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Effect of Different Sources and Solubility of Phosphorus on Growth, Yield and Quality of *Kharif* Rice (*Oryza sativa* L.)

S. B. Murumkar*, G. R. Pawar* and M. D. Naiknaware*

ABSTRACT: *A field experiment was conducted in randomized block design with four replication during the Kharif 2012 at College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.). The experiment was laid out in randomized block design consisted of five treatments viz., T_0: Absolute control, T_1: 30% WSP (Suphala 15:15:15), T_2: 60% WSP (Suphala 20:20:00), T_3: 80% WSP (Suphala 20:20:00), T_4: 100% WSP (DAP 18:46:00) and replicated four times. The result revealed that among the different sources of phosphorus (100% WSP) recorded higher growth, yield attributes and yield, from rice followed by (80% WSP), (30%WSP) and (60 %WSP).*

Key words: *Kharif Rice, Phosphorus, Solubility*

India is the world's second largest rice producer and consumer next to China. About 90 per cent of all rice grown in the world is produced and consumed in Asian region. In the world, rice is cultivated on 159.4 million hectares of area with total production of 696.3 million tones (Anonymous 2012). Total area under rice in India is 42.56 million hectares with annual production of 95.33 million tones. (Anonymous 2011). In Maharashtra, area under rice is 15.18 lakh hectares with 26.87 lakh tones production. Average productivity of rice is 2.2 tones ha^{-1} in India and 1.77 tones ha^{-1} in Maharashtra, which are far below the world's average of 2.7 tones ha^{-1}. In *Konkan,* rice is cultivated over an area of 4.20 lakh hectares with an annual production of about 10.08 lakh tones. (Anonymous 2010).

Phosphorus is an essential nutrient because of its vital role in photosynthesis and many energy transformation processes within the plant. Phosphorus is noted especially for its role in capturing and converting the sun's energy into useful plant compounds. India has vast resources of indigenous phosphate rocks around 260 million tones (FAI, 1994). Unfortunately, most of the phosphate rocks of Indian origin have the limitation of low phosphorus content, low reactivity and are not suitable for manufacturing the phosphatic fertilizers. The solubility of the various inorganic phosphorus compounds directly affects the availability of phosphorus for plant growth. Soluble phosphorus, either from fertilizer or natural weathering, reacts with clay, iron, and aluminum compounds in the soil and is converted readily to less available forms by the process of phosphorus fixation. Because of these fixation processes, phosphorus moves very little in most soils (less than an inch in most soils), stays close to its place of origin, and crops seldom absorb more than 20 per cent of fertilizer phosphorus during the first cropping season after application. The solubility of phosphorus in fertilizer varies. Regardless of the actual chemical form of the phosphorus, the analysis of phosphorus fertilizers are given as phosphate (P_2O_5). The water solubility of this phosphorus can vary from 0 to 100 per cent. Generally, the higher the water solubility, the more effective the phosphorus source. Therefore it is essential to study effect of various solubility of phosphorus fertilizers on its availability to crop and subsequently its uptake by the crop and yield of the crop.

One of the reason for lower yield of rice is lower P content in the Indian soil. Motsara (2002) reported that 60% soils are low to medium in available phosphorus. Deficiency of phosphorous results in reduction in plant height and number of tiller per plant in rice. It also improves quality and helps in making available other nutrients. (Bhattacharya and Chatterjee 1970). The productivity of rice in *Konkan* is very low because of low consumption of phosphatic

* Assistant Professor Lokmangal College of Agriculture, Wadala, (MPKV), Rahuri

fertilizers and poor nutrient management. Lack of knowledge and very poor supply of input needs to particularly no consumption of inorganic fertilizers for very long time. Phosphorus is deficient in flooded rice than in upland rice because of more available forms of phosphorus are usually present in flooded soil. Erratic results and inconsistent response of low land rice to phosphate fertilization has been generally attributed to varying degree of solubility and availability of the reaction products of the added and native phosphate compounds under water-logged condition. (Mandal and Das, 1970). Taking account of the above fact present experiment was conducted.

