International Journal of Manures and Fertilizers Vol. 3 (8), pp. 572-575 August, 2014. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Interaction between micro elements and macro elements with manure on barley feed yield and soil nutrient content in Sistan region

Ramah T. Mohammadi, Shahram G. Hatima and Radmehr P. R Arsham

Department of Plant and Crop Science, Faculty of Agriculture, University of Tabriz, East Azarbaijan Province, Iran.

Accepted 28 July, 2014

In order to study the effect of interaction of 'micro' and 'macro' elements on soil chemical properties, grain yield and feed yield in barley, an experiment was conducted as split plot design on randomized complete block design with three replications in the research field of Zabol University 2009. The different proportions of manure and chemical fertilizer treatment were: 100% manure (F_1), 100% chemical fertilizer (F_2), 50% manure + 50% chemical fertilizer (F_3) and control (F_4) as the main plot and the use of micro nutrient elements treatments were: iron sulfate (N_1), zinc sulfate (N_2), manganese sulfate (N_3) and control (N_4) as sub plot in this experiment. Results show that the effect of different proportions of manure and chemical fertilizer treatment on grain yield, feed yield, and soil chemical properties were significant. Among soil chemical properties, pH decreased due to use of all fertilizer treatments (organic and inorganic fertilizer) and soil salinity increased due to consumption of chemical fertilizer. Micronutrient treatments had significant influence on this nutrition elements concentration and the use of iron sulfate, zinc sulfate and manganese sulfate caused increase of these elements in soil but these treatments had no influence on grain yield of barley.

Key words: Barley, feed yield, manure, soil nutrient.

INTRODUCTION

Mineral nutrition alone contributed significantly to increased crop yields during the 20th century. Borlaug and Dowswell (1994) reported that 50% of the increase in crop yields worldwide during the 20th century was due to application of chemical fertilizers. They also stated that during the 21st century, the essential plant nutrients would be the single most important factor limiting crop yields, especially in developing countries. Stewart et al. (2005) reported that average percentage of yield attributable to fertilizer generally ranged from about 40 to 60% in the USA and England and tended to be much higher in the tropics. Although, micronutrient elements are needed in relatively very small quantities for adequate plant growth and production, their deficiencies cause a great disturbance in the physiological and metabolic processes in the plant (Bacha et al., 1997). A balanced fertilization program with macro and micronutrients in plant nutrition is very important in the production of high yield with high quality products (Sawan et al., 2001). Macro and micronutrients deficiencies have been reported for different soils and crops (Hussain et al., 2006). Soylu et al. (2005) reported significant increase in number of spikes (m^{-2}) in wheat with foliar application of different micronutrients individually or in combination. Six micronutrients that is, Mn, Fe, Cu, Zn, B and Mo are known to be required for all higher plants (Welch, 1995). In another study, Abd El-Wahab (2008) stated that micronutrients such as Fe, Mn and Zn have important roles in plant growth and yield of aromatic and medicinal plants. He reported micronutrients especially Fe and Zn act as metal components of various enzymes and also are associated with photosynthesis and protein synthesis and iron has important functions in plant metabolism such as activating catalase enzymes. Iron is mainly present in

*Corresponding author. E-mail: ramaftee@yahoo.com

Table 1. Chemical analysis of soil of experiment.

Parameter	Value
Mn (Mg/l^{-1})	0.32
Zn (Mg/l^{-1})	1.615
Fe (Mg/l^{-1})	0.03
Ca (Meq/l^{-1})	12.1
P (Meq/l^{-1})	1.56
K (Meq/l^{-1})	317
N (Meq/l^{-1})	0.027
EC (Ds/m^{-1})	1.8
pH	7.2

the form of insoluble Fe (III), therefore, unavailable to higher plants particularly in neutral and alkaline soils (Shao et al., 2007). Havlin et al. (1999) reported that iron is critical for chlorophyll formation and photosynthesis and is important in the enzyme systems and respiration of plants, manganese is involved in the enzyme systems related to carbohydrate and nitrogen fixation in legumes and zinc is essential for sugar regulation and enzymes that control plant growth.

