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# Effect of Seed Treatment with Molybdenum and Foliar Application of Micronutrients on Growth, Yield and Quality of Soybean

S. N. Giri[1], S. R. Puri[2] and R. K. Sathe[3]
Vasantrao Naik Marathwada Krishi Vidyapeeth Parbhani - 431 402 ( India)
Corresponding author Email : rajivsathe510@gmail.com
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**Abstract**

Field experiment was conducted to study the effect of foliar application of micronutrients and seed treatment with molybdenum on growth, yield and quality of Soybean grown under rainfed condition of Maharashtra at College of Agriculture, Badnapur in 2017- 2018. The result revealed that the highest number of branches (14.26 plant$^{-1}$) observed in the treatment receiving combined application of zinc and iron with seed treatment of molybdenum. The higher number of (51.33) nodules was recorded in treatment seed treatment of molybdenum. At flowering, pod formation and harvest stage maximum dry weight (11.28, 17.96 and 23.02 g plant$^{-1}$) observed in the plot which received combined application of zinc and iron with seed treatment of molybdenum. The higher values of chlorophyll content at 20 DAS (21.16 mg 100 g$^{-1}$), 60 DAS (18.26 mg 100 g$^{-1}$) and 80 DAS (11.46 mg 100 g$^{-1}$) of soybean was recorded with $T_9$ (foliar application of zinc and iron with seed treatment of molybdenum). However, the higher chlorophyll content at 40 DAS (30.93 mg 100 g$^{-1}$) of soybean was observed under treatment $T_6$ receiving foliar application of zinc and iron. The highest grain (2247.60 kg ha$^{-1}$) and straw yield (2666.30 kg ha$^{-1}$) were observed in $T_6$ which receives foliar spray of zinc and iron. The lowest grain (1605.00 kg ha$^{-1}$) and straw (1886.60 kg ha$^{-1}$) yield were recorded in $T_1$ (control). Application of zinc and iron with molybdenum significantly increased oil (21.19%) and protein (42.82%) content of soybean while, the lowest oil (18.10%) and protein (38.92%) content were recorded in treatment control. Overall, data concluded that micronutrient had positive effect on nutrient uptake with qualitative and quantitative traits of soybean in the conditions of studied area.

**Key words : .**

Imbalance and indiscriminate use of fertilizers and emergence of micronutrients deficiencies have been identified as the most important factors for decline in crop productivity. The increasing cost of fertilizer nutrients have leaded to search for alternative practices of managing the fertilizer nutrients more judiciously, efficiently and in balance proportions. Such approach would reduce the depletion of macro and micronutrients from soil and make agriculture more sustainable. Among the nutrients, macro-nutrients have been given the priority and little attention has been paid towards micronutrients. In the absence of micronutrients, plant shows physiological disorders which eventually lead to low crop yield and fairquality.

Soybean [*Glycine max* (L.) Merill.] is known as Chinese pea or Manchurian bean which belongs to family Leguminaceae. It is originated in Asia. It is the miracle crop which has phenomenal growth and production. Soybean is also called as gold of America. In India, from last few years, processing and value addition is trading the revolution in rural economy which improved the socio-economic status of farmers. Soybean cultivation has placed India on the world map in recent past. The vital importance in Indian Agriculture, but also plays a decisive role in oil economy of India. It is the cheapest and main source of dietary protein of majority vegetarian. Soybean seed consists of 18-25 per cent oil and 30-50 per cent protein (Vahedi, 2011). Among the pulses, soybean is recognized as excellent source of high quality protein and oil. It is rich in vitamin A, B and D. Besides oil

and high quality protein, the plant has ability to fix atmospheric nitrogen with the help of root nodule bacteria and also add organic matter in the soil, thereby increasing the soil productivity. Oilseeds occupy a significant place in Indian economy. The literature cited and referred elsewhere found that very scanty information is available pertaining to the of the research to increase the productivity of soybean under marathwada condition.

