

Effect of Complete Micro Nutrient Fertilizer Application on Soybean Yield and Yield Components

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ABSTRACT

In last decades, sever population growth cause to enormous problems in developing countries. One of the effective factors in improving of quantity and quality of agricultural products is optimal application of chemical fertilizers. Hence, any research in this field can be an effective step to decrease production costs and increase productivity. In order to evaluation effects of complete micro nutrient on soybean yield and yield component, an experiment was conducted in Islamic Azad University of Tabriz. Three level of complete micro nutrient (a1: 3 ppt or 10 kg ha⁻¹, a2: 6 ppt or 20 kg ha⁻¹ and a3: 9 ppt or 30 kg ha⁻¹) and seven growth stages (b1: control, b2: soil application, b3: foliar application at 8-12 leaf stage, b4: foliar application at flowering stage, b5: foliar application at pod stage, b6: foliar application at pod and flowering stages and b7: foliar application at 8-12 leaf stage, pod and flowering stages) arranged in a RCBD based split plot design in three replication. Pod per plant, Pot weigh per plant, chlorophyll content, seed yield ($p < 0.05$) and filled pod weight and kernel pods number ($p < 0.05$) were affected by levels of complete micro nutrient. Application times was affected on stem height, seed number per pod, filled pod, pod weight, shilling percentage, yield ($p < 0.05$) and pod per plant, 100 kernel weight, 3 kernel pods number ($p < 0.05$). Interaction effect on filled pod weight, shilling percentage, 100 kernel weight, leaf area and yield was significant ($p < 0.05$). The highest seed yield was obtained by using 3 ppt of complete micro nutrient at 8-12 leaf stages caused 88.88% increasing in seed yield compared to control. The highest 100 kernel weight was obtained by using 30 kg ha⁻¹ of complete micro nutrient in soil application form as caused 14.90% increasing in seed yield compare to control. If intention is cultivation of Wiliam cultivar of soybean, 3 ppt of complete micro nutrient at 8-12 leaf stages are the most suitable fertilizer concentration and application stage for achieving higher seed yields, 100 kernel weight, filled pod weight and leaf area in comparison with other application concentrations and methods.

Keywords: Soybean, Foliar, Soil Application

1. INTRODUCTION

Soybean is one of the most important oil seeds around the world and according to last FAO world statistics the cultivating area of soybean was almost 9000 hectare with average yield of 1105 ton per hectare in 2000 (Khajepoor, 2004). One of the effective factors in improving of quantity and quality of agricultural products is optimal application of chemical fertilizers.

Last result of surveys shows convincingly that micro nutrient components have remarkable role in improvement of crop production via balancing of major elements (N, P and K) (Malakoti, 1999). Micro nutrient elements are consist of Zn, Mn, Fe, Cu, Br and Mo. In most cases absorbing of nutrient element via plant roots does not provide nutrient requirements of plants. Plant nourishing through leaves is more efficient than root absorbance. Leaves nourishing give rise to improving of

photosynthesis rate and competition reduce due to increasing of leaf area, also it prevents of pollutions of underground water sources. Hence, foliar application of fertilizers is more suitable in comparison with the other type of applications (Noor *et al.*, 2004).

Zinc mostly absorb through soil solutions and has a significant role in plant enzymatic systems as structural catalyst and interferes in proteins destruction in plant cells. Cu, in most cases, effect on enzymatic activities in plants. Besides, this element cooperative in electron transfers chain reactions and play as an activator of some enzymes. Different application methods were recommended in deficiency conditions, which are, consist of soil application, foliar application and seed insemination (Malakoti and Tehrani, 2005). Mn, mostly, exists in plants as a major or auxiliary catalyst (Lesani and Mojtahedi, 2000). This element plays a major role in electron transfer and chlorophylls production with Fe and is part of arginase and phosphotransferase enzymatic system (Malakoti and Tehrani, 2005). Br is one of the important elements that have the main effects on germination, fruit formation and transfer of photosynthetic components. The first visible sign deficiency of Br in plants is prevention of terminal bud growth which new leaves death occur in continue (Malakoti and Keshavarz, 2003). Fe is necessary for all plants growth. Chlorophylls will not product efficiently and leave look pale due to Fe deficiency (Malakoti, 1999).