A field experiment was conducted during the summer season of 2010 at the college of Agricultural, Dapoli. The soil of experimental plot was Sandy clay loam in texture , acidic in pH and medium in organic carbon content. It was low in available nitrogen, medium in available phosphorus and available potassium. The experiment was laid out in randomized block design consisted of five treatments viz., T_0: Absolute control, T_1: 30% WSP (Suphala 15:15:15), T_2: 60% WSP (Suphala 20:20:00), T_3: 80% WSP (Suphala 20:20:00), T_4: 100% WSP (DAP 18:46:00) and replicated four times. Twenty five days old seedlings of Ratnagiri-24 variety were transplanted on 03rd August, 2012 with the spacing 20 cm x 15 cm. This comprised of five treatments as 100 per cent RDF (100:50:50 N.P.K Kg ha^{-1}) through 30% WSP (Suphala 15:15:15), 60% WSP (Suphala 20:20:00), 80% WSP (Suphala 20:20:00), DAP (18:46:00) and potassium (MOP) fertilizers to rice crop. 50 per cent nitrogen dose and full dose of phosphorus (P) and potassium (MOP) were applied to rice by broadcasting at the time of transplanting. Remaining 30 per cent nitrogen dose was applied at maximum tillering (30 DAT) and other 20 per cent at panicle initiation stage (45 DAT) as per the treatments. The biometric observations for growth and yield attributing characters were taken at 30 DAS, 45 DAS 60 DAS and at harvest stage of crop by randomly selecting five plants per plot. The individual plot wise grain sample was subjected to nitrogen content analysis by modified Microkjeldahl's method (Tandon, 1993). Then the protein content was calculated by multiplying the nitrogen content (%) in grains by 6.25. Data obtained on various variables were analyzed by analysis of variance method (Panse and Sukhatme, 1967).

Effect on Growth and Development Parameters

It was evident from the data presented in previous chapter (Table 1) that a marked effect of phosphorus treatments was observed on growth characters of rice throughout the crop growth period.

At 30 DAT, the plant height was significantly influenced by different treatments under study. This might be due to the highest phosphorus availability at initial stage. The crop growth become faster from 30 DAT to 60 DAT but thereafter, the rate of increase in plant height was slow until harvest (Table 2). At 30 DAT, the maximum plant height was recorded in case of treatment T_4 which was significantly superior over rest of the treatments. At 45 DAT, plant height was recorded maximum in treatment T_4 followed by treatments T_2 and T_3 which were at par with each other but found superior over treatments T_1 and T_0. At 60 and 75 DAT, the maximum plant height was recorded with treatment T_4 followed by treatments T_3, T_2 and T_1 which were statistically at par with each other but found significantly superior over absolute control. At harvest treatment T_4 recorded significantly superior plant height over rest of the treatments except T_3. The increased plant height might be due to increased uptake of phosphorus supplied through different sources of phosphorus. Phosphorus is an essential nutrient because of its vital role in photosynthesis and many energy transformation processes within the plant which might have contributed for taller plants. Similarly increase in growth characters under application of phosphorus through different sources was observed by Sucharitha and Bhoopati (2001) and Sharma *et al.* (2009).

The mean number of functional leaves $hill^{-1}$ as influenced periodically by various treatments is presented in Table 9. In general number of functional leaves $hill^{-1}$ increased with increase in age of the crop up to 60 DAT. Thereafter at harvest, the functional leaves decreased on account of senescence. At 30 DAT the number of functional leaves $hill^{-1}$ were non-significant due to phosphorus application.

At 45 DAT, the treatment T_4 recorded maximum number of functional leaves followed by treatments T_1,T_3 and T_2 which were at par with each other but found significantly superior over absolute control. At 60 DAT, treatment T_3 recorded maximum number of functional leaves than the treatments T_1, T_4 and T_2 which were statistically at par with each other but found significantly superior over absolute control. At 75 DAT and at harvest the number of functional leaves were found to be non-significant. This might be due to supplementation of phosphorus through different sources which might have resulted in more vegetative growth, there by enhanced more number of leaves. These findings are on similar lines with the findings of Rajagopalan and Krishnarajan (1987) and Rao and Shukla (1995).

The leaf area of rice showed significant effect of phosphorus at all the growth stages. At 30 and 45 DAT, the treatment T_4 recorded maximum leaf area followed by treatment T_3 which were at par with each other but found significantly superior over rest of the treatments. Similarly, treatments T_2 and T_1 were also at par with each other but found significantly superior over absolute control. At 60, 75 DAT and at harvest treatment T_4 recorded significantly superior leaf area over rest of the treatments except treatment T_3. Similarly, treatments T_3, T_2 and T_1 which were on par with each other but found significantly superior over absolute control.

Data regarding mean number of tillers are presented in Table 1 showed that mean number of tillers were not significantly influenced by all the treatments means all the treatments were equally effective in mean number of tillers. These results confirm the findings of Rao and Shukla (1995) and Jayaraj and Chandrasekharan (1997).

Increase in dry matter production per unit area is a first step towards achieving higher yield. The decrease in grain yield is proportional to the decrease in accumulated biomass. Dry matter production is an important pre-requisite for higher yields as it signifies photosynthetic ability of the crop and also indicates other synthetic process during developmental sequences.