Considering the need, it is important to manage the nutrients particularly micronutrients for increase the yield of soybean under the low availability of micronutrients (Fe, Mo and Zn below critical limit) and low moisture condition occurring in the dry spell of Kharif season. Hence, the present investigation was carried out to see the response of soybean to foliar application of micronutrients under rainfed condition.

## Material and Methods

The experiment was conducted in 2017-18 at College of Agriculture, Badnapur. Experiment was conducted to study the effect of foliar application of micronutrients and seed treatment with molybdenum on growth, yield, uptake of nutrients and quality of Soybean. The experiment was laid out in randomized block design with nine treatments and three replications *viz*. $T_1$: Control (RDF 30:60:30), $T_2$: NPKS + Water spray, $T_3$: NPKS + $FeSO_4$ spray (0.5%), $T_4$: NPKS + $ZnSO_4$ spray (0.5%), $T_5$: NPKS + Seed treatment with Mo, $T_6$: NPKS + $FeSO_4$ spray (0.5%) + $ZnSO_4$ spray (0.5%), $T_7$: NPKS + $FeSO_4$ spray (0.5%) + Mo, $T_8$: NPKS + $ZnSO_4$ spray (0.5%) + Mo and $T_9$: NPKS + $FeSO_4$ spray (0.5%) + $ZnSO_4$ spray (0.5%) + Mo. The soil had pH 7.6 and EC 0.28 $dSm^{-1}$ and clayey texture. NPK fertilizer application (30:60:30) and other agronomic practices were carried out uniformly according to the recommendations in all the treatments. Seed treatment of molybdenum @ 4 g $kg^{-1}$ (Source: Ammonium molybdate) at the time of sowing and foliar application of $ZnSO_4$ (0.5%) and $FeSO_4$ (0.5%) at 30, 50, 70 DAS was given.

The determination of chlorophyll content (20, 40, 60 and 80 DAS) in soybean leaves was estimated with standard method proposed by Arnon (1949). Whereas, available Zn and Fe were determined by DTPA extraction method (Lindsay and Norvell (1978) and available Mo determined by ammonium oxalate method as described by Chopra and Kanwar (1991). The soil physico chemical charecteristics are presented in Table A. For recording number of branches, number of nodules and chlorophyll content, a random 5 samples were taken from central rows of each treatment. Protein content was estimated by multiplying N content with 5.71. Oil content in soybean seed was estimated by using Soxhlet ether extraction method (Ranganna, 1994). Petroleum ether was used as extractant.

## Result and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads.

**Number of branches :** The data pertaining to the effect of micronutrients on number of branches (Table 1) showed that foliar application with or without seed treatment of micronutrients significantly increase number of branches. It is clear from the results that foliar application of zinc and iron with seed treatments of molybdenum ($T_9$) increased the branching of soybean (14.26 plant-1) and significantly superior over control. The beneficial effect might be due to interaction effect of zinc and iron with or without seed fortification of molybdenum on metabolic activities like synthesis of IAA, metabolism of auxins and synthesis of nitrate

reductase enzyme in the leguminous crop of soybean. Similar results were also reported by Ravi et al.

Number of nodules : Data presented in Table 1 show that number of nodules plant$^{-1}$ ranged from 33.66 to 51.33 nodules plant$^{-1}$. The significantly maximum number of nodules (51.33) was recorded in treatment $T_5$ which received seed treatment of molybdenum. The lowest number of nodules found in $T_1$ (control) which received N, P, K and S alone. It might be due to role of Mo for improving nitrogen fixation symbiotically in legumes and in the roots of non legumes which improved the nodule number plant$^{-1}$. These results confirmed with findings of Nadiya Gad (2012) in groundnut. Sale et al., (2018) revealed that the highest number of branches (16.83 plant$^{-1}$) observed in the treatment receiving combined application of zinc and iron with seed fortification of molybdenum. The higher number of (44.66) nodules was recorded in treatment seed fortification of molybdenum.

**Total dry weight :** Data presented in Table 1 that application of zinc, iron and molybdenum significantly influenced on Total dry weight.

