Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 5, Issue, 01, pp.065-067, January, 2013

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

EFFECT OF ZINC PHOSPHORUS AND SULFUR INTERACTIONS ON GROWTH AND YIELD OF RICE UNDER NEUTRAL AND ALKALI SOILS

***Rasavel M., and Ravichandran, M**

Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture,
Annamalai University, Annamalai Nagar, Tamil Nadu

ARTICLE INFO

Article History:
Received 02th October, 2012
Received in revised form
19th November, 2012
Accepted 26th December, 2012
Published online 16th January, 2013

Key words:
Phosphorus,
Sulfur,
Zinc,
Growth,
Yield,
Rice

ABSTRACT

Field experiments were conducted to study the interaction of phosphorus, sulfur and zinc on growth and yield of rice in neutral and alkali soils. The treatments consisted of two levels of P_2O_5 (25, 50 kg/ha), two levels of S (20, 40 kg/ha) and four levels of Zn(0,5,10, 15 kg/ha) besides an absolute control, thus totaling seventeen treatments. The results revealed significant interactions among P,S and Zn on growth and yield of rice. The growth and yield of rice was less when P, Zn and S were applied at lower rates, but improved with increasing levels of nutrients. However, the highest grain (5216, 4678 kg/ha) and straw yields (6123, 5642 kg/ha) was noticed with application of 50 kg P_2O_5, 20 kg S and 10 kg Zn /ha in neutral and alkali soils respectively. This was comparable with 50 kg P_2O_5, 40 kg S and 10 kg Zn /ha. Similar effect was noticed with respect to growth and yield attributes. It is clearly exhibited that in the absence of zinc application, growth and yield of rice is reduced in spite of addition of adequate amounts of P and S. Further, for a given level of P and S, addition of highest amount of Zn (15 kg/ha) reduced the growth and yield of rice.

INTRODUCTION

Intensive farming leads to heavy withdrawal of nutrients from soils and its access depends largely upon the external application of nutrients commensurate with the nutrient uptake. Zinc is one of the essential micronutrients. It is a constituent of enzymes regulates various metabolic reactions in the plant. In the soil surface it is found chiefly and sphalerite, a sulphide mineral, in soils, it is predominantly associated with clay function. It also exists as a constituents of organic matter, limited quantity of zinc exists on the soil exchange complex and soil solution. Soil concentration of Zn are usually less than 1 ppm but may rise approximately to 100 ppm. Sulphur is in one of the sixteen essential plant nutrients and ranked fourth after N, P, K for the growth and development of all plants. Sulphur involved in the formation of protein, vitamins, enzymes required for the plant in conducting biochemical processes. Sulphur deficiencies are wide spread in Indian soils and reports of more areas found deficient in S are coming regularly. Deterioration in soil productivity is often observed under modern intensive cropping system especially due to deficiency of S and is fast emerging an important yield limiting factor under long term rice culture (Nambiar, 1994). Sulphur application in general benefits more than one and in sequence and producers a significant residual response. Integrated use of organics and mineral fertilization have been found to be more effective in maintaining higher productivity and stability through correction. Phosphorus is the backborne of a sound fertilizer management. Phosphorus and zinc show antagonism (Kanath and Sarkar, 1990) and their interaction may take place in the soil as well as in the plant. Such information in rice is meager. Hence the present investigation were undertaken to assess the interaction effect of zinc with phosphorus and sulphur levels on growth and yield of rice.