Esmaili and Abasian (2006) reported that application of different levels of MnSO₄ and ZnSO₄ micro nutrient fertilizers cause to increasing in plant height, Stem diameter and dry weight of stem in Corn. Abadi *et al.* (2008) pointed out that Fe application resulted in maximum seed yield and total dry matter in sugar beet in comparison with other micro elements. According to Yang (1993), using of Br in Rapeseed (*Brassica napus* L.) resulted in improvement of quantity and quality yield. Also, height of plant, photosynthesis rate and nitrate reductase activity were increased. Fatemi (2001) suggested that foliar application of nitrogen and boron fertilizers in soybean (*Glycine Max* L.) have a significant effect on seed performance, seed jacket, number and weight of seed. Also, foliar utilization of nitrogen fertilizer was resulted in increase in protein percentage, reduce of seeds oil content. Unlikely, Br fertilizer application resulted in protein reduction and percentage of oil content. Masoni *et al.* (1996) in Italy conduct a survey to evaluation of deficiency effects of Fe, S, Mn, Mg on sun flower (*Heliantus annus* L.), corn (*Zea maize* L.), wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) and pointed out that deficiency of all mentioned elements were decreased the performance

through decrease of chlorophyll concentration rate in leaves. Schon (1990) reported that foliar application in soybean was resulted in significant increase in proportion of seed's numbers to seed's cover on stems. Freeborn *et al.* (2001) mentioned that soil and foliar application of nitrogen in reproductive stage of soybean increase the yield. Bakhshi and Karimian (2004) expressed that concentration of Fe and total absorption significantly increased related to Fe application usage levels in soybean. Kamargi and Gloy (2006), pointed out that foliar application of Zn, Fe, Br and related combinations on saff flower (*Carthamus tinctorius* L.) affect morphologic traits, seed yield, straw yield, plant height, one thousand seed weight and number of auxiliary stems significantly which maximum amount of mentioned traits was achieved with Fe application.

The present experiment was aimed to assess the effects of micro nutrients foliar application method and to determine the best stage of plant growth period and concentrations of complete micro nutrient application on yield of Wiliam cultivar of soybean (*Glycine Max* L.) under farm condition.

2. MATERIALS AND METHODS

This experiment conducted as Split Plot Design bases on randomized complete block design in triplicate at experimental farm of agriculture faculty of Tabriz Azad University on Wiliam cultivar of soybean (*Glycine Max* L.). Experimental treatments consisted of factor A (Concentration of complete micro nutrients) in three level (a1: 3 ppt, a2: 6 ppt and a3: 9 ppt) and factor B (Time or stage of foliar application) in seven level (b1: Control, b2: Soil application, b3: foliar application at 8-12 leaf stage, b4: foliar application at flowering stage, b5: foliar application at pod stage, b6: foliar application at pod and flowering stages, b7: foliar application at 8-12 leaf stage, pod and flowering stages). In order to comparison soil and foliar application of fertilizers, separate plot with three treatment of soil application method (30, 20-10 kg ha⁻¹) considered in each replication.

The experimental farm unit was consisting of 63 plots (25×4 m). There will be four rows of plants with 50 cm distance in furrow planting method. The seeds were planted in three cm distance with each other. The distance of plots will be 50 cm and the distance of replications were almost one meter. Regarding to local weather conditions, planting date was in middle of May. Nutrients requirements of soybean to other elements were determined and use related to soil analysis and recommendation of fertilizers usage for soybean. After

germination and initial growth of plants, they were regularly managed and conventional growing practices including irrigation, fertilization and pest and disease control similarly carried out on plants. Treatments of foliar application of complete micro nutrients performed in mentioned levels. The time of foliar spraying of experimental units with mention concentrations in different stages performed.

In order to prevent of foliar spraying effects in control treatments, water spraying done simultaneously for these units. Earlier of shilling stage, index of leaf area and chlorophyll content were measured.

After the complete growth of plants, two rows from each side and 50 cm of top and bottom of plots were removed and remain plants harvested from middle area of each plot. Features such as the highest stem height, number of auxiliary stem, length of seed cover, number of seeds per cover, one hundred seeds weight, weight of covers per plant and seed yield in hectare were recorded. The data were subjected to analysis of variance by mstatc and SAS statistical software. Mean comparisons were carried out by Duncan multi-dimension test at 5% signification level.

3. RESULTS

Variance analysis of micro nutrient application method indicated that application methods as well as interaction effects of concentration rate and application stage did not have any significant effect on the stem length at 5% level of signification. Mean comparison for the effects of survey treatments on the stem length showed that micro nutrient application in 8-12 leaf stage + flowering stage + pod stage had highest rate in comparison with rest. There was no significant difference between micro nutrient application in three stages and application only in 8-12 leaf stage regarding this trait (**Table 1**).