The result revealed that at flowering, at pod formation and at harvest maximum dry weight (11.28, 17.96 and 23.02 g plant$^{-1}$) observed in the plot which received NPKS + $FeSO_4$ (0.5%) + ZnSO4 (0.5%) + Mo ($T_9$) followed by plot $T_7$ and $T_6$. While minimum dry weight (5.89, 10.92 and 12.40 g plant$^{-1}$) was observed in control.

**Chlorophyll content :** The effect of various treatments on chlorophyll content of leaf were recorded at 20, 40, 60 and 80 DAS of soybean and results are depicted in Fig. 1. The result indicates that in general, the higher amount of chlorophyll was recorded at 40 DAS compared to 20 DAS, 60 DAS and 80 DAS indicating gradual decline in chlorophyll content at 80 DAS. The higher amount of chlorophyll content at all stages was recorded in treatment $T_9$ receiving zinc, iron and seed treatment with molybdenum. The chlorophyll content at 40 DAS ranged from 17.00 to 26.66 mg 100 g$^{-1}$. The highest amount of chlorophyll was recorded (30.93 mg 100 g$^{-1}$) in treatment $T_9$ receiving foliar application of zinc and iron with seed treatment of molybdenum. The chlorophyll content at 80 DAS ranged from 10.17 to 11.46

**Table 1.** Nodules plant$^{-1}$, No of branches plant$^{-1}$, Total dry weight (g) plant$^{-1}$ and yield as influenced by foliar application of micronutrient at critical growth stages of soybean

| Treatments | Nodules plant$^{-1}$ | No. of branches plant$^{-1}$ | Total dry weight (g) plant$^{-1}$ | | | Yield (kg ha$^{-1}$) | |
|---|---|---|---|---|---|---|---|
| | | | At flowering | At pod formation | At harvest | Straw | Grain |
| $T_1$ : Control | 34.00 | 9.20 | 5.89 | 10.92 | 12.40 | 1886.60 | 1605.00 |
| $T_2$ : NPKS + Water | 37.33 | 9.40 | 6.56 | 11.31 | 15.33 | 2063.30 | 1780.30 |
| $T_3$ : NPKS + $FeSO_4$ (0.5%) | 33.66 | 9.26 | 7.05 | 11.85 | 16.83 | 2160.00 | 1856.00 |
| $T_4$ : NPKS + $ZnSO_4$ (0.5%) | 36.66 | 9.53 | 7.79 | 12.20 | 17.91 | 2246.00 | 1966.30 |
| $T_5$ : NPKS + Seed treatment with Mo | 51.33 | 9.73 | 7.95 | 12.23 | 18.22 | 2360.30 | 2070.30 |
| $T_6$ : NPKS + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) | 40.66 | 11.86 | 9.41 | 13.83 | 21.03 | 2596.30 | 2147.60 |
| $T_7$ : NPKS + $FeSO_4$ (0.5%) + Mo | 35.66 | 12.20 | 9.60 | 14.56 | 22.66 | 2569.00 | 2240.00 |
| $T_8$ :NPKS + $ZnSO_4$ (0.5%) +Mo | 36.00 | 11.20 | 8.36 | 13.18 | 20.66 | 2427.30 | 2080.60 |
| $T_9$ : NPKS + $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) + Mo | 37.66 | 14.26 | 11.28 | 17.96 | 23.02 | 2666.30 | 2247.60 |
| S.E. ± | 2.51 | 0.35 | 0.24 | 0.38 | 0.56 | 67.60 | 89.60 |
| C.D @ 5% | 7.57 | 1.07 | 0.74 | 1.14 | 1.68 | 203.60 | 269.80 |

mg 100 $g^{-1}$ and found lower as compared to other stages.

