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Examination of the nutrient uptake by the rice plant (Oryza sativa L.) under calcareous soils

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Abstract

The present work deals with the studies on the rice plant growth in the calcareous soils and survey of nutrients uptake by rice plant in these soils. The experiments were carried out in split- split plot design in randomized complete block with 3 blocks including 20 treatments. The experimental soil pH is 7.62 that can be categorized as calcareous soil indicating a sufficient amount of lime ($CaCO_3$) present in the soil (16.7%). Ca^{+2} and Mg^{2+} availability are excessive in this condition. Ca and Mg content in the grain were more than average range in the untreated plot (0.61 and 0.47%, respectively). It was found that using S powder and sulfate fertilizers decreased Ca and Mg uptake by the grain. The minimum Ca (0.33%) and Mg (0.14%) content were attained at treatment no. 17 (NPK + S powder + Zn sulfate). N, P, K and Na uptake increased marginally by the rice grain when NPK, S and Zn, Cu and Mn-fertilizers (treatment no. 20) applied which is in the similar ranges compared to no.17. Thus treatment no.17 is the best treatment for this proposes.

Keywords: Calcareous soil, Nutrient, Rice, Sulfur, Sulfate.

Introduction

The two greatest problems faced by the third world countries, at present, are the exponential increase in population and the basic need for providing adequate food. The food production in turn can be improved by improving the conditions of arable soil and the correct use of fertilizers. The presence of excess amounts of lime in soil disorders the nutrition uptake and injures plant growth (Somani and Kanthaliya, 2004 and Das, 1996). There is deficiency of nutrients in agronomic soils because of the existence of alkaline soils in Iran (Parvizi and Ronaghi, 2000). Triple super phosphate and low distance of cultivation are the cases of decrease of density of micronutrients in arable soils. Thus, correct use of nutrients and providing of ideal conditions for their availability and uptake, are important factor for increase of plant's yield (Malakoti and Tehrani 1999). Hence it is thought of interest to study the effect of sulfur as powder and sulfate fertilizers on soil pH and uptake of nutrients by the rice plant.

Experimental field

The experiments were carried out in paddy field of Mazandaran province, which is located in northern Iran. The experiments were arranged in a randomized complete block; split- split plot design and was compared with an untreated control. There were 3 factors in these experiments, these are, Macro-element as main plot in two levels: (control and NPK-fertilizer) and sulfur as sub plot in two levels (control and sulfur powder) and Microelement as sub-sub plot in five levels (1-control, 2-Zn sulfate, 3-Cu sulfate, 4-Mn sulfate and 5-Zn, Cu, Mn-sulfate). Thus, there were 20 treatments (2 x 2 x 5) that were located in each plot and each of these was replicated three times (60 plots). The experimental field was leveled and divided into 60 plots and macro and microelement and sulfur powder were applied to the plots area as recommended by routine soil analysis (Malakoti, and Gheybi, 1997). N, P and K-fertilizers were as urea (50 kg/ha), Tripl super- phosphate (50 kg/ha) and potassium sulfate (25 kg/ha), respectively. Zn, Cu and Mn-fertilizers were as Zn sulfate (30 kg/ha), Cu sulfate (10 kg/ha) and Mn sulfate (20 kg/ha), respectively. Sulfur powder has also been chosen at the rate of 100 kg/ha.

Afterwards, the rice seedling was transplanted when it was at 15 cm height. Distance of transplanting hill was 25 x 25 cm and was cultivated 4 stems in each hill (Ghasempour and Khodabandeh, 2004). The type of rice variety was Tarom that belongs to Basmati varieties.

Determination of N, P and K content in the grain

To determine of the N, P and K concentration in the rice grains following methods have been done: one gram of the each sample was powdered and burnt in the heater (dish) at about 500-550 ^{O}C for a 5-6 hours which changed it to ash. To the ash some HCL was added, and after one hour distilled water was also added to make the volume of the solution to about 100 cc. N, P and K content of this solution was also obtained using Kejeldahla system (KJELTEC auto tecator 1030 analyzer Sweden), Spectro-photometer (Pharmacia- LKB-Novaspec 2 England) and Flame photometer (410 corning England), respectively.

