International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133; Print ISSN: 2664-7125; Impact Factor: RJIF 5.28
Received: 13-01-2021; Accepted: 28-01-2021; Published: 19-02-2021
Volume 3; Issue 1; 2021; Page No. 308-311

Effect of foliar application of micronutrients on growth attributes of Makoi (*Solanum Nigrum* l.) under hill zone of Karnataka

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Abstract
Field experiment was carried out to study the "Effect of foliar application of micronutrients on growth attributes of Makoi (*Solanum nigrum* L.)" under hill zone of Karnataka at Agricultural and Horticultural Research Station, Thirthahalli during 2019-2020. The experiment was comprised of nine treatments and three replications. The experiment was laid out in randomized complete block design (RCBD). The study revealed that among different treatments, plants treated with micronutrient mixture @ 0.5 per cent recorded higher plant height (72.33 cm), number of branches (39.80), number of leaves (281.20) and plant spread (N- S) 66.33 cm.

Keywords: foliar, attributes and RCBD

Introduction
Solanum nigrum L. (Makoi) also called as black night shade, is an important upcoming medicinal plant belongs to the family solanaceae. The plant has tremendous medicinal value, hence it is called as Kasi or Karikachi in Kannada, Kakamachi in Telugu, makoi or makoy in Hindi and Manatakalli in Tamil (Kirthikar and Basu, 1975) [11]. The economic parts of the plant are berries, leaves and even the whole herb. The alkaloids *viz*., alpha-solamargine and alpha-solasonine have been isolated and identified from the green unripe fruits (Ridout *et al*., 1989) [21]. The berries also contain four steroidal glycoalkaloids namely alpha-solanigrine, beta-solanigrine, solamargine and solasonine. The solamargine and solasonine are also present in leaves (Varshney and Sharma, 1965) [29]. The herb is used against abdominal upsets and having a antiseptic, antidysentric properties. The plant is also credited with emollient, antispasmodic, diuretic, and laxative properties. It is used in curing of heart disease, fever, leucoderma, pains, piles, ulcer, asthama, vomiting and eye troubles (Umesha *et al*., 2011) [27]. *Solanum nigrum* holds great potential as an alternate source to pharmaceutical and nutraceutical industries with many advantages. The vitamins and seed oil are at parity with many food value species. Hence, there is a great scope to identify suitable techniques to exploit makoi for different purpose. Considering the importance of the crop, there is a need to develop production practices for cultivation of Makoi under hill zone condition in order to get more herbage yield. Therefore the present investigation entitled "Effect of foliar application of micronutrients on growth attributes of makoi (*Solanum nigrum* L.) Under hill zone of Karnataka" was carried out.

Material and Methods
The present investigation was undertaken at Agricultural and Horticultural Research Station, Thirthahalli, in Shivamogga district of Karnataka, India during 2019-2020. The experiment was laid out in randomized block design with nine treatments in three replications, considering T_1 - Control (RDF + FYM only), T_2 - Ferrous sulphate @ 0.25%, T_3 - Ferrous sulphate @ 0.50%, T_4 - Zinc sulphate @ 0.25%, T_5 - Zinc sulphate @ 0.50%, T_6 - Borax @ 0.25%, T_7 - Borax @ 0.50%, T_8 - Micronutrient mixture @ 0.25%, and T_9 - Micronutrient mixture @ 0.50%.
The experimental site was ploughed, harrowed, weeds and stubbles were removed and brought to fine tilth. The seedlings were raised in nursery raised beds. The raised beds were prepared with soil, farmyard manure and sand in the ratio of 1:1:1. Before sowing, the seeds were pre-soaked in GA_3 solution at the concentration of 500 ppm for 12 hours to overcome the dormancy and to ensure good germination. The seedlings were ready for transplanting after thirty days of sowing. Thirty days old healthy, uniform sized seedlings were selected and transplanted in the experimental plots as per the treatments at the spacing of 60 cm x 45 cm. Spray schedule was common for all the treatments except treatment one. First spray was taken at 30 days after transplanting of seedlings and second spray was taken at 60 days after transplanting. The crop was ready for harvesting after three months of transplanting. The crop was harvested at mature green berry stage. While, harvesting the whole plants were cut at 5 cm above the ground level. The freshly harvested plants were cut into small pieces of convenient length along with the green immature berries intact and these pieces were dried under partial shade till the moisture level of 25-30 percent was achieved.

Result and discussion
The growth attributes varied significantly among the treatments at all the stages of crop growth due to foliar application of micronutrients. The growth attributes *viz.*, plant height, number of branches per plant, number of leaves per plant and plant spread

increased throughout the crop growth period (45, 75 and 90 DAT).