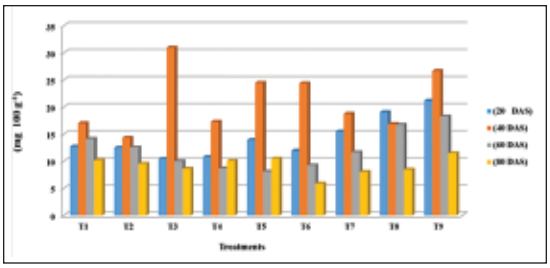

**Fig. 1.** Chlorophyll content of soybean (mg 100 $g^{-1}$) as influence by foliar application of micronutrient

The results indicate that the higher value of chlorophyll content was also noted in $T_6$ receiving foliar application of iron and zinc. It may be due to zinc and iron take part in chlorophyll synthesis and imparts dark green colour to the plants. Similar results were found by Babaein *et* al. (2011) and in sunflower crop and Galavi *et* al. (2011) in safflower with application of iron and zinc.

**Soybean yield :** Data presented in Table 1 with respect to grain and straw yield show the response of micronutrients (zinc and iron) foliar application with or without seed fortification of molybdenum.

**Grain and straw yield :** Significant differences between increases in grain yield were observed. The highest grain yield was observed (2247.60 kg $ha^{-1}$) in $T_9$ which received N, P, K, S and foliar application of iron and zinc with seed treatment of molybdenum. It was at par with $T_7$, $T_6$, $T_8$ and $T_5$ and superior over rest of the treatments. The lowest grain yield was observed in control (1605.00 kg $ha^{-1}$). The highest straw yield observed (2666.30 kg $ha^{-1}$) in $T_9$ which receives N, P, K, S and foliar application of iron and zinc with seed treatment of molybdenum. It was at par with $T_6$ and $T_7$ These are superior over rest of the treatments including control (1886.60 kg $ha^{-1}$) which was lowest.

This result might be due to enzymatic activity, enhancement microelement effectively increased photosynthesis and translocation of assimilates to the seed. The available soil zinc and iron status (0.4 mg Zn $kg^{-1}$) and (1.2 mg Fe $kg^{-1}$) is below critical level hence there is significant response in terms of straw yield observed in the treatment receiving zinc and iron. Similar results found by Ravi et al. (2008), Kobraee et al. (2011) claimed that zinc and iron application at the same time could be lead to higher dry matter. Galavi *et* al. (2012) in safflower.

Generally micronutrient play a critical role in plant that lead to increase of leaf area index and there by increased light absorption and increase the dry matter accumulation and economic yield.

**Quality parameters :**

**Oil content :** Significant treatment differences were observed in respect of seed oil content (Fig. 2) with the application of zinc, iron and with or without molybdenum. Soybean oil content ranged from 18.10 to 21.19 per cent under various treatments. Application of zinc and iron with molybdenum was found significantly highest increase of oil content of soybean (21.20%). This treatment was found at par with $T_8$, $T_6$, and $T_7$ and superior over rest of the treatments. Lowest oil percentage was observed (18.20%) in control ($T_1$).

**Protein content :** The combination of Fe, Zn (foliar) with Mo seed treatment of micronutrients application significantly increase protein content of soybean. Protein content of soybean ranged between 38.92 to 42.82 % under various treatment. Application of zinc iron and molybdenum increased protein content (42.99%) in soybean in treatment $T_9$. It was at par with $T_7$ and $T_8$ and superior over rest of the treatments. The lowest protein content was observed (40.76 %) in treatment $T_1$ (control) which receives RDF alone.

Increase in protein content might be due to iron and zinc which are two important elements in enzymes structure involved in amino acids are the base of protein synthesis, protein content increased with the application of these micronutrients. The available soil zinc and iron status (0.4 mg Zn $kg^{-1}$) and (1.2 mg Fe $kg^{-1}$) is below critical level hence there was significant response in terms of protein content observed in the treatment.

Present investigation indicates that the combined application of zinc, iron and molybdenum increased yield, nutrient uptake and quality parameters in soybean. The maximum grain and straw yield as well as nutrient uptake was obtained from combine application of zinc and iron foliar spray. The maximum oil and protein percentage was achived from treatment receiving zinc, iron and molybdenum. It was inferred that micronutrient had positive effect on nutrient uptake with qualitative and quantitative traits of soybean. These results are agreed with the result of Ravi et al. (2008) in safflower, Ebrahimian et al. (2010) in sunflower, Yasari and Vahedi (2012) on soybean.