Determination of Ca, Mg and Na contents in the grain

To determine Ca, Mg and Na content of the grain, 1 gm of dried powdered sample was digested with a mixture of 5 ml each of HCL, HNO_3 and $HCLO_4$ on using heat for a period of 30 minutes until the disappearance of white fumes. After cooling, 100 ml of distilled water was added and filtered. Next, 5 ml of each sample was chosen and diluted by 100 ml of distilled water. The clear solution obtained was analyzed for Ca, Mg and Na using ICPAES (Inductively Coupled Plasma-Atomic Emission Spectrometer).

Results and discussion:

N, P, K, Ca, Mg and Na contents at various stages are recorded in Table 1.

Table 1. N, P, K, Ca, Mg and Na concentration in the rice grain

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)
1-Control	1.25	0.163	0.30	0.61	0.47	0.023
2-Zn	1.25	0.163	0.30	0.59	0.26	0.025
3-Cu	1.25	0.166	0.30	0.60	0.35	0.040
4-Mn	1.26	0.166	0.30	0.60	0.27	0.046
5-ZN,Cu,Mn	1.25	0.166	0.31	0.60	0.27	0.035
6-S	1.29	0.166	0.30	0.59	0.24	0.050
7-S+Zn	1.26	0.170	0.31	0.57	0.22	0.038
8-S+Cu	1.28	0.166	0.30	0.58	0.23	0.041
9-S+Mn	1.25	0.166	0.30	0.58	0.25	0.051
10-S+Zn,Cu,Mn	1.27	0.170	0.30	0.58	0.28	0.061
11-NPK	1.27	0.173	0.31	0.44	0.24	0.047
12-NPK+Zn	1.31	0.173	0.30	0.52	0.20	0.048
13-NPK+Cu	1.35	0.176	0.30	0.44	0.29	0.042
14-NPK+Mn	1.31	0.173	0.30	0.45	0.16	0.040
15-NPK+Zn,Cu,Mn	1.25	0.176	0.31	0.54	0.18	0.054
16-NPK+S	1.28	0.176	0.30	0.57	0.27	0.057
17-NPK+S+Zn	1.31	0.176	0.30	0.33	0.14	0.041
18-NPK+S+Cu	1.26	0.173	0.31	0.55	0.30	0.061
19-NPK+S+Mn	1.26	0.173	0.30	0.50	0.34	0.048
20-NPK+S+Zn,Cu.Mn	1.43	0.176	0.31	0.36	0.38	0.080

The P, Ca and Mg content are also shown graphically in Figs. 1, 2, and 3 respectively.