Zinc is one of the eight essential trace elements which is necessary for the normal healthy growth and reproduction of crop plants (Parker and Thomason, 1992). Zn is a vital element for wheat growth and it activates some enzymes such as carbonic anhydrase, dehydrogenase, proteins and peptidase. Hemantaranjan and Gray (1988) indicated that using Zn led to increases in leaf chlorophyll and indol acetic acid, so photosynthesis will be improved and then dry mater will be increased. Soleimani (2006) reported increase in biological yield for foliar application of zinc. Another study showed that the use of zinc in blue sage (*Salvia farinacea* L.) enhanced the length of peduncle, length of main inflorescence, number of inflorescence and florets, and fresh and dry weight of inflorescences/plant (Nahed and Balbaa, 2007). A similar effect of Zn supply on this parameter was also reported on *Matricaria chamomilla* (Grejtovský et al., 2006). The positive effects of Fe and Zn on plant may be due to their effects as a metal component of some enzymes or regulatory for the others. Moreover, they have essential roles in plant metabolism (Abd El-Hady, 2007).

The recycling and the use of nutrients from organic manure have been given more consideration for insuring sustainable land use in agricultural production development. The long term effects of the combined application of organic and inorganic fertilizers in improving soil fertility and crop yield have been demonstrated by many workers (Chen et al., 1988). Recently, Wang et al. (2001) reported that organic and inorganic fertilizers showed great benefits not only for the increase in the N uptake by the plant but also the improvement of the fodder yield. Materechera and Salagae (2002) used partially decomposed cattle and chicken manure amended with wood ash and reported that higher plant yield of fodder maize was obtained by the use of chicken manure. Manure can supply nutrients required by crops and replenish nutrients removed from soil by crop harvest. Hence, this investigation was carried out to evaluate the effects of farmyard manure, and chemical fertilizer on yield and other quality parameters as well as soil properties of barley grown in Sistan region of Iran.

MATERIALS AND METHODS

This experiment was conducted in 2009 cropping at Agriculture Research Center of Zabol University. The site lies at longitude 61° 29, and latitude 31° 2 and the altitude of the area is 487 m above sea level. It has a warm dry climate with the mean minimum, mean maximum and average air temperatures of 16, 30 and 29°C, respectively. The soil characteristics of Agriculture Research Center is sandy-loam in texture, pH = 7.4 and electrical conductivity (EC) = 1.8 ds.m^{-1} (the soil properties prior to the experiment is shown in Table 1). The experimental design was split plot using randomized complete block design with three replications. The different proportion of manure and chemical fertilizer were: F_1 = 100% of manure (60 ton/ha); F_2 = 100% chemical fertilizer (urea 250 kg/ha, super phosphate triple 200 kg/ha and oxide potassium 100 kg/ha); F_3 = 50% of manure + 50% of chemical fertilizer; F_4 = control as the main plot and the use of elements treatment were: N_1 = iron sulfate, N_2 = zinc sulfate, N_3 = manganese sulfate and N_4 = control as sub plot in the experiment. All treatments were exerted before sowing. Barley was planted manually in October 2008. Experiment plots were seeded with Sistan cultivar with 25 cm row to row distance and 2 cm between plants. Seeds were sown 4 cm deep. Weeds were removed by hand. After planting, irrigation was applied as required during the growing season. The barley was harvested in April 2009. For measurement of plant characteristics, two edge rows were eliminated as margin effects and 1 m^2 of each plot was used for sampling. Data collected (obtained by combining the four center rows at each experiment unit) included: grain yield, 1000-grain weight, weight of ear, number of grain per ear and some of soil characteristic such as pH, EC and soil nutrient content.

