



P-ISSN: 2349-8528
E-ISSN: 2321-4902
IJCS 2019; 7(1): 68-70
© 2019 IJCS
Received: 14-11-2018
Accepted: 18-12-2018

Sushil Kumar
Department of Agronomy
Institute of Agricultural Sciences
Banaras Hindu University,
Varanasi, Uttar Pradesh, India

SK Verma
Department of Agronomy
Institute of Agricultural Sciences
Banaras Hindu University,
Varanasi, Uttar Pradesh, India

Influence of crop establishment methods and zinc fertilization on soil parameters under direct-seeded rice

Sushil Kumar and SK Verma

Abstract

A field experiment consisting of three crop establishment methods and five zinc fertilization treatments was conducted in a split-plot design with three replications at Varanasi during *Kharif* season of 2016-17 and 2017-18. Soil samples after harvesting of rice were collected and analyzed for available nitrogen (N), phosphorus (P), potash (K), and zinc (Zn); organic carbon (OC) and soil microbial biomass carbon (SMBC). Results revealed that zero till-direct seeded rice observed higher available N, P, K and Zn, OC and SMBC. With respect to Zn fertilization, 3 kg Zn ha⁻¹ foliar application proved superior for available N, P and K. However, for available Zn, OC and SMBC, 6 kg Zn ha⁻¹ basal application was adjudged better. It is concluded that zero till-direct seeded rice and basal application of 6 kg Zn ha⁻¹ proved superior for available Zn, OC and SMBC under direct seeded rice.

Keywords: available nutrients, crop establishment methods, direct-seeded rice, OC

Introduction

Rice is the world's most important crop and a staple food for more than half of the world's population. Worldwide, rice is grown on 161 million hectares (mha) area with an annual production and productivity of 678.7 million tonnes (mt) and 4510 kg ha⁻¹, respectively. About 90% of the world's rice is grown and produced (143 m ha of area with a production of 612 mt of paddy) in Asia (FAO, 2009) ^[1]. The major methods of rice establishment in the world are transplanting and direct seeding. So, based on the method of rice establishment, rice production systems may be categorized as transplanted rice (TPR) production systems and direct-seeded rice (DSR) production systems. Under present situation of water and labour scarcity and escalating inputs cost farmers are changing either their rice establishment methods only (from transplanting to direct seeding in puddled soil i.e. Wet-DSR) or both tillage and rice establishment methods (puddled transplanting to dry direct seeding in un-puddled soil i.e. Dry-DSR). DSR is seen as a major opportunity to change production practices to attain optimal plant density and high water productivity in water scarce areas. DSR system refers to a process in which seeds are directly sown in the field instead of transplanting 25 days old seedlings from the nursery into the puddled soil as done in TPR system. Direct seeding avoids three basic operations, namely puddling (a process where soil is compacted to reduce water seepage), transplanting and maintaining standing water (Joshi *et al.*, 2013) ^[2]. At present globally 23% of rice area is under DSR (Kumar and Ladha, 2011) ^[3]. In different rice production systems, DSR can be sown onto a prepared seedbed after conventional tillage (CT) or under zero-till (ZT) conditions (Rao *et al.*, 2007) ^[4]. It has been reported that dry direct seeding of rice with ZT not only reduces fuel and labor costs but also overcome the problem of soil erosion. Apart from the above advantages the adoption of ZT proved helpful in improving soil physical and chemical properties (Chaudhary *et al.*, 2015) ^[5] and conservation of soil moisture. Among micro-nutrients, Zn deficiency is widespread in traditional lowland (Dobermann and Fairhurst, 2000) ^[6] due to high soil pH and high carbonates content as well as low redox potential (Alloway, 2009) ^[7] and has also been found responsible for yield reduction in rice (Fageria *et al.*, 2002) ^[8]. Thus, Zn is applied either basal or foliar to overcome the problem of Zn deficiency which not only improves Zn availability for plant uptake but also found beneficial in improving soil quality parameters. Keeping above points in mind, the

Correspondence
Sushil Kumar
Department of Agronomy
Institute of Agricultural Sciences
Banaras Hindu University,
Varanasi, Uttar Pradesh, India

the presented study was undertaken to evaluate the effects of crop establishment methods and Zn fertilization on soil parameters under DSR system.