In the case of pot number per plant trait, there was a strong positive link between different concentration of micro nutrient and pod number at 1% signification level. Comparing means of various concentrations of fertilizer showed significant effect at 5% probability level.

As can be seen from table, different concentration of complete micro nutrient fertilizer had significant effect on pod weight per plant at 5% probability level. In addition, application methods of fertilizer had remarkable effect on this feature at 5% signification level. Micro nutrient fertilizer application at 8-12 leaf stage possessed the highest weight. There was no meaningful difference between this and other treatments (**Table 1**).

Table of variance analysis showed that utilization technique of micro nutrients had significant effect on seed number per pod and three kernel pod number features at 5 and 1% probability levels respectively (**Table 1**). In Plants with Mn deficiency, a remarkable decline in the amount of soluble carbohydrate has been occurred, particularly in roots section. According to the scientists, the main cause of this phenomenon is poor pollination or carbohydrate deficiency due to seed set in soybean. Soybean is one of the sensitive plants to Mn deficiency (Malakoti and Tehrani, 2005). Using fertilizer with different concentrations and interaction effects of concentration and application methods did not have any significant effect on three kernel pod numbers in Wiliam cultivar of soybean under farm condition (**Table 1 and 2**).

Micro nutrient fertilizer various concentrations effect, different stages of fertilizer utilization and interaction effect of concentration and different application stages effect on filled pod weight is indicated in **Table 2**. Also, Table of variance analysis of these factors showed that different fertilizer concentrations and various application methods had significant effect on filled pod weight at 1% and 5% probability levels respectively. The highest amount of this trait belongs to combination of micro nutrient application in 8-12 leaf stage and 3 ppt concentration (**Table 2**) variance analysis show convincingly that interaction effect between concentration and various application method of micro nutrient had significant effect on the leaf area at 5% probability level (**Table 2**). Like leaf area, various stages of fertilizer application and interactions affected significantly on shilling percentage at 5% probability level (**Table 2**).

Other results in the case of 100 kernel weight feather exhibited that different application methods of fertilizer was significant at 1% probability level, on the other hand, interaction effects of fertilizer concentration and application methods showed significant effect at 5% probability level. Unlike these treatments, various concentrations did not have any remarkable effects on 100 kernel weight (**Table 2**). Application of Micro nutrient fertilizer in different concentrations as well as treatment combinations significantly influenced seed yield in soybean at 5% probability level (**Table 2**).

Mean companions for interaction effects of fertilizer concentration and application stages on seed yield of soybean revealed that using 3 ppt complete micro nutrient fertilizer at 8 to 12 leaf stage cause to produce the highest seed yield in comparison with other treatments.

Table 1. Mean comparison of complete micro nutrient application method on underlying features

Application stages	Seed No per pod	Pod per plant	Pod weight per plant	Stem height (cm)	3 kernel pod Number
No application (b1)	2.400 ^b	39.444 ^b	10.224 ^b	59.433 ^b	58.556 ^a
Soil application (b2)	2.508 ^{ab}	63.222 ^a	14.484 ^a	70.889 ^a	49.750 ^b
Foliar app. at 8-12 leaf (b3)	2.495 ^{ab}	71.333 ^a	16.000 ^a	72.967 ^a	43.299 ^{bc}
Foliar app. at flowering (b4)	2.387 ^b	67.556 ^a	14.208 ^a	72.039 ^a	40.023 ^c
Foliar app. at pod stage (b5)	2.339 ^b	62.222 ^a	15.516 ^a	65.444 ^{ab}	44.972 ^{bc}
Foliar app. at flowering and pod stage (b6)	2.400 ^b	65.111 ^a	14.000 ^a	59.844 ^b	39.758 ^c
Foliar app. at 8-12 leaf + flowering + pod stages (b7)	2.601 ^a	66.667 ^a	14.341 ^a	74.344 ^a	43.75 ^{bc}

a, b, c Within a column, means without a common letter differ ($P < 0.05$).

