Original Research Article

Effect of Zinc and Iron Fertilization on Soil Nutrient Status of Direct Sown Rice

Abstract

A field experiment was conducted to find out the effect of Direct sown rice to zinc and iron nutrition at Agriculture College Farm, Bapatla during *kharif*, 2017. The experimental treatments include RDF (180 :60 :40 N-P_2O_5-K_2O (kg ha^{-1}); RDF + $ZnSO_4$ @ 50kg ha^{-1} through soil application; RDF + $FeSO_4$ @ 25kg ha^{-1} through soil application; RDF + $ZnSO_4$ @ 50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application; RDF + foliar spray of $ZnSO_4$ @ 0.2% at 20 and 45 DAS; RDF + foliar spray of $FeSO_4$ @0.5% at 20 and 45 DAS; RDF + foliar spray of $ZnSO_4$ @ 0.2% and $FeSO_4$ @ 0.5% at 20 and 45 DAS. The results revealed that, the soil properties *viz*., available nitrogen, phosphorus and potassium were not significantly influenced by fertilization of zinc and iron. Among the micronutrients there was significant influence on Zn and Fe content, while Mn and Cu were not significantly influenced by zinc and iron fertilization along with recommended dose of fertilizer.

Key words: Rice, Soil fertility, Zinc, Iron, Soil available nutrients.

Introduction

Rice (*Oryza sativa* L.) is a staple food for more than one third of the world population (Zhao *et al.*, 2011). In India, it is grown in an area of 44.1 million hectares with a production of 108.9 million tonnes and productivity of 2391 kg ha^{-1}. It occupies one-quarter of the total cropped area contributing about 40 to 43 per cent of total food grain production and continues to play a vital role in the national food security system (Viraktamath *et al.*, 2011).

Direct Seeding of Rice (DSR) refers to the process of establishing the crop from seeds sown in the field rather than by transplanting seedlings from the nursery (Farooq *et al*., 2011). Direct seeding avoids three basic operations *viz*., puddling, transplanting and maintaining standing water. Under present situation of water and labour scarcity, farmers are changing their rice establishment methods (only from transplanting to direct seeding in puddled soil *i.e.* Wet-DSR) or both tillage and rice establishment methods (puddle transplanting to dry direct seeding in un-puddled soil *i.e*. Dry-DSR). DSR is a major opportunity to change production practices to attain optimal plant density and high water efficiency in water scarce areas. Now, new varieties have been developed for rainfed upland rice ecosystem also. It covers in about 6.0 million hectares in India, which accounts for 13.5% of the total area under rice crop (Joshi *et al*., 2013**)**.

Micronutrients, particularly zinc and iron have attained a great significance in today's intensive and exploitive agriculture which is aiming at higher crop productivity. The total iron and zinc content of Indian soils of varies from 0.8-1.96 mg kg^{-1} and 0.2-6.9 mg kg^{-1}, respectively. In direct seeding, availability of several nutrients including N, P, S and micronutrients such as Zn and Fe, is likely to be a constraint. Nonetheless, farmers are inclining to adopt direct sown rice and the area under direct sown rice is increasing year after year. Hence, keeping in view the importance of Zn and Fe nutrition on growth and yield of direct sown rice crop, an experiment was conducted to find out the response of direct sown rice to zinc and iron nutrition**.**

Material and Methods

A field experiment was conducted at the Agricultural College Farm, Bapatla situated at Krishna zone of Andhra Pradesh during *kharif*, 2017. The soil of the experimental field was sandy clay in texture, neutral in soil reaction (pH of 7.48), non-saline (EC 0.53 dS m^{-1}), low in organic carbon (4.0 g kg^{-1}), low in available nitrogen (224 kg ha^{-1}) and medium in available phosphorus (38.8 kg P_2O_5 ha^{-1}), medium in available potassium (285 kg K_2O ha^{-1}), sufficient in available Zn (1.29 mg kg^{-1}), Fe (5.39 mg kg^{-1}), Mn (6.98 mg kg^{-1}) and Cu (1.74 mg kg^{-1}). The experimental treatments include RDF (180 :60 :40 N-P_2O_5 -K_2O (kg ha^{-1}); RDF + $ZnSO_4$ @ 50kg ha^{-1} through soil application; - RDF + $FeSO_4$ @ 25kg ha^{-1} through soil application; RDF + $ZnSO_4$ @ 50 kg ha^{-1} + $FeSO_4$ @ 25 kg ha^{-1} through soil application; RDF + foliar spray of $ZnSO_4$ @ 0.2% at 20 and 45 DAS; RDF + foliar spray of $FeSO_4$ @ 0.5% at 20 and 45 DAS; RDF + foliar spray of $ZnSO_4$ @ 0.2% and $FeSO_4$ @ 0.5% at 20 and 45 DAS. The treatments were laid out in randomized block design and replicated thrice. Recommended dose of phosphorus and potassium were applied uniformly to all the treatments in the form of single super phosphate and muriate of potash as basal. Urea was applied in 3 equal splits *i.e.*, basal, tillering and panicle initiation stage of the crop. $ZnSO_4$ was used as a source of zinc fertilizer and $FeSO_4$ was used as a source of iron fertilizer. Foliar application was done at different growth stages such as 20 and 45 DAS. For foliar application 0.2% $ZnSO_4$ and 0.5% $FeSO_4$ solution was prepared. The soil samples collected at different growth stages viz., tillering, panicle initiation and harvest stages of crop growth were dried under shade, pounded, to pass through 2mm sieve. The samples were analyzed for available N,P,K and micronutrients (Zn, Fe, Cu and Mn) by adopting standard procedures (Jackson, 1967).