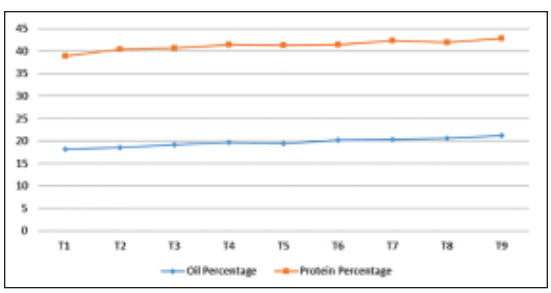


**Fig. 2.** Oil content and Protein content as influence by foliar application of micronutrient

## References

Arnon, D. I. 1949. Copper enzymes in isolated chloroplast polyphenol oxidase in Beta vulgaris. Pl. Physiol., 24(1):1-15 Asian. Ed. p 368.

Babaein, M., Piri, I., Tavassoli, A., Esmaeilian, Y. and Gholami, H. 2011. Effect of water stress and micronutrients (Fe, Zn and Mn) on chlorophyll fluorescence, leaf chlorophyll content and sunflower nutrient uptake in Sistan region. African J. Agric. Res., 6(15): 3526-3531.

Ebrahimian, E., Bybordi, A. and Eslam, B. P. 2010. Efficiency of zinc and iron application methods on sunflower. J. Food, Agric. & Environ., 8 (3 and 4) : 783-789.

Galavi, M., Ramroudi, M. and Tavassoli, A., 2011. Effect of micronutrients foliar application on yield and seed oil content of safflower (*Carthamus tinctorius*). African J. Agric. Res., 7(3) : 482-486.

Kinaci, E. and Gulmezoglu, N. 2007. Grain yield and yield components of triticale upon application of different foliar fertilizers. Interciencia, 32(9) : 624-628.

Kobraee, S., Shamsi, K. and Rasekhi, B. 2011. Effect of micronutrients application on yield and yield components of soybean. Ann. Biol. Res., 2(2): 476-482.

Mahatma, N. 2007. Effect of sulphur and micronutrients (iron and zinc) on yield and quality of cotton in vertisol. M Sc. (Ag.) Thesis Dharwad Agricultural University, Karnataka (India).

Mostafavi, K. 2012. Grain yield and yield components of soybean upon application of different micronutrient foliar fertilizers at different growth stages. Internat. J. Agric. Res. & Rev., 2(4): 389-39.

Purvis, E. R. and Peterson, N. K. 1956. Method of soil and plant analysis for molybdenum. Soil. Sci., 81: 223-228.

Ranganna, S. 1994. Hand book of analysis and quality control for fruit and vegetable products, Second Edition, Tata McGraw - Hill Publishing Company Ltd. Delhi.

Ravi, S., Channal, H. T., Hebsur, N. S., Patil, B. N. and Dharmatti. P. R. 2008. Effect of sulphur, zinc and iron nutrition on growth, yield, nutrient uptake and quality of safflower (*Carthamus tinctorius* L.). Karnataka J. Agric. Sci., 21(3): 382-385.

Sale R. B, Nazirkar R. B, Ritu S. Thakare and Nilam, B. Kondvilkar. 2018 Effect of foliar spray of zinc, iron and seed priming with molybdenum on growth and yield attributes and quality of soybean in the rainfed condition of Vertisol, International J. Chemical Studies; 6(1): 828-831.

Sale.R.B, and Nazirkar R.B, 2013 Response of soybean [*Glycine max* (L.) Merill.] yield, nutrient uptake and quality to micronutrients (Zn,Fe and Mo) under Khandesh region of Maharashtra, Asian J. Soil Sci.,8 (2): 245-248.

Vahedi, A. 2011. The effects of micronutrient application on soybean seed yield and on seed oil and protein content. J. American Sci., 7(6): 44-49.

Vahedi, A. and E. Yasari. (2012). Micronutrients Impact on Soybean (Glycine max (Merrill) Qualitative and Quantitative Traits. International J. Bio. 4(2): 112-118.