Materials and Methods

A field experiment consisting of three crop establishment methods *viz.*, conventional till-direct seeded rice (CT-DSR), conventional till-wet direct seeded rice (CT-WDSR) and zero till-direct seeded rice (ZT-DSR) in the main plots and five zinc fertilization *viz.*, Control (no Zn application), 3 kg Zn ha⁻¹ (basal application), 3 kg Zn ha⁻¹ (foliar application), 6 kg Zn ha⁻¹ (basal application) and 6 kg Zn ha⁻¹ (foliar application) in the sub-plots was undertaken in a split-plot design with three replications at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, situated at 25°15'26.9" N Latitude, 82°59'17.1" E longitude and at an altitude of 74.4 meters above the mean sea level (MSL) during *Kharif* season of 2016-17 and 2017-18. The experimental site had homogeneously fertile with uniform textural make-up and slightly slopy topography. Soil of the experimental field was sandy clay loam in texture with moderate fertility had low organic carbon (0.46%) and available nitrogen (204 kg ha⁻¹), and medium available phosphorus (22 kg ha⁻¹) and potassium (222 kg ha⁻¹) but was found deficient in Zn (0.53 ppm). Apart from the above, soil also indicated slightly alkaline behaviour (pH 7.5). The experimental field was prepared as per treatments specification and sowing of the crop using seed rate @ 30 kg ha⁻¹ was done with the help of zero-till seed drill and drum-seeder at the row-to-row spacing of 20 cm on June 30 and 24 in 2016-17 and 2017-18, respectively. Rice variety (HUR-105) known for its promising performance under irrigated conditions of Varanasi region of the Eastern Uttar Pradesh was used as test crop. A uniform dose of 120 kg N, 60 kg P₂O₅ and 60 kg K₂O ha⁻¹ was applied in all the treatments through urea (46% N), DAP (46% P₂O₅) and muriate of potash (60% K₂O), respectively. Half of the total N and full dose of P and K were applied as the basal application just before sowing. However, remaining half dose of N in the form of urea was top dressed in two equal splits at active tillering and panicle initiation stages, respectively during both the years. Zinc sulphate fertilizer was applied as per treatments specification as basal and two equal foliar splits (0.25 and 0.5% Zn solution) at 15 and 30 DAS. The source of Zn fertilizer was ZnSO₄·H₂O with 33% Zn content. For weed management, two herbicides (pendimethalin @ 1 kg a.i. ha⁻¹ at 2 DAS and bispyribac-Na @ 25 g a.i. ha⁻¹ at 20 DAS) was sprayed using knapsack sprayer with the flat fan nozzle. The need-based irrigations were also given to fulfil the water requirement of crop and to keep the crop in vigorous condition during both the years of investigation. At maturity, the crop was harvested manually with the help of sickle on November, 15 and 9 in 2016-17 and 2017-18, respectively. The soil samples (0-15 cm depth) from each plot with the help of augur were collected after harvest of the crop during both the years and analyzed using standard procedures. The statistical analysis of data was done using analysis of variance as described by (Gomez and Gomez, 1984) [9] and the comparisons were made at 5 per cent level of significance.

Results and Discussion

Available N (kg ha⁻¹)

Crop establishment methods did not significantly influence the available N, but Zn fertilization significantly (P=0.05) influenced the available N in the soil. Among crop

establishment methods, zero till-direct seeded rice recorded higher available N due to lower N uptake by crop and residue retention of the previous crop along with minimum soil disturbance. Results are in line with the research finding of Pandey *et al.* (2012) [10]. In case of Zn fertilization treatments, higher available N was recorded with 3 kg Zn ha⁻¹ (foliar application) probably might be due to lower N uptake by crop.

Available P (kg ha⁻¹)

Neither crop establishment methods nor Zn fertilization significantly influenced the available P in the soil. Among crop establishment methods, zero till-direct seeded rice recorded higher available P due to lower P uptake by crop and residue retention of the previous crop along with minimum soil disturbance. Results are in line with the research finding of Pandey *et al.* (2012) [10]. With respect to Zn fertilization treatments, higher available P was recorded with 3 kg Zn ha⁻¹ (foliar application) probably might be due to lower P uptake by crop. Our results confirm the research findings of Pooniya and Shivay (2011) [11].

Available K (kg ha⁻¹)

Neither crop establishment methods nor Zn fertilization had significant effect on the available K in the soil. Among crop establishment methods, zero till-direct seeded rice recorded higher available K probably due to lower K uptake by crop and residue retention of the previous crop along with minimum soil disturbance. In case of Zn fertilization treatments, higher available K was recorded with 3 kg Zn ha⁻¹ (foliar application) probably might be due to lower K uptake by crop. Our results support the research findings of Pooniya and Shivay (2011) [11].

Available Zn (ppm)

Crop establishment methods and Zn fertilization significantly (P=0.05) influenced the available Zn in the soil. Among crop establishment methods, zero till-direct seeded rice recorded higher available Zn might be due to lower Zn uptake by crop. Across the Zn fertilization treatments, higher available Zn was recorded with 6 kg Zn ha⁻¹ (basal application) probably might be due to presence of residual Zn. Our results are analogues with the research findings of Pooniya and Shivay (2011) [11] and Ghoneim (2016) [12].

Organic carbon (%)

Neither crop establishment methods nor Zn fertilization significantly influenced the OC in the soil. Among crop establishment methods, zero till-direct seeded rice recorded higher OC due to residue retention of the previous crop and minimum soil disturbance. Our results are in agreement with the research finding of Chaudhary *et al.* (2015) [5] and Wang *et al.* (2016) [13]. With respect to Zn fertilization treatments, higher OC was recorded with 6 kg Zn ha⁻¹ (basal application) probably might be due to addition of Zn which has positive effect on soil microbial activities.