Plant height

The plants receiving RDF + FYM + micronutrient mixture @ 0.5% (T_9) recorded significantly highest plant height (40.62 cm, 57.79 cm and 72.33cm) at 45, 75 and 90 days after transplanting, respectively. While, T_1 treatment recorded the lowest plant height (31.51cm, 36.51 cm and 46.74 cm) at 45, 75 and 90 days after transplanting, respectively (Table 1). The enhanced crop growth in plant height may be ascribed to plenty availability of micronutrients to plant which might have increased the stimulatory effect on most of the metabolic and physiological processes of plant. The above improvement in plant height can also be ascribed to the effective role of micronutrients in controlling different enzymatic activities and photosynthetic pigments formation, consequently influencing on plant growth. These findings were noticed by El-Kateeb (1994) in *Ruta graveolens* L., Swaefy (1996) [25] in *Mentha piperita* L., Singh and Gupta (1996) [24] in chickpea, Verma (1997) [28] in coriander, Swaefy (2002) [26] in *Trachyspermum ammi* L., Meena (2003) [14] in fenugreek, Sammauria (2007) [23] in fenugreek, Nasiri *et al.* (2010) [18] in chamomile plant, Kumar *et al.* (2010) [12] in *Mentha arvensis* L. Said and Mahmoud (2010) [22] in sweet basil and Gupta (2012) [6] in fennel.

Table 1: Effect of foliar application of micronutrients on plant height of Makoi at various stages of crop growth

Treatments	Plant height (cm)		
	45DAT	75DAT	90 DAT
T_1-Control (RDF + FYM only)	31.51	36.51	46.74
T_2- Ferrous sulphate @ 0.25%	34.29	43.52	54.22
T_3- Ferrous sulphate @ 0.50%	37.40	45.45	55.87
T_4- Zinc sulphate @ 0.25%	36.25	42.35	52.94
T_5- Zinc sulphate @ 0.50%	39.83	50.02	60.94
T_6- Borax @ 0.25%	33.49	41.53	51.74
T_7- Borax @ 0.50%	35.56	43.37	54.15
T_8- Micronutrient mixture @0.25%	37.46	47.60	58.69
T_9- Micronutrient mixture @ 0.50%	40.62	57.79	72.33
S. Em ±	1.14	1.62	1.54
C D @ 5%	3.43	4.87	4.60

Note: FYM – Farm yard manure (10 t/ha) and RDF - Recommended dose of fertilizers (100: 50: 50 kg NPK/ha) is common for all treatments
DAT = Days after transplanting

Number of branches

The plants receiving RDF + FYM + micronutrient mixture @ 0.5% (T_9) recorded significantly highest number of branches (28.50, 35.20 and 39.80) at 45, 75 and 90 day after transplanting respectively. While, treatment T_1 recorded the lowest number of branches (13.23, 19.70 and 25.33) at 45, 75 and 90 days after transplanting, respectively (Table 2). The increased number of branches might be due to the effect of micronutrients in increasing the metabolic processes which in turn increases different plant metabolites responsible for cell division which resulted in breaking of apical dominance and enhances the spread of lateral buds to growing branches and accelerated the higher number of branches. Similar results were perceived by Naguib *et al.* (1998) [17] in dill, Mohamed (2000) [16] in *Coriandrum sativum* and *Carum carvi*, El-Kateeb *et al.* (1994) in *Ruta graveolens*L., Maurya (1990) [13] in coriander, Kassem and Aabeir (2002) [10] in rosemary.

Number of leaves

The plants receiving RDF + FYM + micronutrient mixture @ 0.5% (T_9) recorded significantly highest number of leaves per plant (98.90, 157.20 and 281.20) at 45, 75 and 90 day after transplanting, respectively. While, T_1 treatment recorded the lower number of leaves per plant (57.73, 95.13 and 143.17) at 45, 75 and 90 days after transplanting respectively (Table 3).Increase in the leaf parameters might be due to role of micronutrients in cell division, meristematic activity of plant tissue and expansion of cell. The beneficial effect of micronutrients on leaf growth might be due to its role in physiological processes and cellular function within the plant. Hansch and Mendel (2009) [7] mentioned that in general, the micronutrients play a vital role in the biosynthesis of endogenous hormones which are responsible for encouraging number of leaves. Similar trend was also recorded by many scientists Kassem and Aabeir (2002) [10] in rosemary, Chand *et al.* (2011) [3] and Farooqui and Mishra (1983) in mint. Reports of enhanced number of leaves per plant with application of micronutrients were also reported by Barman and Pal (1993) [1] in tuberose, Bhattal *et al.* (2004) [2] in tomato.