Table 2. Interaction means comparison of fertilizer concentration and application stage on yield components

Treatments		Yield components				
Fertilizer concentration	Application stages	Leaf area (cm ²)	filled pod weight	Shilling (%) weight	100 kernel (g)	Seed yield (gm ⁻²)
3 ppt (a1)	b1	2342.617 ^{bcdef}	27.587 ^c	62.658 ^{abc}	12.903 ^c	345.067 ^c
	b2	1544.503 ^{ef}	36.817 ^{bc}	61.128 ^{abc}	15.267 ^{abc}	499.667 ^{bc}
	b3	3910.237 ^a	52.693 ^a	62.149 ^{abc}	16.357 ^{ab}	653.867 ^a
	b4	2634.65 ^{abcdef}	41.567 ^{abc}	61.246 ^{abc}	16.533 ^{ab}	504.667 ^{abc}
	b5	2176.837 ^{def}	45.987 ^{ab}	62.497 ^{abc}	14.320 ^{bc}	573.067 ^{ab}
	b6	3781.673 ^{ab}	33.740 ^{bc}	60.267 ^{abc}	7.8830 ^a	408.133 ^{bc}
	b7	2690.697 ^{abcdef}	39.107 ^{abc}	59.916 ^{abc}	14.540 ^{bc}	486.800 ^{abc}
6 ppt (a2)	b1	2394.463 ^{bcdef}	27.802 ^c	61.741 ^{abc}	14.567 ^{bc}	342.567 ^c
	b2	2135.640 ^{def}	40.513 ^{abc}	62.291 ^{abc}	15.127 ^{bc}	501.200 ^{abc}
	b3	1491.183 ^f	37.787 ^{abc}	65.610 ^a	16.567 ^{ab}	495.733 ^{abc}
	b4	2460.163 ^{abcdef}	34.850 ^{bc}	64.826 ^{ab}	16.683 ^{ab}	450.333 ^{bc}
	b5	3714.197 ^{abc}	45.267 ^{ab}	64.944 ^a	16.667 ^{ab}	594.400 ^{ab}
	b6	2525.510 ^{abcdef}	30.347 ^{bc}	57.446 ^c	16.733 ^{ab}	346.933 ^c
	b7	2841.120 ^{abcdef}	31.960 ^{bc}	56.150 ^c	15.720 ^{ab}	359.200 ^c
9 ppt (a3)	b1	2309.340 ^{cdef}	27.607 ^c	64.772 ^{ab}	14.157 ^{bc}	358.800 ^c
	b2	2972.850 ^{abcde}	34.313 ^{bc}	59.963 ^{abc}	16.267 ^{ab}	412.933 ^{bc}
	b3	2645.293 ^{abcdef}	38.08 ^{abc}	60.502 ^{abc}	16.033 ^{ab}	461.600 ^{abc}
	b4	2377.117 ^{bcdef}	35.828 ^{bc}	60.898 ^{abc}	16.033 ^{ab}	437.400 ^{bc}
	b5	3009.837 ^{abcd}	31.993 ^b	57.880 ^{bc}	16.100 ^{ab}	366.533 ^c
	b6	3193.820 ^{abcd}	41.882 ^{abc}	62.402 ^{abc}	16.183 ^{ab}	524.310 ^{abc}
	b7	2862.823 ^{abcdef}	34.507 ^{bc}	60.707 ^{abc}	14.557 ^{bc}	423.020 ^{bc}

a, b, c Within a column, means without a common letter differ ($P < 0.05$).

4. DISSCUSION

Sakar *et al.* (1988) in a survey with Zn, Br and Mn application suggested that these elements increased plant height in soybean. Also, results achieved from present research are conformed to those established by Ghasemian (2000) on the significant increase in the filled pod weight due to application of Fe, Zn and Mn fertilizer treatments in soybean. He says: "fertilizer treatment consists of 40 kg Zn with 40 kg Mn and 50 kg Fe in hectare produced highest amount of pod weight per plant". Similar results reported by Hemantarajan and Trivedi (1997). In addition, Freeborn (2000) reported

that Br and N foliar application over flowering stage increased nodule formation and yield of soybean.

Generally, the results obtained from the present experiment showed that there are negative link between micro nutrient fertilizer concentration and fertilizer efficiency among Fe, Br and Zn fertilizers. According to achieved results, increasing in the amount of fertilizer application cause to decreasing in fertilizer efficiency, therefore, financially speaking, it is important to select an optimum amount of fertilizer concentration in order to achieve higher production rate. Also, optimum concentration of fertilizers will prevent soil pollution, soil PH changing, plant toxicity, under water pollutions and subsequent problems in future cultivations.