Corresponding author: rasavel.m@gmail.com

MATERIALS AND MEHTHODS

The field experiments were conducted in the wet land fields of farmers land. The experimental farm is geographically situated at 11°57' N latitude and 79°12' E longitude with altitude of 73 m above mean sea level. Experimental soils were neutral and alkali in reaction .The neutral soil showed pH 7.3, $KMnO_4$ - N 240 kg ha^{-1} (Subbiah and Asija, 1959), Olson's – P 19.0 kg ha^{-1}(Jackson, 1973), NH_4OAc - K 325 kg ha^{-1} (Jackson, 1973) and DTPA -Zn 0.38 mg kg^{-1} (Lindsay and Norvell, 1978). Similarly, the alkali soil showed pH9.4, $KMnO_4$ - N 225 kg ha^{-1} Olson's – P 16.5 kg ha^{-1}, NH_4OAc - K 295 kg ha^{-1} and DTPA -Zn 0.21 mg kg^{-1}. The experiments were conducted in RBD with seventeen treatment combinations with three levels of zinc (0, 5, 10, & 15 kg Zn ha^{-1}), two levels of phosphorus (25, & 50 kg P_2O_5 ha^{-1}) and two levels of sulphur (20, & 40 kg ha^{-1}) , besides one absolute control to study the growth and yield of rice. The sources of zinc and phosphorus, sulphur were zinc sulphate, diammonium phosphate, gypsum, respectively. The seedlings of rice variety ADT 43 was planted after 20 DAS. The growth (plant height, number of tillers/hill, LAI, Chlorophyll content and DMP) and yield parameters (Panicle length, number of grains/panicle) and grain and straw yields were recorded.

RESULTS AND DISCUSSION

Effect of phosphorus, sulfur and zinc on growth and yield of rice in neutral and alkali soil is furnished in Table 1 and 2. The growth and yield of rice was significantly influenced by addition of P, S and Zn over control. The growth and yield of rice in both soils were low when P, S and Zn were applied at lowest rates and it improved with increasing levels of the nutrients. With increasing levels of phosphorus at same level of sulfur and in the absence of zinc improved the growth of rice compared to control .But at the same level of P and in the absence of zinc, increasing level of S declined the growth. However, the effect was more prounced in the presence of zinc rather than in the absence of it. The highest plant height (89.5, 52.8 cm), Number of tillers hill^{-1}(17.2,16.3), LAI(5.89,5.12), Chlorophyll content(4.58,4.16 mg g^{-1}), DMP (8436,7385 kg/ha), Panicle length (24.9,21.6 cm) and Number of grain/panicle (115.6,108.3) was noticed with application of 50 kg P_2O_5/ha, 20 kg S/ha and 10 kg Zn/ha (T_8) in neutral and alkali soils respectively.

It was superior to rest of the treatment combinations except T_{16} (50 kg P_2O_5/ha, 40 kg S/ha and 10 kg Zn/ha). The growth was reduced at the highest level of P, S and Zn applied. Application of Zn increased the growth parameters possibly due to inter relationship with auxin, an important growth parameter regulating the stem elongation and cell enlargement. Excess application of P to soil which is low in available zinc may induce deficiency by increasing zinc uptake from the soil (Barrow, 1987). Increasing level of P application may increased dry matter production is the resultant of better growth and higher number of tiller which resulted in high photosynthetic actively and formation of more photosynthate (Sarika Sune *et al.,* 2006).

Yield

The highest grain (5216, 4678 kg/ha) and straw yields (6123, 5642 kg/ha) was noticed with application of 50 kg P_2O_5, 20 kg S and 10 kg Zn /ha in neutral and alkali soils respectively. The per cent increase in grain yield over control by above treatment was (79.2, 130.2) in neutral and alkali soils

Table 1. Effect of Zn-P interaction as influenced by sulphur on growth and yield parameters in rice under neutral soil