Soil pH was measured in 1:2.5 (soil: water) suspension (Page, 1982) and EC was measured with a 1:10 (soil: water) ratio. The data were analyzed using MSTATC software; mean comparison was done using Duncan multiple comparison at 5% probability

Table 2. Analysis of variance for grain yield and feed yield and soil chemical properties.

S. O. V	Df	Grain yield	Feed yield	Mn	Mg	Zn	Fe	EC
Replication	2	24756/40^{ns}	7/22^{ns}	0/0008^{ns}	0/0008^{ns}	0/04049^{ns}	0/00034^{ns}	7377/7^{ns}
Proportions of manure and chemical fertilizer	3	42471/29**	136/11**	0/16689**	0/1385**	0/29968**	0/00174**	56580/57*
Error a	6	12225/65	5/63	0/045	0/03992	0/09203	0/0043	13428/65
Nutrient	3	6460/78*	15/57**	0/24*	0172/0^{ns}	0/20793**	0/00102*	18607/18^{ns}
Interaction	9	5606/07**	8/79**	0/25426**	01852/0^{ns}	03590/0^{ns}	0/00118**	42435/42**
Error b	12	2173/99	1/32	0/0651	0/00974	0/02728	0/00028	9427/90
CV	-	20/17	3/16	31/37	0/59	7/3	9/71	8/05

*, ** significantly at 5 and 1% levels of probability respectively and ns (non significant).

level.

RESULTS AND DISCUSSION

Grain yield

Proportions of manure and chemical fertilizer, use of nutrient and interaction with them had significant effect on barely grain yield ($P < 5\%$) (Table 2). Results showed that all proportions of manures and chemical fertilizer treatments significantly increased barley grain yield as compared to control (F_4) and the highest grain yield was obtained in the F_3 (50% manure + 50% chemical fertilizer) and F_2 (100% chemical fertilizer) treatments with mean of 2758/2 and 2713/5 kg/ha respectively as shown in Table 3. The increase in maize growth with the use of organic materials was also been observed by Silva et al. (2004). This study confirms the role of manure and chemical fertilizer in increasing grain yield of barley and the results show that manure and chemical fertilizer can increase grain yield of barley but combination of them has more effect on increase in grain yield. In a recent evaluation of the direct effects of cattle manure on corn, it was verified (Silva et al., 2004) that manure increased green ear yield and grain yield in two corn cultivars. Cattle manure also increased water retention and availability, and phosphorus, potassium and sodium contents in the soil layer from 0 to 20 cm (Silva et al., 2004). The residual effect of organic fertilizers on yield, including cattle manure has been found to be positive in sorghum (Patidar and Mali, 2002), corn (Raramurthy and Shivashankar, 1996) and *Brassica juncea* (Rao and Shaktawat, 2002). Therefore, there was a direct effect of cattle manure on green ear yield and grain yield (Silva et al., 2004).

Between nutrient treatments, N_1 (Fe^{2++}), N_2 (Zn^{2++}) and N_3 (Mg^{2++}) increased barley grain yield 20, 17/5 and 8/6% respectively as compared to control (N_4) and the highest grain yield (2539/6 kg/ha) was measured in N_1 (Fe^{2++}) as compared to other treatments as shown in Table 2.

Feed yield

Proportions of manures and chemical fertilizer, use of nutrient and the interaction of them had significant effect on barely feed yield ($P < 5\%$) (Table 1). Mean comparison in Table 2 showed that maximum amount of feed yield was obtained in F_2 (100% chemical fertilizer) with mean of 2761.15 kg/ha and was followed by F_3 with mean of 1985/57 kg/ha. Obtained results in this part showed that chemical fertilizer had a main effect on biomass production in barley and with decrease in the chemical fertilizer proportion, the yield of feed was decreased but use of manure increased feed production in relation to the control treatment. Between the use of nutrient, N_1 (Fe^{2++}) had maximum effect on barley feed yield and it increased about 29% in relation to the control treatment (N_4), also N_2 treatment (Zn^{2++}) and N_3 treatment (Mn^{2++}) increased feed yield about 13 and 6.6% in relation to the control. This result corroborates with the earlier findings of Ebrahimi et al. (1995).