5. CONCLUSION

In brief, if intention is cultivation of Wiliam cultivar of soybean (*Glycine Max* L.), 3 ppt of complete micro nutrient at 8-12 leaf stages is the most suitable fertilizer concentration and application stage for achieving higher seed yields, 100 kernel weight, filled pod weight and leaf area in comparison with other application concentrations and methods.

6. REFERENCES

- Abadi, D.J., S.R. Madden and N. Hachem, 2008. Column-stores vs. row-stores: how different are they really? Proceedings of the 2008 ACM SIGMOD International Conference on Management of Data, Jun. 09-12, ACM Press, Vancouver, Canada, pp: 967-980. DOI: 10.1145/1376616.1376712
- Bakhshi, M. and V. Karimian, 2004. Effect of Fe application on soybean yield and chemical composition. Proceeding of 3rd National Congress in Efficient Application of Fertilizers in Agriculture, (NCEAF' 04), Iran, pp: 174-179.
- Esmaili, M. and A. Abasian, 2006. Effect of CuSO₄ and MnSO₄ micro nutrient fertilizers on Corn (cv 704). Proceeding of the 9th National Congress of Agronomy and Plant Breeding, (APB' 06), Iran, pp: 13-15.
- Fatemi, N., 2001. Determination effects of planting date and nitrogen and boron foliar application on quality and quantity of soybean seeds. M.Sc. Thesis, University of Tarbiat Modares, Iran.
- Freeborn, J.R., 2000. Nitrogen and boron applications during reproductive stages for soybean yield enhancement. Virginia Polytechnic Institute.
- Freeborn, J.R., D.L. Holshouser, M.M. Alley, N.L. Powell and D.M. Orcutt, 2001. Soybean yield response to reproductive stage soil-applied nitrogen and foliar-applied boron. *Agron. J.*, 93: 1200-1209. DOI: 10.2134/agronj2001.1200
- Ghasemian, V., 2000. Evaluation of micro nutrient elements effects on quality and quantity of soybean seeds in East Azerbaijan. M.Sc. Thesis, Tarbiat Modarres University.
- Hemantarajan, A. and A.K. Trivedi, 1997. Growth and yield attributes of soybean (*Glycine max* L. Merr) as influenced by sulphur and iron nutrition. *Ind. J. Plant Physiol.*, 2: 304-306.
- Kamargi, H. and M. Gloy, 2006. Effect of Fe, Br and Zn and their combinations foliar application on quantities characters of saff flower. Proceeding of the 9th National Congress of Agronomy and Plant Breeding, (APB' 06), Iran, pp: 118-120.
- Khajepoor, M., 2004. Industrial plants. Technical University of Isfahan Publication, Iran.
- Lesani, H. and M. Mojtahedi, 2000. Basics of Plant Physiology. 5th Edn., University of Tehran Publication, Iran, pp: 129-133.
- Malakoti, M. and M. Tehrani, 2005. Role of Micro Nutrients in Increasing of Quality and Improvement of Agriculture Products. 4th Edn., University of Tarbiat Modares Publication.
- Malakoti, M. and P. Keshavarz, 2003. Boron Place in Plant Efficient Nutrition. 1st Edn., Sana Publication, Iran.
- Malakoti, M., 1999. Broad methods of Recognize and Importance of Efficient Methods of Chemical Fertilizers. 1st Edn., University of Tarbiat Modares Publication, Iran.
- Masoni, A., L. Evacoli and M. Movoti, 1996. Spectral properties of leaves deficient in iron, sulfur, magnesium and manganese. *Agron. J.*, 88: 937-943.
- Noor, A., A. Hosseinzadeh and M. Ghafari, 2004. Evaluation of planting date and foliar application of micro elements of sunflower yield component. Proceeding of 3rd National Congress in Efficient Application of Ferilizres in Agriculture, (EAFA' 04), Iran, pp: 321-321.
- Sakar, M.T., A.A. Leila and M.N.M. Helay, 1988. Physiological studies on soybean as affected by certain growth substances and micronutrients [Egypt]. *J. Agric. Sci.*, 13: 613-622.
- Schon, D.A., 1990. Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions. 1st Edn., Wiley, San Francisco, USA., ISBN-10: 1555422209, pp: 376.
- Yang, H.H., 1993. Kevlar Aramid Fiber. 1st Edn., J. Wiley, Chichester, ISBN-10: 0471937657, pp: 200.