Mean total dry matter production hill^{-1} of rice was non-significant at 30 DAT. Total dry matter production hill^{-1} was highest in case of treatment T_4 which was found significantly superior over rest of the treatments except at 60 DAT. At 60 DAT, treatment T_4 was at par with T_3 but found significantly superior over rest of the treatments. The increase total dry matter yield by application of phosphorus. Which might be due to higher solubility of phosphorus which help to better vegetative growth viz., plant height, number of leaves hill^{-1} and number of tillers hill^{-1}. These results confirm with the findings of Jayaraj and Chandrasekharan (1997) and Banerjee and Pramanik (2009).

Effect on Yield and Quality Parameter

The grain yield of rice is a function of yield attributing characters viz., number of panicles hill^{-1}, length of panicle, number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1}, weight of filled grains panicle^{-1} and test weight. (Table 2). The number of panicles hill^{-1} were found to be non-significant during the experimentation. The data revealed that, the length of panicle and number of filled grains panicle^{-1} were observed maximum in case of T_4 followed by treatments T_3, T_1 and T_2 which were at par with each other but found significantly superior over absolute control. The data regarding to weight of filled grains panicle^{-1} revealed that the treatment T_4 recorded significantly higher weight of filled grains panicle^{-1} over rest of the treatments except treatment T_1. The number of unfilled grains panicle^{-1} and test weight of rice were found to be non-significant during the experimentation. These findings are close conformity with those of Annadurai and Palaniappan (1995), Sucharitha *et al.,* (2001) and Sharma *et al.* (2009).

Application of phosphorus through different sources significantly increased the grain and straw yields of rice over absolute control (Table 2). Treatment T_4 recorded maximum grain yield followed by treatments T_3, T_1 and T_2 which were at par with each other but found significantly superior over absolute control. The increase in yield over treatment T_0 due to treatments T_4, T_3, T_1 and T_2 were to the tune of 91.26, 86.73, 78.31 and 66.66 per cent respectively. Treatment T_4 recorded maximum straw yield and biological yield followed by treatments T_3, T_1 and T_2

Table 1
Growth attributing characters as influenced by effect of different sources and solubility of phosphorus

Treatments	*Plant height(cm)$^{-1}$*	*Functional leaves(No/ plant)**	*Number of tillers/hill*	*panicle dry matter hill^{-1} (g)*	*Total dry matter hill^{-1} (g)*
T_0 - Absolute control	66.90	22.70	8.45	7.32	20.15
T_1 - 30% WSP (Suphala 15:15:15)	77.90	33.15	9.30	11.00	31.83
T_2 - 60% WSP (Suphala 20:20:00)	77.40	29.55	8.95	10.06	31.27
T_3 - 80% WSP (Suphala 20:20:00)	80.45	33.75	9.70	11.71	34.67
T_4 - 100% WSP (DAP 18:46:00)	83.15	33.00	10.00	12.44	39.02
S.E ±	1.31	1.76	0.57	0.40	0.94
C. D. at 5%	4.05	5.41	N.S.	1.26	2.90

*60 DAT

Table 2
Yield and quality attributing characters as influenced by effect of different sources and solubility of phosphorus.

Treatments	*Number of panicles hill^{-1}*	*Length of panicle (cm)*	*Number of filled grains panicle^{-1}*	*Number of unfilled grains panicle^{-1}*	*Test weight (gm*	*Grain yield (q/ha)*	*Straw yield (q/ha)*	*Protein content of grain (%)*
T_0 - Absolute control	8.45	19.68	105.48	30.15	15.81	24.72	27.16	7.05
T_1 - 30% WSP (Suphala 15:15:15)	9.30	21.92	123.40	27.40	15.99	44.08	52.13	7.80
T_2 - 60% WSP (Suphala 20:20:00)	8.95	21.89	123.23	28.25	15.97	41.20	51.83	7.91
T_3 - 80% WSP (Suphala 20:20:00)	9.70	22.14	128.98	29.50	15.91	46.16	52.52	7.90
T_4 - 100% WSP (DAP 18:46:00)	10.00	22.37	134.55	28.80	16.30	47.28	52.99	7.80
S.E ±	0.57	0.43	4.54	4.65	0.28	2.61	1.65	0.53
C. D. at 5 %	N.S.	1.33	13.99	N.S.	N.S.	8.04	5.09	N. S.

which were statistically par with each other but found significantly superior over absolute control. The increase in straw yield over treatment T_0 due to treatment T_4, T_3, T_1 and T_2 were to the tune of 95.10, 93.37, 91.94 and 90.83 per cent respectively. The increase in straw yield could be attributed to increase in growth characters like plant height, number of functional leaves hill^{-1} and dry matter accumulation hill^{-1} due to higher solubility and availability of phosphorus. The better plant growth and improved yield attributes finally led to higher grain and straw yields, as also reported by Rajagopalan and Krishnarajan (1987), Annadurai and Palaniappan (1995), Mahadkar *et al.* (1998), Singh *et al.* (1998), Varma *et al.* (2002), Selvi *et al.* (2003) and Sharma *et al.* (2009). Data from the Table 2 revealed that the mean protein content in rice grain was 7.69 %. Data presented in Table 2 revealed that, the different treatments does not showed any significant difference among them with respect to protein content in grain of rice.

