.3(2.10)	4.6(1.53)

CD(5%) for Iron Fe=0.096NAA=0.167

Table-3:Effect of different doses of NAA and chelated Zn onCuuptake(ppm) by Mentha piperita Linn						
Treatments	NAA					
Zinc EDTA	N0	N1	N2	N3	N4	N5
Z0	0.80(0.26)	1.20(0.40)	1.50(0.50)	1.70(0.56)	1.50(0.50)	1.20(0.40)
Z1	1.00(0.33)	1.20(0.40)	1.50(0.50)	1.80(0.60)	1.30(0.43)	1.30(0.43)

Table-3c:Effect of different doses of NAA and chelated Fe on Cu uptake(ppm) by Mentha piperita Linn						
Treatments	NAA					
Iron EDTA	N0	N1	N2	N3	N4	N5
F0	0.696(0.232)	0.960(0.320)	1.344(0.440)	1.416(0.472)	1.374(0.458)	1.253(0.417)
F1	1.130(0.376)	1.353(0.451)	1.772(0.590)	1.923(0.641)	1.862(0.620)	1.536(0.512)

CD (5%) for Iron=0.034 NAA=0.059

Table-4:Effect of different doses of NAA and chelated Zn on Fe uptake(ppm) by Mentha piperita Linn						
Treatments	NAA					
Zinc EDTA	N0	N1	N2	N3	N4	N5
Z0	23.8(7.93)	26.6(8.86)	27.5(9.16)	29.3(9.76)	29.1(9.70)	27.9(9.30)
Z1	26.3(8.76)	28.0(9.33)	29.9(9.96)	30.5(10.16)	29.5(9.83)	28.1(9.36)

CD(5%) for NAA=1.3

Table-4d:Effect of different doses of NAA and chelated Fe on Fe uptake(ppm) by Mentha piperita Linn						
Treatments	NAA					
Iron EDTA	N0	N1	N2	N3	N4	N5
F0	33.6(11.20)	42.2(14.06)	44.1(14.70)	47.5(15.83)	45.0(15.00)	42.3(14.10)
F1	43.3(14.43)	50.2(16.73)	53.9(17.96)	55.9(18.63)	54.7(18.23)	48.3(16.10)

CD (5%) for Iron =1.196 NAA=2.071

*N=Naphthalene Acetic Acid, Z=Zinc EDTA, F=Iron EDTA

Zinc uptake

Results incorporated in table 2b clearly showed that the application of varying doses of NAA with Zn influenced the uptake of Zn and in every case was greater than the control. The above observations showed that NAA with Zn/Fe EDTA helped to increase the uptake while significant increase was found only due to sole application of NAA, Zn/Fe EDTA. However, Zn application appreciably influenced Zn uptake than the application of Fe of the plants. Observation from the table indicated that N2Z1 and N3Z1 have given 48% and 67.5% more Zn uptake over the control with value 0.74ppm and 1.19ppm respectively.

Copper uptake

Table-3 indicated that application of NAA was found to increase the Cu uptake with increasing doses till 60ppm with or without the incorporation of Zn/Fe EDTA and then generally a fall at higher concentrations. Although the fall was observed very low with combination of Zn/Fe EDTA. The second cutting values in second year trial were higher than the corresponding first year. Cutting affected by NAA with Zn EDTA. The results were found significant over control due to foliar application of NAA and Fe EDTA separately in second year experiment.
Increasing rates of NAA as leaf spray seemed to have promoted more Cu table3c uptake with maximum limit 60ppm with or without Zn/Fe EDTA. It was found to be toxic to the menthe plants with higher doses of NAA. The absorbed value was recorded 50% and 54% in the respective first year and second year investigation. The increase was found 61% and 64% more over control due to easier utilization of Cu in second year experiment at level N2F1 and N1F1 respectively. These results are also in consonance with the findings of (Mishra et al., 1991, Stephen et al., 1989) have also found similar findings with spraying of Fe on tomato plants.

Fe uptake

The uptake of iron in tissues of mentha piperita influenced by NAA with Zn and NAA with Fe EDTA in first and second year experiments was incorporated in respective table-4d. The values shown in the observations reflect the following facts. (a) Fe uptake in mint plants grown with different doses of NAA and Fe in second year trial were greater than first year experiment affected by NAA and Zn EDTA. This enhancement observed till 60ppm NAA (b) Fe uptake in Mentha piperita plants in both trials were found higher over control (c) the Fe uptake in mint plants fall down above 60ppm of NAA application with or without Zn/Fe EDTA spray under the present experiment set. The above characteristics of Fe uptake in mint plants may be explained in the following lines:

The higher doses of NAA with Zn/Fe EDTA tremendously increased in the green stem and leaf however Fe progressively improved transpiration endosmosis and other cell activities that facilitates mere Fe uptake recorded 29%, 37%, 40% over control at respective level N3F0, N2F1 and N3F1. It is noted that NAA and Zn influenced 19%, 20%, 22% more uptake of Fe than control at levels of N3Z0, N2Z0 and N3Z1 respectively. These results are also in close agreement with the findings of Subrahmanyam et al., 1991 and Mishra et al., 1991. At higher concentration of NAA (above 60ppm) the cell water underwent exosmosis resulting lesser iron absorption due to loss of protoplasm. Leaves of Mentha pipperita readily obtained chelated iron in the treatments with foliar spray and formed rapidly more active cell plasma and chloroplast that favored greater transpiration pull/exosmosis of Fe while 80ppm and 100ppm NAA even with the combination of Fe/Zn as foliar spray narrowed down the uptake perhaps due to its plasmolysing power. (Subrahmanayam et al., 1992) reported the increased concentration and uptake of Fe in Mentha arvensis due to foliar application of iron. (Chattopadhyay et al., 1989) observed the lower N, P, K, Fe, Zn and Mn content in chloratic and high in normal menthe leaves. Increased translocation of Fe from root to shoot in Thlaspi Caernulescens was observed by Roser P Tolra et al., 1996 with the incorporation of chelated Zn. The influence of Fe uptake were also supported by the findings of (El Sherif, et al., 1993) when Zn were applied whereas the positive role of growth hormone in the uptake of Fe was recorded by (Chaudhery et al., 1982; Srivastava et al., 1991) on mentha crops.

Conclusion

It is concluded from the observations that combination of Z1N3 and F1N3 has played good role in increasing micronutrients which is essential for human nutritional deficiency.

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