Results and discussion

Available Nitrogen

At tillering, panicle initiation and harvest stages of crop growth the highest (270, 263 and 251 kg ha^{-1}, respectively) soil available nitrogen was recorded in the treatment applied with RDF + $ZnSO_4$ @ 50 kg ha^{-1}+ $FeSO_4$ @ 25 kg ha^{-1} through soil application while the lowest (248, 238 and 228 kg ha^{-1}, respectively) was recorded with RDF (Table 1). The available nitrogen status increased at tillering stage over initial value (224 kg ha^{-1}), later decreased at panicle initiation and at harvest stage of the crop. The nutrient management in upland drilled rice (aerobic rice) revealed that there was not significant change in available nitrogen status of soil due to application of RDF along with Zn and Fe either through soil or foliar spray, which might be attributed to loss of N due to denitrification, volatilization, leaching and fixation relatively higher in drilled rice than in conventional transplanted rice (Singh and Singh, 1998).

Available Phosphorus

Highest soil available phosphorus was recorded (49, 46 and 42 kg ha^{-1} at tillering, panicle initiation and harvest stages of crop growth, respectively) in the treatment received with RDF + $ZnSO_4$ @ 50 kg ha^{-1}+ $FeSO_4$ @ 25 kg ha^{-1} through soil application while the lowest soil available phosphorus was recorded (40, 39 and 37 kg ha^{-1}, respectively) with RDF. There is an increase in the available phosphorus status at tillering stage over initial level (38 kg ha^{-1}), later it was observed that the trend was decreased at panicle initiation and harvest stage of the crop. This might be due to absorption by crop plants and fixation of P in the soil (Mahendar *et al*., 2017).

Available Potassium

At tillering, panicle initiation and harvest stages of crop growth the highest soil available potassium (357, 341and 336 kg K_2O ha^{-1}, respectively was recorded in the treatment received with RDF + $ZnSO_4$ @ 50 kg ha^{-1}+ $FeSO_4$ @ 25 kg ha^{-1} through soil application while the lowest soil available potassium values are recorded (331, 301 and 293 kg K_2O ha^{-1}, respectively) with RDF. The content of available potassium increased at tillering stage over initial level (285 kg ha^{-1}) and later decreased trend was observed at panicle initiation and harvest stage of the crop. This might be attributed to loss of applied nutrients through various processes *viz*., leaching and fixation (Parmesh *et al*., 2013 ; Jadhav *et al*., 2014).

Available Zinc

At tillering, panicle initiation and at harvest stage the maximum (3.73, 3.48 and 3.42 mg kg^{-1}) soil available zinc content was maintained under RDF+ $ZnSO_4$@50kg ha^{-1} + $FeSO_4$@25kg ha^{-1} through soil application, which was on par with RDF+ $ZnSO_4$@50kg ha^{-1} through soil application (3.34, 3.26 and 3.19 mg kg^{-1}). These two treatments are significantly superior to rest of the treatments. The minimum (1.42, 1.39 and 1.31 mg kg^{-1}) soil available zinc content was recorded with RDF (Table 3). Soil application of zinc sulphate along with recommended dose of fertilizers as basal application had helped in significantly increasing zinc status of soil.

Available Iron

At tillering, panicle initiation and at harvest stage the maximum (13.30, 11.40 and 9.89 mg kg^{-1}) soil available iron content was recorded under RDF+ $ZnSO_4$@50kg ha^{-1} + $FeSO_4$@25kg ha^{-1} through soil application which was on par with RDF+ $FeSO_4$ @ 25 kg ha^{-1} through soil application(13.11, 11.22 and 9.60 mg kg^{-1}). The minimum (9.27, 7.89 and 5.65 mg kg^{-1}) amount of soil available iron content was recorded with RDF. Combined soil application of zinc and iron along with recommended dose of fertilizers significantly influenced iron status of soil. The increase in content of iron could be attributed to more favourable conditions either through an increase in solubility in soil solution or possible stimulation of root activity. The superiority of soil application of iron sulphate could be due to more vegetative growth and root growth which releases hydrogen ion, phenolic compounds and organic acids helping in increased availability of iron (Ibrahim *et al*., 2015).