Treatment	Plant height (cm)	Number of tillers per hill	Leaf area index	Chlorophyll content (mg g^{-1})	DMP (kg/ha)	Panicle length (cm)	Number of grains panicle^{-1}	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1-P_0ZnS_0	55.7	9.2	3.43	2.76	4473	15.3	68.2	2910	3072
T_2-$P_{25}Zn_0S_{00}$	63.6	10.8	3.83	3.03	5634	17.2	76.3	3296	3869
T_3-$P_{25}Zn_1S_{20}$	65.1	11.0	3.93	3.10	5778	17.6	78.4	3379	3967
T_4-$P_{25}Zn_2S_{20}$	68.9	11.5	4.11	3.25	6244	18.4	82.2	3634	4265
T_5-$P_{25}Zn_3S_{30}$	71.2	11.9	4.22	3.47	6399	18.9	84.2	3801	4462
T_6-$P_{50}Zn_0S_{20}$	76.2	13.1	4.75	3.71	6842	20.2	90.0	4107	4821
T_7-$P_{50}Zn_1S_{20}$	78.0	14.5	5.87	3.97	7312	21.6	100.2	4390	5153
T_8-$P_{50}Zn_2S_{20}$	89.5	17.2	5.89	4.58	8436	24.9	115.6	5216	6123
T_9-$P_{50}Zn_3S_{20}$	82.5	15.8	5.44	4.23	7796	23.6	106.8	4800	5635
T_{10}-$P_{25}Zn_0S_{40}$	61.2	10.5	3.75	2.96	5516	16.8	74.9	3226	3787
T_{11}-$P_{25}Zn_1S_{40}$	68.1	10.5	3.88	3.07	5708	17.4	77.5	3339	3920
T_{12}-$P_{25}Zn_2S_{40}$	67.1	11.1	4.03	3.18	5926	18.0	80.4	3557	4176
T_{13}-$P_{25}Zn_3S_{40}$	68.7	11.7	4.16	3.29	6323	18.7	83.2	3755	4408
T_{14}-$P_{50}Zn_0S_{40}$	73.5	12.9	4.45	3.67	6758	19.9	88.9	4056	4762
T_{15}-$P_{50}Zn_1S_{40}$	75.2	14.2	5.01	3.92	7225	21.3	95.1	4337	5091
T_{16}-$P_{50}Zn_2S_{40}$	86.3	16.9	5.77	4.48	8759	24.4	113.2	5106	4994
T_{17}-$P_{50}Zn_3S_{40}$	79.5	15.6	5.32	4.14	7617	22.5	104.4	4690	5505
CD (p = 0.05)	2.86	1.46	0.243	0.152	296.95	0.30	3.70	150.6	184.3

Table 2. Effect of Zn-P interaction as influenced by sulphur on growth and yield parameters in rice under alkali soil

Treatment	Plant height (cm)	Number of tillers per hill	Leaf area index	Chlorophyll content (mg g^{-1})	DMP (kg/ha)	Panicle length (cm)	Number of grains panicle^{-1}	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1-P_0ZnS_0	32.8	6.9	3.08	2.54	4090	12.6	64.1	2031	2481
T_2-$P_{25}Zn_0S_{00}$	40.5	7.2	3.31	2.75	5088	14.1	72.1	2956	3565
T_3-$P_{25}Zn_1S_{20}$	41.8	9.8	3.39	2.82	5218	14.5	74.0	3031	3655
T_4-$P_{25}Zn_2S_{20}$	42.3	10.4	3.79	2.95	5466	15.2	77.5	3259	3930
T_5-$P_{25}Zn_3S_{30}$	45.3	11.2	3.88	3.03	5602	16.4	82.5	3409	4111
T_6-$P_{50}Zn_0S_{20}$	48.0	12.4	4.15	3.24	5989	17.5	87.8	3683	4442
T_7-$P_{50}Zn_1S_{20}$	49.6	13.6	4.44	3.46	6401	18.7	93.9	3937	4748
T_8-$P_{50}Zn_2S_{20}$	52.8	16.3	5.12	4.16	7385	21.6	108.3	4678	5642
T_9-$P_{50}Zn_3S_{20}$	50.5	14.8	4.73	3.69	6825	20.0	100.1	4305	5192
T_{10}-$P_{25}Zn_0S_{40}$	35.6	8.7	3.24	2.69	4981	13.8	70.6	2894	3490
T_{11}-$P_{25}Zn_1S_{40}$	36.8	9.7	3.35	2.79	5155	14.3	73.1	2995	3612
T_{12}-$P_{25}Zn_2S_{40}$	37.8	10.2	3.59	2.89	5351	14.8	75.9	3190	3848
T_{13}-$P_{25}Zn_3S_{40}$	40.8	10.9	3.84	2.99	5535	16.2	81.2	3368	4062
T_{14}-$P_{50}Zn_0S_{40}$	43.0	12.1	4.10	3.20	5916	17.3	86.8	3638	4388
T_{15}-$P_{50}Zn_1S_{40}$	46.0	13.3	4.38	3.42	6325	18.5	92.9	3890	4691
T_{16}-$P_{50}Zn_2S_{40}$	51.3	15.8	5.01	3.91	7230	21.1	106.0	4580	5524
T_{17}-$P_{50}Zn_3S_{40}$	41.8	14.0	4.62	3.60	6668	19.5	97.8	4206	5037
CD (p = 0.05)	2.38	1.28	0.166	0.218	240.01	0.76	4.55	118.4	137.5