CONCLUSION

From the investigation, it could be concluded that, among the different sources of phosphorus (100% WSP) recorded higher growth, yield attributes, yield, total uptake by the crop, available soil N, available P_2O_5, available K_2O, net returns, and B: C ratio from rice followed by (80% WSP), (30% WSP) and (60% WSP).

REFERENCES

Annadurai, K. and Palaniappan, S.P. (1995), Phosphorus management for low land transplanted rice. "A test verification trail with 2 % DAP spray" *Madras agric. J.* **82** (6, 7 and 8): 452 – 456

Anonymous, (2010), Crop wise District wise Area, Production and Productivity, Department of Agriculture, Government of Maharashtra.

Anonymous, (2011), Agricultural Statistics at a Glance 2011. Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

Anonymous, (2012), World Area, Production, Productivity. *http*//www.faostat.org.

Banerjee, K. and Pramanik B. R. (2009), Effect of different doses and sources of phosphorus and phosphate solubilizing bacteria on the growth and yield of Kharif rice. *Res. on Crops*. **10**(3): 489-491.

Bhattacharya, K.K. and Chatterjee B.N. (1970), Growth of rice as influenced by phosphorous *Indian J. of agric. Sci.* **48**(10): 495-497.

FAI (1994), Fertilizer statistics. Edn. 39, Fertilizer Association of India, New Delhi.

Jayaraj, T. and Chandrasekharan B. (1997), Foliar application to enhance seed yield quality in rice. *Seed Research.* Vol. 25(1): 50-52.

Mahadkar, U.V., Ramteke, J.R., Patil, R.A., Shinde, P.P. and Kanade, V.M. (1998), Yield of rice as influenced by sources and coating of phosphorus fertilizers. *J. Maharashtra agric. Univ.* **23**(1): 90-91.

Mandal, L.N. and Das, R.K. (1970), Transformation of applied water soluble phosphorus in acidic low land rice soils. Soil sci. 110: 263-267.

Panse, V G and sukhatme P V. (1967), Statistical Methods for Agricultural Workers, ICAR, New Delhi.

Rajagopalan, S. and Krishnarajan, J. (1987), Effect of nursery management techniques on phosphorus nutrition of rice in main field. *Oryza.* **24**: 199-205.

Rao, C.P. and Shukla, D.N. (1995), Effect of sources and Levels of Phosphorus at different levels of Zinc 0n growth and yield of rice. *The Andhra agric. J.* **43**(1): 30-34.

Selvi, D.S., Mahimai, R., Santy, P. and Rajkannan, B. (2003), Influence of integrated nutrient management on crop yield, P uptake and available P status of soil in a rice based cropping system. *Oryza.* **40**(3&4): 65-69.

Sharma, S.N., Prasad, R., Shivay, Y.S., Dwivedi, M.K., Kumar, S. and Kumar, D. (2009), Effect of rates and sources of phosphorus on productivity and economics of rice (*Oryza sativa)* as influenced by crop- residue incorporation. *Indian J. Agron*. **54**(1): 42-46.

Sharma, S.N., Prasad, R., Shivay, Y.S., Dwivedi, M.K., Kumar, S. and Kumar, D. (2009), Effect of rates and sources of phosphorus on productivity and economics of rice (*Oryza sativa)* as influenced by crop- residue incorporation. *Indian J. Agron*. **54**(1): 42-46.

Sucharitha R. and Boopathi, S.N.M. (2001), Evaluation of methods of phosphorus fertilization on the growth and yield components of rice varieties. *Madras Agric. J.* **88**(1-3): 106-111.

Tandon, H.L. (1993), Methods of analysis of soil, plant, water and fertilizers development and consulation organization, New Delhi.

Varma, L.P., Singh, R. and Singh, S. (2002), Influence of split application of phosphatic fertilizers on its availability, utilization and yield of transplanted rice (*Oryza sativa* L.) *J. Indian Soc. Soil Sci.* Vol**. 50**(2): 221-222.