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Research Article

Effect of integrated nutrient management and planting geometry on root parameter and nutrient uptake of aerobic rice

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SUMMARY : A field experiment was conducted with three integrated nutrient management practices and three spacings were laid out in Factorial Randomized Complete Block Design replicated thrice during *Kharif* 2009 at College of Agriculture, Shimoga. The integrated nutrient management practices included 50% RDN through chemical fertilizers and 50% RDN through organic sources like farm yard manure, poultry manure and vermicompost with three spacing *viz.,* 30 x 30 cm, 20 x 20 cm and 20 x 10 cm. Among integrated nutrient management practices (M_3) 50% RDN through chemical fertilizers + 50% RDN through vermicompost recorded significantly higher root length (22.01 cm $hill^{-1}$), root weight (6.00 g $hill^{-1}$), root volume (56.82 cc $hill^{-1}$), nitrogen uptake (59.57 kg ha^{-1}), phosphorus uptake (16.76 kg ha^{-1}) and potassium uptake (26.78 kg ha^{-1}). Among different planting geometry wider spacing of 30 x 30 cm (S_3) recorded significantly higher root length (23.14 cm $hill^{-1}$), root weight (6.27 g $hill^{-1}$), root volume (58.22 cc $hill^{-1}$), nitrogen uptake (58.55 kg ha^{-1}), phosphorus uptake (16.33 kg ha^{-1}) and potassium uptake (24.84 kg ha^{-1}).

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KEY WORDS :
Aerobic rice, INM, Spacing, Root parameter, Nutrient uptake

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BACKGROUND AND OBJECTIVES

Rice occupies the enviable prime place among the food crops cultivated around the world and is cultivated in an area of 147 m ha with the production of 610 m t with a productivity of 3.75 t ha^{-1}. About 90 per cent of rice grown in the world is produced and consumed in the Asian region. India has largest area (43.18 m ha) among the rice growing countries and ranks second in production (97.0 m t) with an average productivity of 2101 kg ha^{-1}. It produces 97.0 m t of rice in an area of 43.18 m ha with average productivity of 2101 kg ha^{-1}. In Karnataka, it is grown in an area of 1.42 m ha with an annual production of 3.60 m t and productivity is 2.53 t ha^{-1} (Anonymous, 2010).

Rice is considered to be primarily an irrigated crop. Food security in Asia is challenged by increasing food demand and is threatened by declining water availability. In Asia the per capita availability of water has declined by 40 to 60 per cent between 1955 and 1990 in Asia. Projections indicated that most of the Asian countries will have severe water problems by 2025 (Anonymous, 2008). To optimize the use of water with limited supply in rice production technology, important methods like aerobic method of paddy cultivation is of paramount importance. Aerobic rice is a new method of growing rice characterized by direct seeding of high yielding varieties in non puddled condition without standing water. The total water requirement from sowing to harvest is estimated about 650 to 830 mm under aerobic condition and about 1350 mm under flooded condition and water productivity will be increased from 20 to 40 per cent (Castaneda *et al.,* 2005). Further, water use in aerobic rice is about 60 per cent less than that of low land rice and, the total water productivity being 1.6 to 1.9 times higher.

Among several factors responsible for increase in rice production, adequate supply of essential nutrients in balanced way is one of the key factors for getting higher yield. Much of the nutrients required by the rice crop comes from the soil, but is insufficient to meet the nutrient requirements for high yields. The NPK ratio of 4:2:1 is considered to be optimum, but in reality a wide ratio of 10:9:1 prevalent in the country (Tandon, 2001). In India for that reason, mainly balanced and integrated fertilization has received more attention.

Use of fertilizers in conventional rice cultivation has been reported to have poor nutrient use efficiency due to excessive use of water and readily available nature of nutrients in fertilizers. But total replacement of fertilizer by manures to avoid such losses may not be an easy alternative as manures contain fewer nutrients. Hence, it is desirable to adopt integrated approach in meeting the nutrient demand of the crop which involves application of chemical fertilizers, organic manures like FYM, poultry manure, vermicompost or crop residues to bridge the gap between nutrient demand and supply to improve the grain yield. Integrated nutrient management (INM) is the adoption of technically appropriate and managerially efficient in achieving the objectives of judiciously utilizing all the major sources of plant nutrients in an integrated manner so as to attain optimum economic yield from a specific cropping system (Sarkar, 2000). INM technology is sustainable as compared to modern chemical farming as it relies more on organic inputs (Singh *et al.,* 2001).