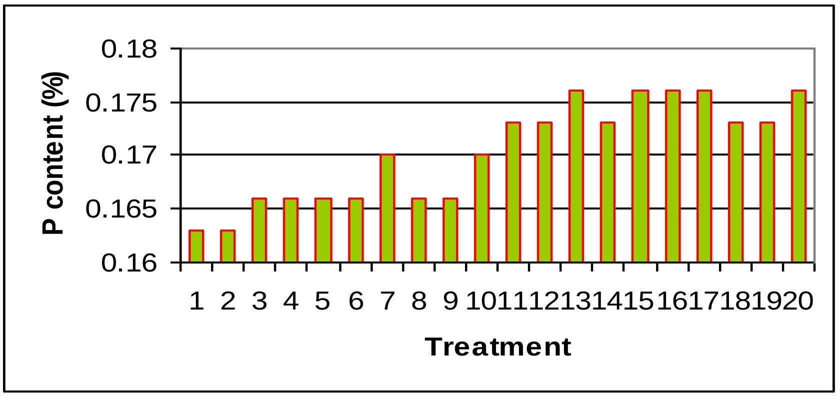

Fig. 1. P content in the rice grain

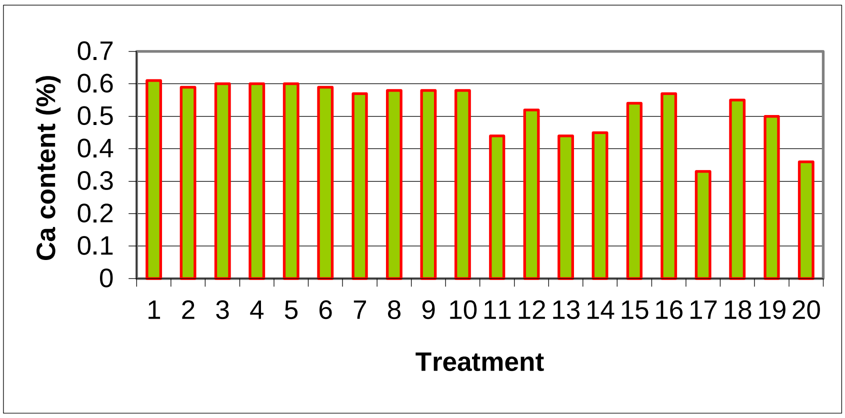

Fig. 2. Ca content in the rice grain

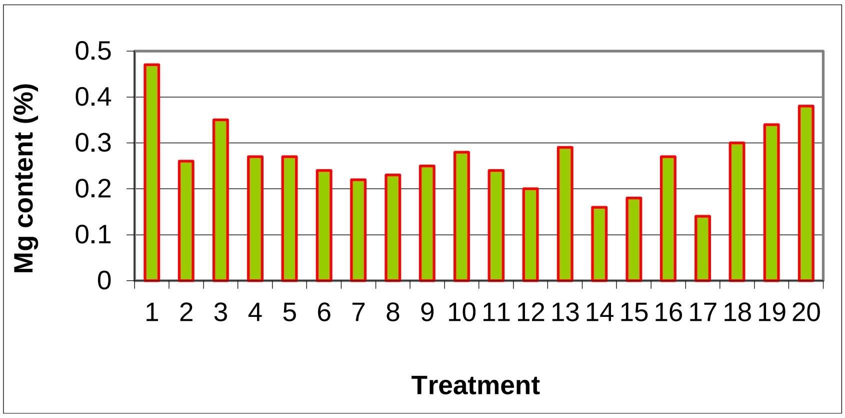

Fig. 3. Mg content in the rice grain

The experimental soil pH is 7.62 that can be categorized as calcareous soil indicating a sufficient amount of lime ($CaCO_3$) present in the soil (16.7%). Calcareous soils typically have pH > 7.2 (Das, 1996 and Biswas and Mukherjee, 1994). Perhaps the alkaline pH (7.62) of the sample analyzed is due to the hydrolysis of lime that releases OH^- ions (Das, 1996). The experimental soil is marly (limey) with sand size carbonate particles that have been transported from the Alborz Mountains. The experimental soil does not belong to excess lime soil but has adequate Ca^{2+} available in the form of $CaCO_3$. Ca levels in calcareous soils vary from less than 1% to more than 25% (Havlin et al, 1999) that in the experimental soil is 6.6% if all the Ca is presumed to be present as $CaCO_3$.

Average removal of Ca and Mg in modern irrigated rice in the grain is 0.05 and 0.15 %, respectively (Dobermann, 2000). Ca^{+2} and Mg^{2+} availability are excessive at the present experimental soil under pH 7.62. Ca (0.61%) and Mg (0.47%) content were more than average range in the untreated grains (Control plot). It was observed that Ca and Mg content decreased in the grain, using S powder and micronutrient fertilizers (Table 1 and Figs. 2 and 3) compared to the control plot. The minimum Ca (0.33%) and Mg (0.14%) contents in the grain were attained at treatment no. 17 (NPK + S + Zn sulfate). The maximum N and Na content were also attained at treatment no. 20 (NPK + S + Zn, Cu and Mn sulfates). P content in the grain did not change much compared to the control plot at treatment nos. 1 – 10, which is without NPK fertilizers. It increased marginally at treatment nos. 11 – 20 that is with NPK fertilizers (Table 1 and Fig. 1). K content did not change much using applied fertilizers compared to the control plot. The results show that N, P, K uptake by the grain did not change much compared to the control plot, but Ca and Mg content decreased significantly compared to the control plot which might be pointed to the lowering soil pH using S powder and sulfate fertilizers. It was observed that treatment no. 17 (NPK + S + Zn sulfate) could be defined as the best treatment in the present work.