Soil microbial biomass carbon (mg kg⁻¹ of soil)

Crop establishment methods and Zn fertilization significantly (P=0.05) influenced the SMBC in the soil. Among crop establishment methods, zero till-direct seeded rice recorded higher SMBC probably due to residue retention of the previous crop and minimum soil disturbance. Our results are in congruence with the research finding of Chaudhary *et al.* (2015) [5] and Wang *et al.* (2016) [13]. In case of Zn fertilization

treatments, higher SMBC was recorded with 6 kg Zn ha⁻¹ (basal application) probably due to addition of Zn in soil.

Table 1: Effect of crop establishment methods and zinc fertilization on available N, P, K and Zn, OC and SMBC in soil after harvest of direct-seeded rice (mean data of two years)

Treatments	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)	Zn (ppm)	OC (%)	SMBC (mg kg ⁻¹ of soil)
Crop establishment methods						
Conventional till-direct seeded rice	192.29	21.48	219.90	0.614	0.454	191.35
Conventional till-wet direct seeded rice	190.86	20.98	218.67	0.578	0.456	189.37
Zero till-direct seeded rice	194.92	22.37	220.69	0.649	0.465	198.97
SEm ±	2.41	0.58	3.01	0.010	0.003	1.66
CD (P=0.05)	NS	NS	NS	0.041	NS	6.52
Zinc fertilization						
Control (no zinc)	189.40	20.59	217.05	0.353	0.457	188.74
3 kg Zn ha ⁻¹ (basal application)	194.18	22.19	221.08	0.709	0.459	195.12
3 kg Zn ha ⁻¹ (foliar application)	196.85	22.46	222.26	0.618	0.457	190.19
6 kg Zn ha ⁻¹ (basal application)	191.23	20.93	218.72	0.762	0.461	199.66
6 kg Zn ha ⁻¹ (foliar application)	191.78	21.88	219.66	0.628	0.459	192.46
SEm ±	1.09	0.69	1.87	0.007	0.001	0.99
CD (P=0.05)	3.19	NS	NS	0.021	NS	2.88

Conclusion

Based on the results, it is suggested in the conclusion that zero-till direct seeded rice proved superior for available N, P, K and Zn, OC and SMBC. Among Zn fertilization treatments, foliar application of 3 kg Zn ha⁻¹ found better for available N, P and K whereas basal application of 6 kg Zn ha⁻¹ adjudged superior for available Zn, OC and SMBC.

References

1. FAO, Aquastat. Faostat Database on Water and Agriculture. FAO, Rome, 2009, www.fao.org/nr/water/aquastat/data/query/index.html?lang/4en (accessed November, 2018).
2. Joshi E, Kumar D, Lal B, Nepalia V, Gautam P, Vyas AK. Management of direct seeded rice for enhanced resource-use efficiency. *Plant Knowledge J.* 2013; 2(3):119-134.
3. Kumar V, Ladha JK. Direct seeding of rice: recent developments and future research needs. *Adv. Agron.* 2011; 111:297-413.
4. Rao AN, Johnson DE, Sivaprasad B, Ladha JK, Mortimer AM. Weed management in direct-seeded rice. *Adv. Agron.* 2007; 93:153-255.
5. Chaudhary VP, Gangwar B, Gangwar S. Effect of long-term conservation tillage on soil physical properties and soil health under rice-wheat cropping system in sub tropical India. *Agric. Mech. Asia, Africa, and Latin America.* 2015; 46(2):1-73.
6. Dobermann A, Fairhurst TH. Nutrient disorders and nutrient management. Potash and Phosphate Institute/PPI of Canada and International Rice Research Institute, Singapore, 2000, 192.
7. Alloway BJ. Soils factors associated with zinc deficiency in crops and humans. *Environ. Geochem. Health.* 2009; 31:537-548.
8. Fageria NK, Baligar VC, Clark RB. Micronutrients in crop production. *Adv. Agron.* 2002; 77:185-268.
9. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. 2nd Edition. A Wiley Inter science Publication, New York, 1984, 657.
10. Pandey D, Agarwal M, Bohra JS. Greenhouse gas emissions from rice crop with different tillage permutations in rice-wheat system. *Agric. Eco. Environ.* 2012; 159:133-144.
11. Pooniya V, Shivay YS. Effect of green manuring and Zn fertilization on productivity and nutrient uptake in Basmati Rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system. *Ind. J. Agron.* 2011; 56(1):29-35.
12. Ghoneim AM. Effect of different methods of Zn application on rice growth, yield and nutrients dynamics in plant and soil. *J. Agric. Ecol. Res. Int.* 2016; 6(2):1-9.
13. Wang Z, Liu L, Chen Q, Wen X, Liao Y. Conservation tillage increases soil bacterial diversity in the dryland of northern China. *Agron. Sustain. Dev.* 2016; DOI 10.1007/s13593-016-0366-x.