Keeping in view of the above lacunae an investigation on effect of integrated nutrient management and planting geometry on root parameter and nutrient uptake of aerobic rice' was carried out during *Kharif* 2009 in the Zonal Agriculture Research Station of College of Agriculture, Navile, Shimoga.

RESOURCES AND METHODS

The field experiment was conducted at Zonal Agricultural Research Station Navile, Shimoga of region IV and agro climatic zone VII (Southern Transitional Zone) of Karnataka which is situated at $14^{0}0'$ to $14^{0}01'$ North latitude and $75^{0}45'$ to $77^{0}42'$ East longitude with an altitude of 650 meters above the mean sea level. The soil of experimental site was red sandy loam with slightly acidic reaction (pH 5.6), and low in nitrogen (245.96 kg ha^{-1}), medium in phosphorus (33.90 kg ha^{-1}) and medium in potassium (184.50 kg ha^{-1}). The crop experienced favourable weather conditions during the crop growth period.

Recommended dose of fertilizer (100: 50: 50 kg N, P_2O_5 and K_2O kg ha^{-1}) was applied through chemical fertilizers. Nitrogen was applied in three split doses *viz.*, 50 per cent as basal, 25 per cent at 30 days after sowing and remaining 25 per cent at 60 days after sowing. Among the different sources of organic manures used, FYM and poultry manure was incorporated into the soil 20 days before sowing, and vermicompost was applied at the time of sowing.

Plant sample was uprooted at 90 DAS to record the root length, root dry weight, root volume and to observe the rooting pattern in different nutrient sources with different spacing. Entire root length was measured with scale and expressed in cm. Root samples were washed with water and dried in hot air oven at 65^{0} C and was expressed in grams(g). The root volume was recorded by immersing roots in water and amount of water is converted to volume basis and expressed in cubic centimeter (CC).

Nitrogen content was determined by digesting the plant samples with concentrated sulphuric acid and digestion mixture. The digested samples were distilled by microkjeldhal method in an alkaline condition and titrated against standard acid (Piper, 1966). Phosphorus and potassium contents were determined after the samples were digested with diacid mixture (Nitric acid + Perchloric acid). Phosphorus content was determined by Vanadomolybdo phosphoric yellow colour method and observation was recorded at 430 nm using Spectrophotometer instrument (Piper, 1966). Potassium content was determined from the same diacid digested extract with the digital flame photometer (Piper, 1966).

OBSERVATIONS AND ANALYSIS

Root length, root weight and root volume differed significantly due to nutrient management practices and spacing. Significantly higher root length (22.01 cm), root weight (6.00 g) and root volume (56.82 cc) was recorded in the treatment combination of 50% RDN through chemical fertilizers + 50% RDN through vermicompost. However, the minimum root length (19.97 cm), root weight (5.04 g) and root volume (51.64 cc) was observed in 50% RDN through chemical fertilizers + 50% RDN through poultry manure. Application of 50% RDN through chemical fertilizer + 50% RDN through vermicompost could able to produce a massive root system, *i.e.* root length (22.01cm), root weight (6.00 g) and root volume (56.82 cc) (Table 1) which comes in contact with larger surface area of the soil and might have absorbed more amount of moisture and nutrients supplied by the different organic manures (vermicompost, FYM and poultry manure) and chemical fertilizers (Sridhar, 2008). Vermicompost is known to have a favourable effect on soil structure, texture and tilth and thus facilitates quick and greater availability of plant nutrients and provides a better environment for root growth and proliferation, thereby creating more absorptive surface for uptake of nutrients. (Jadhav *et al.,* 2008).

Wider spacing of 30 x 30 cm recorded significantly higher root length (23.14 cm), root weight (6.27 g) and root volume (58.22 cc). While, the lowest root length (18.89 cm), root weight (4.67 g) and root volume (47.56 cc) was obtained with 20 x 10 cm. wider spacing of 30 x 30 cm as provide passing of wheel hoe on both the directions might have made the air circulation in the soil and supplied oxygen to the better root growth. These will develop root in contact with large volume of soil. This might have helped to absorb more nutrients and moisture for plant growth, resulting into higher dry matter production with higher nutrient uptake. These results are in corroborating with the findings of Yoshida and Hasegawa (1982) and Kirk *et al*. (1994).