Average removal of P element in modern irrigated rice in the grain is 0.2 % (Dobermann, 2000). In the present study, the maximum P content in the grain is 0.176 % (Table 1 and Fig. 1), which was not reached to the average range in the grain. But it increased compared to the control plot (0.163%). It might be precipitated on the soil mineral as Ca-phosphate because of the presence of calcareous soil in this area. Thus it shows that application of S powder and sulfate fertilizers, created more availability of P element for the rice plant, which can be pointed to the lowering soil pH.

Conclusion:

Addition of sulfur powder and sulfate-fertilizers on the paddy field increases nutrient uptake like N, P, K, and Na. It also decreases significantly Ca and Mg uptake the rice grain using S powder and sulfate fertilizers under the calcareous soils conditions.

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References

1. **Benton, J. (1999)** Plant nutrition manual. CRC Press LLC. Printed in the U.S.A 149p.
2. **Bhandari AL, Ladha JK, Pathak H, Padre AT, Dawe D, Gupta RK (2002)** Yield and Soil Nutrient Changes in a Long-Term Rice-Wheat Rotation in India. *Soil Science Society of America Journal* **66**, 162-170.
3. **Biswas, TD. and Mukherjee, SK. (2003)** Text book of soil science. 2nd Edn. Tata McGraw-Hill Publishing Company. 433p.
4. **Chapma AL (1980)** Effect of sulphur, sulphuric acid and gypsum on the yield of rice on the Cununurra soils of the Ord irrigation area, western Australia. *Australian Journal of Experimental Agriculture Animal Husbandry* **20**, 724–730.
5. **Das, D.K. (1996)** Introductory Soil Science. 1st Edn. Kalyani Publ. New Delhi. 498p.
6. **Dobermann A, Fairhurst T (2000)** 'Rice. Nutrient disorders and Nutrient management.' Handbook series. 191 p. Potash & Phosphate Institute (PPI), Potash & Phosphate Institute of Canada (PPIC) and International Rice Research Institute.
7. **FAO (1989)** Utilization of tropical foods: Cereals. No. 47/1. Rome. 114 p.
8. **Gao S, Tanji KK, Scardaci SC, Chow AT (2002)** Comparison of Redox Indicators in a Paddy Soil during Rice-Growing Season. *Soil Science Society of America Journal* **66**, 805-817.
9. **Havlin, J.L., Beaton, J.D., Tisdale, S.L. and Nelson, W.L. (2003)** Soil Fertility and Fertilizers. 6th Edn. Pearson Education, Indian Reprint. 499 p.
10. **Kobayashi S, Schwarta SJ, Lineback DR. (1985)** Rapid analysis of starch, amylose and amylopectin by high-performance size-exclusion chromatography. J Chromatogr. 1;319 (2):205-14.

11. **Malakoti, M.J., and Tabatabai, S.J. (1997)** Plants nutrition by foliar application. Proceeding of the 1st national congress of reduction of poisons consumption and suitable using of chemical fertilizers in agriculture. Agricultural Ministry. Karaj. Iran.
12. **Malakoti MJ, Gheybi MN (1997)** Determination of critical level of strategies agricultural nutrients and correct recommendation of fertilizers in country. In 'Proceeding of the 1st National congress of reduction of poisons consumption and suitable use of chemical fertilizers in agriculture'. pp. 24-25. (Agricultural Ministry, Karaj. Iran. In Persian).
13. **Malakoti, M.J., and Tehrani, M.M. (1999)** Effects of Micronutrients on the yield and quality of agricultural products. Micronutrients with Macro-Effects. Publ. of Tarbiat Modarres Uni. Tehran. 299 p. (In Persian)
14. **Qasempour AM, Khodabandeh N (2004)** 'Rice cultivation'. p. 190. Publication of Azad University of Qaemshahr. Iran. (In Persian)
15. **Sharma P, Swarup A (1996)** Comparison of Pyrite varying in water-soluble sulfur with Gypsum for the reclamation of alkali soils under a Rice-Wheat rotation. *Biology and Fertility of soil Journal* **24**, 96-101
16. **Slaton NA, Norman RJ, Gilmour JT (2001)** Oxidation Rates of Commercial Elemental Sulfur Products Applied to an Alkaline Silt Loam from Arkansas. *Soil Science Society of America Journal* **65**, 239-243.