Soil elements

Fertilizer proportions had significant effect on soil elements concentration (Table 1). Obtained results in this part show that soil concentration of iron, zinc, magnesium and manganese was increased compared to the control treatment with use of 100% manure (F_1) as shown in Table 2. The amount of soil elements F_3 treatment was less compared with F_1 treatment and there was no significant difference between F_2 and the control

Table 3. Mean comparison of interaction effects of yield and yield components.

Treatment	Grain yield	Feed yield	Fe (ppm)	Zn (ppm)	Mg (ppm)	Mn (ppm)
Proportions of manure and chemical fertilizer						
100% manure	229.77^{b}	1270.15^{c}	0.183^{a}	2.419^{a}	16.789^{a}	0.971^{a}
100% chemical fertilizer	271.35^{a}	2761.15^{a}	0.176^{b}	2.041^{b}	16.617^{b}	0.686^{a}
50% manure + 50% chemical fertilizer	275.82^{a}	1985.57^{b}	0.181^{s}	2.294^{ab}	16.730^{a}	0.803^{a}
Control	147.46^{c}	834.73^{d}	0.156^{b}	2.284^{b}	16.551^{b}	0.792^{b}
Nutrient						
Fe	253.96^{a}	2090.92^{a}	0.184^{a}	2.304^{b}	16.684^{b}	0.896^{a}
Zn	245.62^{ab}	1703.39^{b}	0.171^{b}	2.441^{a}	16.715^{b}	0.970^{a}
Mg	221.98^{b}	1580.93^{c}	0.178^{b}	2.330^{b}	16.868^{a}	0.702^{a}
Control	202.84^{c}	1476.36^{d}	0.163^{c}	2.063^{b}	16.620^{ab}	0.686^{a}

Mean fallowed by similar letters in each column are not significantly at the 5% level of probability.

treatment (F_4) results. In this part, it shows that the use of manure caused an increase in soil elements concentration, while soil element(Fe, Zn, Mg and Mn) concentration decreased with a decrease in manure proportion. Manure has different food elements and the use of it causes increase in soil elements. Brosard et al. (1997) expressed that organic matter increase food elements of soil and their absorption efficiency by plant. Soil nutrient concentration was significantly affected by the use of nutrient treatment (Table 1). This results show that use of N_1 (Fe^{2++}), N_2 (Zn^{2++}) and N_3 (Mg^{2++}) increased Fe, Zn and Mn in soil, respectively, but these treatments did not have any significant effect on soil concentration of Mn.

Salinity of soil

Salinity of soil significantly affected by manure and fertilizer proportions, but the use of nutrient and their interaction effect was not significant (Table 1). All fertilizer proportions treatments in comparison to control (F_4) increased salinity of soil as shown in Table 2. This result shows that F_2 increased salinity of soil more than the other treatments followed by F_3 (was in second rank. Totally, this result indicate that the use of chemical fertilizer caused increase in soil salinity.

Conclusion

In general, it can be concluded that the use of manure and chemical fertilizer considerably improves yield and yield component of barley. The result in this investigation shows that the use of 50% manure with 50% chemical fertilizer produced high yield of barley in Sistan region; and between nutrient treatments, the use of iron fertilizer had more effect on quantity characteristic of barley in comparison to other fertilizer.

REFERENCES

Abd E-Hady BA (2007). Effect of Zinc Application on Growth and Nutrient Uptake of Barley Plant Irrigated with Saline Water. J. Appl. Sci. Res., 3(6): 431-436.

Abd El-Wahab MA (2008). Effect of some trace elements on growth, yield and chemical constituents of *trachyspermum ammi* L. (AJOWAN) plants under Sinai conditions. Res. J. Agric. Biol. Sci., 4(6): 717-724.