Table 2: Effect of foliar application of micronutrients on number of branches per plant of Makoi at various stages of crop growth

Treatments	Number of branches per plant		
	45DAT	75DAT	90 DAT
T_1- Control (RDF + FYM only)	13.23	19.70	25.33
T_2- Ferrous sulphate @ 0.25%	16.57	22.47	27.13
T_3- Ferrous sulphate @ 0.50%	18.30	26.17	31.43
T_4- Zinc sulphate @ 0.25%	15.90	23.63	30.73
T_5- Zinc sulphate @ 0.50%	25.27	31.57	35.83
T_6- Borax @ 0.25%	15.13	22.93	28.07
T_7- Borax @ 0.50%	17.87	25.00	31.77
T_8- Micronutrient mixture @ 0.25%	24.63	30.30	34.70
T_9- Micronutrient mixture @ 0.50%	28.50	35.20	39.80
S. Em ±	1.36	1.90	1.37
C D @ 5%	4.09	5.69	4.11

Note: FYM – Farm yard manure (10 t/ha) and RDF - Recommended dose of fertilizers (100: 50: 50 kg NPK/ha) is common for all treatments
DAT = Days after transplanting

Table 3: Effect of foliar application of micronutrients on number of leaves per plant of Makoi at various stages of crop growth

Treatments	Number of leaves		
	45 DAT	75 DAT	90 DAT
T_1- Control (RDF + FYM only)	57.73	95.13	143.17
T_2- Ferrous sulphate @ 0.25%	64.13	102.03	194.83

T_3- Ferrous sulphate @ 0.50%	67.07	109.77	202.27
T_4- Zinc sulphate @ 0.25%	76.20	116.20	212.73
T_5- Zinc sulphate @ 0.50%	86.53	139.77	255.60
T_6- Borax @ 0.25%	62.30	97.43	177.90
T_7- Borax @ 0.50%	72.97	112.73	209.77
T_8- Micronutrient mixture @0.25%	84.93	133.86	231.46
T_9- Micronutrient mixture @0.50%	98.90	157.20	281.20
S. Em ±	2.07	2.77	7.63
C D @ 5%	6.20	8.31	22.87

Note: FYM – Farm yard manure (10 t/ha) and RDF - Recommended dose of fertilizers (100: 50: 50 kg NPK/ha) is common for all treatments
DAT = Days after transplanting

Plant spread

The plants receiving RDF + FYM + micronutrient mixture @ 0.5% (T_9) recorded significantly highest plant spread N-S direction (43.87 cm, 51.03 cm and 66.33 cm) at 45, 75 and 90 day after transplanting, respectively. While, T_1 treatment recorded the lower plant spread N-S direction (23.37 cm, 32.83 cm and 39.50cm) at 45, 75 and 90 days after transplanting, respectively (Table 4). These outcomes might be mainly due to the combined effect of micronutrient mixture and inorganic fertilizers. Micronutrients increased the production of certain biochemical growth promoting substances like auxins, gibberellins and cytokinins which favours the vegetative growth of Makoi. These results are in accordance with the findings of Mehrab (2014) [15], who mentioned significantly higher plant spread by the combined application of zinc, iron, manganese and boron at 200 ppm as foliar spray in thyme. Similar results were observed by Kanwal *et al.* (2016) [9] in sacred basil and in other crops like Patel *et al*. (2010) [19] in brinjal, Kalroo *et al*. (2014) in chilli, Patil (2004) [20] in okra.

Table 4: Effect of foliar application of micronutrients on plant spread (N-S) of Makoi at various stages of crop growth

Treatments	plant spread (N-S) (cm)		
	45DAT	75DAT	90 DAT
T_1- Control (RDF + FYM only)	23.37	32.23	39.50
T_2- Ferrous sulphate @ 0.25%	27.30	35.57	44.20
T_3- Ferrous sulphate @ 0.50%	31.07	36.50	43.83
T_4- Zinc sulphate @ 0.25%	33.77	40.17	50.53
T_5- Zinc sulphate @ 0.50%	37.20	46.03	57.23
T_6- Borax @ 0.25%	23.27	35.13	45.73
T_7- Borax @ 0.50%	30.97	42.47	50.97
T_8- Micronutrient mixture @ 0.25%	35.70	43.53	54.43
T_9- Micronutrient mixture @ 0.50%	43.87	51.03	66.33
S. Em ±	1.43	1.54	1.66
C D @ 5%	4.83	4.61	4.97

Note: FYM – Farm yard manure (10 t/ha) and RDF - Recommended dose of fertilizers (100: 50: 50 kg NPK/ha) is common for all treatments
DAT = Days after transplanting

Conclusion

The results of study inferred that, foliar application of micronutrients had positive effect on plant growth and development compared to control. Application of micronutrients mixture at 0.5 per cent as foliar spray along with soil application of RDF + FYM could significantly increase the plant height, number of branches, number of leaves and plant spread (N-S) of Makoi.

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