Nutrient uptake by grain:

Integrated nutrient management practice with 50% RDN through chemical fertilizer + 50% RDN through vermicompost resulted in higher grain nitrogen (59.57 kg ha^{-1}), phosphorus

Table 1 : Root length (cm hill^{-1}), root weight (g hill^{-1}) and root volume (cc hill^{-1}) as influenced by integrated nutrient management practices and planting geometry in aerobic rice at harvest

Treatments	Root length (cm)	Root weight(g)	Root volume (cc)
Nutrient sources (M)			
M_1	20.15	5.33	50.51
M_2	19.97	5.04	51.64
M_3	22.01	6.00	56.82
S.E ±	0.42	0.16	1.42
C.D. (P=0.05)	1.29	0.49	4.37
Spacing (S)			
S_1	18.89	4.67	47.56
S_2	20.11	5.43	53.18
S_3	23.14	6.27	58.22
S.E ±	0.42	0.16	1.42
C.D. (P=0.05)	1.29	0.49	4.37
Interaction (M x S)			
S.E ±	0.73	0.28	2.46
C.D. (P=0.05)	NS	NS	NS

Note:
M_1: 50 % RDN through chemical fertilizers + 50% RDN through farm yard manure.
M_2: 50 % RDN through chemical fertilizers + 50% RDN through poultry manure.
M_3: 50 % RDN through chemical fertilizers + 50% RDN through vermicompost.
S_1: 20 x 10 cm S_2: 20 x 20 cm. S_3: 30 x 30 cm NS: Non- significant

Table 2 : Nitrogen, phosphorus and potassium uptake (kg ha^{-1}) of grain as influenced by integrated nutrient management practices and planting geometry in aerobic rice at harvest

Treatments	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})
Nutrient sources (M)			
M_1	49.05	14.30	21.12
M_2	48.56	12.45	17.14
M_3	59.57	16.76	26.78
S.E. ±	1.68	0.54	0.72
C.D. (P=0.05)	5.18	1.65	2.21
Spacing (S)			
S_1	47.10	13.27	19.47
S_2	51.53	13.91	20.73
S_3	58.55	16.33	24.84
S.E. ±	1.68	0.54	0.72
C.D. (P=0.05)	5.18	1.65	2.21
Interaction			
S.E. ±	2.91	0.93	1.24
C.D. (P=0.05)	NS	NS	NS

Note:
M_1: 50 % RDN through chemical fertilizers + 50% RDN through farm yard manure.
M_2: 50 % RDN through chemical fertilizers + 50% RDN through poultry manure.
M_3: 50 % RDN through chemical fertilizers + 50% RDN through vermicompost.
S_1: 20 x 10 cm S_2: 20 x 20 cm. S_3: 30 x 30 cm NS: Non- significant

(16.76 kg ha^{-1}) and potassium (26.78 kg ha^{-1}) uptake as compared to other combinations (Table 2). Increased uptake of nutrients may be attributed to improved nutrient availability as a consequence of synergistic relationship between the organic manures and inorganic sources. These results are in conformity with the findings of Suresh and Ramasubba Reddy (2002) who reported higher nutrient uptake due to the integration of organic and inorganics over inorganic fertilizers alone. Similar results were reported by Subramaniyan and Kumaraswamy (2007), Katyal and Sharma (1979) and Jadhav *et al.* (2008).

Significantly higher nutrient uptake of nitrogen (58.55 kg ha^{-1}), phosphorus (16.33 kg ha^{-1}) and potassium (24.84 kg ha^{-1}) was recorded with wider spacing of 30 x 30 cm as compared to 20 x 20 cm and 20 x 10 cm (Table 2). Higher nutrient uptake by rice plants was due to well developed root system.

Conclusion:

Application of recommended dose of fertilizers along with readily available nutrients like vermicompost with wider spacing in aerobic rice will boost better root growth and more nutrient accumulation in grain. However, in order to finding out the more comprahensive result there is a need to study the interaction effect and required more field experimentation.

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