Bacha MA, Sabbah AM, Hamady MA (1997). Effect of foliar application of iron, zinc and manganese on yield, berry quality and leaf mineral composition of Thompson seedless and roomy red grape cultivars. J. King Saud Univ(9), Agric. Sci., 1: 127-140.

Borlaug NE, CR Dowswell (1994). Feeding a human population that increasingly crowds a fragile planet. Paper presented at the 15th World Congress of Soil Science, 10–16 July 1994, Acapulco, Mexico.

Chen LZ, Xia ZL, Au SJ (1988). The integrated use of organic and chemical fertilizer in China. SFCAAS (Ed.). Proceedings of International Symposium on Balanced Fertilization. Chinese Agric. Press. pp. 390-396.

Ebrahim M, Sangtarash M, Kamoisia H (1995). Investigate effect of use Urea and different time of feed harvesting in wheat cultivation. Paper presented at the 4th Congress of agronomy and plant breeding. Isfahan, Iran.

Grejtovský A, Markušová K, Eliašová A (2006). The response of chamomile (*Matricaria chamomilla* L.) plants to soil zinc supply. Plant Soil Environ. 52(1): 1–7.

Hussain MZ, Rehman N, Khan Roohullah MA, Ahmed SR, (2006). Micronutrients status of Bannu basen soils. Sarhad J. Agric. 22(2): 283-285.

Marschner H (1995). Mineral Nutrition of Higher Plants. 2ed. New York: Academic Press, p. 889.

Materechera SA, Salagae AM (2002). use of partially decomposed cattle and chicken manures amended with wood-ask in two South African arable soils with contrasting texture effect on nutrient uptake, early growth and dry matter yield of maize. Communication in Soil Science and Plant Analysis, 33, No. 1/2. (179-200).

Nahed Abd El-Aziz G, Balbaa LK (2007). Influence of tyrosine and zinc on growth, flowering and chemical constituents of *Salvia farinacea* plants. J. Appl. Sci. Res., 3(11): 1479-1489.

Page AL (1982). Methods of Soil Analysis. Part. 2 Chemical and microbiological properties (2nd ed.), Amer. Soc. Agron. Inc. Soil Sci. Soc. Amer. Inc. Madison. Wisconsin U.S.A. properties. Agron. J., 98: 1471-1478.

Parker DR, Aguilera JJ, Thomason DN (1992). Zinc-phosphorus interactions in two cultivars of tomato (*Lycipersicon esculentum* L.) grown in chelator-buffered nutrient solutions. Plant Soil, 143: 163-

Sawan ZM, Hafez SA, Basyony AE (2001). Effect of phosphorus fertilization and foliar application of chelated zinc and calcium on seed, protein and oil yields and oil properties of cotton. J. Agric. Sci. 136:191-198.

Shao G, Chen M, Wang W, Mou R, Zhang G (2007). Iron nutrition affects cadmium accumulation and toxicity in rice plants. Plant Growth Regul. 53: 33-42.

Soleimani R, (2006). The effects of integrated application of micronutrient on wheat in low organic carbon conditions of alkaline soils of western Iran. 18th world congress of soil science.

Soylu S, Sade, B Topalv A, Akgun N, Gezgin S, (2005). Responses of Irrigated Durum and Bread Wheat Cultivars to Boron Application in Low Boron Calcareous Soil. Turk. J. Agric. 29: 275-286.

Stewart WM DW, Dibb AE, Johnston TJ, Smyth (2005). The contribution of commercial fertilizer nutrients to food production. Agron. J. 97: 1–6.

Wang XB, DX Cia, JZZ Hang (2001). Land application of organic and inorganic fertilizers for corn in dry land farming in a region of north China sustaining global farm. Ston DE, Montar R.I.I.I and Steinhardt GC Eds. pp. 419-422.

Welch RM, Allaway WH, House WA, Kubota J (1991). Geographic distribution of trace element problems. In: Mortvedt JJ, ed. Micronutrients in agriculture, 2nd Ed. Madison, Wisconsin: SSSA Book Ser. 4. SSSA. pp. 31-57.