respectively. Similarly, the per cent increase in straw yield over control was (99.3, 127.4). This was comparable with 50 kg P_2O_5, 40 kg S and 10 kg Zn /ha. As observed in growth characters, the grain and straw yield improved markedly in the presence of zinc rather than its absence. For given level of phosphorus and sulfur, increasing levels of zinc improved the grain yield by 2.5 to 15.3 per cent. However, when all the three nutrients were applied at highest level, yield reduction was noticed. Increasing phosphorus doses significantly increased the yield attributes and yield over control. The rate of increase in grain yield with each successive increment in P dose was more than that in straw yield. High doses of P might have accelerated growth and brought about higher production of grain yield (Rao and Shukla, 1997). Similar result was corroborated by Rama Rao *et al.* (1991).The increase in grain yield on addition of S and Zn is attributed to their deficiency in the soils of the experimental fields (Tripathi *et al.,* 1997). The increase in yield may be attributed to the favorable effect of sulphur availability to plants (Ram *et al.,* 1999). The application of S significantly increased the uptake of P. Enhancement of yield of rice due to increase the increment in application of P and Zn might increase the adsorption of nitrogen (Singh and Singh, 1986).

Conclusion

From results, it can be referred that application of 50, 10 and 20 kg ha^{-1} of P_2O_5, Zn and S with recommended dose N and K found beneficial for enhancing the productivity of rice in neutral and alkali soil.

REFERENCES

Barrow, M.J. 1987. The effect of phosphate on gene sorption by a soil. *J. Soil Sci.,* 38: 453-459.

Jackson, M.L. 1973. Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Lindsay, W.L. and W.A. Norvell. 1978. Development of DTPA soil test for zinc, iron, manganese and copper. *Soil Sci. soc. Am. J.,* 42: 421-428.

Nambiar, K.K.M. 1994. Soil fertility and crop productivity under long-term fertilizer use in India. ICAR Publication, New Delhi, pp. 149.

Ram, H., S. Singh and C.N. Chaubey. 1999. Response of rice to sulphur under reclaimed salt affected soil. *Oryza,* 36(3): 272-273.

Roa, C.P. and D.N. Shukla. 1992. Interaction of Zn with different source and levels of phosphorus on growth and yield of rice. *Oryza,* 34(3): 229-233.

Sarika V. Sune, R.M. Deshpande, Khawale, P.V. Banskar and Bhavita P. Gurav. 2006. *J. Soils and Crops,* 16(1): 217-221.

Singh, M.V. and S.B. Singh. 1986. Effect of phosphorus fertilization on the yield and adsorption of nitrogen and zinc by rice and wheat grown in semi reclaimed alkali soil. *Oryza,* 26: 151-155.

Singh, Y.P. and Ranbir Singh. 2004. Interaction effect of sulphur and phosphorus on growth and nutrition content of black gram (*Phaseolus mungo* L.). *J. Indian Soc. Soil Sci.,* 52(3): 266-269.

Standford, D. and L. English. 1949. Use of flame photometer in rapid soil tests of K and Ca. *Agron. J.,* 4: 446-447.

Subbiah, B.V. and L.C. Asija. 1956. A rapid method for estimation of available nitrogen in soils. *Curr. Sci.,* 25: 258-260.

Watanabe, I. and S.R. Olsen. 1965. Test of ascorbic acid methods for determining phosphorus in water and $NaHCO_3$ extracts from soil. *Soil Sci. Soc. Am. Proc.,*29: 677-678.

****