Available Manganese

At all the stages of the crop growth *viz.*, tillering, panicle initiation and at harvest stages of the crop, highest (9.11, 8.33 and 8.14 mg kg^{-1}, respectively) soil available manganese content was recorded in the treatment supplied with RDF + $ZnSO_4$ @ 50 kg ha^{-1}+ $FeSO_4$ @ 25 kg ha^{-1} through soil application. While the lowest (8.35, 7.27 and 6.40 mg kg^{-1}, respectively) was recorded with RDF. The content of available manganese increased at tillering stage over initial level (6.98 mg kg^{-1}) is mainly due to submergence.

Available Copper

At tillering, panicle initiation and at harvest stages of crop growth the highest (4.35, 4.11and 3.99 mg kg^{-1}, respectively) soil available copper was found in the treatment supplied with RDF + $ZnSO_4$ @ 50 kg ha^{-1}+ $FeSO_4$ @ 25 kg ha^{-1} through soil application, while the lowest (3.52, 3.40 and 3.28 mg kg^{-1}, respectively) soil available copper was recorded with RDF. Available copper content increased over initial in soil this might be due to release of copper from and also chelating agents which are capable of keeping copper in available state (Ponnamperuma.,1972)

Conclusions:

The soil properties *viz*., pH, EC and organic carbon were not significantly influenced by the imposed treatments. There was not significant influence of the treatments on available nitrogen, phosphorus and potassium. Among the micronutrients the treatmental influence was significant on Zn and Fe, while Mn and Cu were not significant by influenced. The available zinc and iron content was markedly influenced by zinc and iron fertilization along with recommended dose of fertilizers at all the crop growth stages.

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Table: 1. Effect of Zinc and Iron Fertilization on Available Nitrogen, Phosphorus and Potassium (kg ha^{-1}) Status of Soil under Direct Sown Rice.

Treatments	Nitrogen			Phosphorus			Potassium		
	Tillering	Panicle initiation	At harvest	Tillering	Panicle initiation	At harvest	Tillering	Panicle initiation	At harvest
T_1	248	238	228	40	39	37	331	301	293
T_2	263	254	239	45	42	40	350	323	318
T_3	261	254	237	44	40	39	347	321	317
T_4	270	263	251	49	46.	42	357	341	336
T_5	252	248	229	40	39.	38	341	315	305
T_6	250	247	228	40.	39.	37	332	314	304
T_7	241	250	234	41	40	38	340	318	310
S.Em(±)	12.63	10.48	8.44	2.62	2.04	1.67	12.89	9.88	10.45
CD (P=0.05 %)	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V (%)	8.56	7.23	6.21	10.52	8.64	7.41	6.49	5.35	5.80

Table: 2. Effect of Zinc and Iron Fertilization on Available Zinc, Iron, Manganese and Copper Status (mg kg^{-1}) of Soil under Direct Sown Rice.

Treatments	Zinc			Iron			Manganese			Copper		
	Tillering	Panicle initiation	At harvest	Tillering	Panicle initiation	At harvest	Tillering	Panicle initiation	At harvest	Tillering	Panicle initiation	At harvest
T_1	1.42	1.39	1.31	9.27	7.89	5.65	8.35	7.27	6.40	3.52	3.40	3.28
T_2	3.34	3.26	3.19	10.98	9.08	6.20	9.00	8.18	7.64	4.19	3.88	3.74
T_3	1.71	1.58	1.56	13.11	11.23	9.60	8.92	8.12	7.48	4.14	3.82	3.57
T_4	3.73	3.48	3.42	13.30	11.41	9.89	9.11	8.33	8.14	4.35	4.11	3.99
T_5	1.68	1.57	1.54	9.33	8.96	5.93	8.49	7.32	6.43	3.65	3.63	3.36
T_6	1.63	1.56	1.53	9.34	8.88	5.73	8.42	7.38	6.42	3.57	3.58	3.33
T_7	1.69	1.65	1.54	9.38	8.98	5.99	8.44	7.42	6.52	3.71	3.69	3.38
S.Em (±)	0.14	0.07	0.07	0.32	0.28	0.28	0.36	0.38	0.43	0.25	0.20	0.15
CD (P=0.05 %)	0.45	0.22	0.23	0.98	0.87	0.88	NS	NS	NS	NS	NS	NS
C.V (%)	11.89	6.20	6.53	5.21	5.21	7.13	7.23	8.56	10.64	11.56	9.67	7.46