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Effect of different sources and solubility of NPK uptake by rice at various growth stages and economics

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Abstract
A field experiment was conducted during Kharif 2012 as research on sandy clay loam in texture soils of Agronomy Farm, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) to find out the effect of different sources of nutrients on NPK uptake by rice at various growth periods. The experiment was laid out in a randomized block design in kharif season with four treatments and replicated. The treatments consisted of 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). 2. Among the different sources of NPK (100% WSP) recorded higher growth, yield attributes, yield, total uptake by the crop, available soil N, available P2O5, available K2O, net returns, and B: C ratio from rice followed by (80% WSP), (30%WSP) and (60%WSP).

Keywords: NPK, yield & economics

Introduction

Approximately 90% of annual production is grown and consumed in Asia. However, mean yields in Asia are low compared to global mean yields. Nevertheless, there are several ways to increase crop yields. For example, the proper management of nitrogen (N) fertilizers is important for improving rice yields. In general, fertilizers containing N, phosphorus (P), and potassium (K), essential plant nutrients, are vital for productive crops. Although crop production requires fertilizers, the overly large doses and use of fertilizers with chemically unbalanced NPK ratios and in intensive rice production has resulted in soil-related problems, such as acidification, loss of organic matter, deterioration of the structure, and reductions in biological activities and fertility.

Rice consumption is increasing and demand for rice will outstrip supply if production does not increase faster than its current rate. This means there is a need to produce even more rice for food security. Improved fertility status of soil health and could support sustainable crop production. Long-term fertility experiments have significantly contributed to our understanding of soil fertility management and sustainable crop production in different agroecosystems

The solubility of phosphorus in fertilizer varies. The legal definition of available phosphorus in fertilizer is the sum of the phosphorus that is soluble in water plus that which is soluble in a citrate solution. Regardless of the actual chemical form of the phosphorus, the analysis of phosphorus fertilizers is 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. This is especially important for short season, fast-growing crops, for crops with restricted root systems, for starter fertilizers, and for areas where less-than-optimum rates of phosphorus are applied to soils testing low in phosphorus. The productivity of rice in *Konkan* is very low because of low consumption of phosphatic fertilizers and poor nutrient management. 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.

Materials and Methods

In order to investigate the influence of different sources of nutrients on NPK uptake by rice, the present experiment was conducted in the field number 44 of 'B' block was conducted at the Agronomy farm, College of Agriculture, Dapoli, Dist. Ratnagiri during Kharif 2012.

The selection of site was considered on the basis of suitability of the land for cultivation of crop and resources available for rice crop in *Kharif* season. The treatments were arranged in completely randomized block design with four replications**.** The gross plot size of each treatment was 10.20 m X 3.60 m and net plot size 9.60 m X 3.20 m. Involved 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. For the seasons analysis of variance was performed and means were compared using least significant difference (LSD) (Gomez and Gomez, 1984).

Results and Discussions

It is clear from the result presented in Table 1 and 2 that nitrogen, phosphorus and potassium content and their uptake by grain and straw of rice were influenced significantly due to different phosphorus treatments.

Data presented in Table 1 revealed that there is no any significant difference in nitrogen, phosphorus and potassium content in grain of rice as influenced by different treatments under study. At 30 and 60 DAT maximum nitrogen content in straw of rice was observed in case of treatment T_4 followed by the treatments T_3, T_2 and T_1 which were at par with each other but found significantly superior to the treatment T_0. At harvest, nitrogen content in straw was not influenced significantly by different treatments.

At 30 and 60 DAT, the highest phosphorus content in straw was recorded in T_4 followed by treatment T_3 and T_2 which were at par with each other but found superior over treatments T_1 and T_0. At harvest, phosphorus content in straw of rice was found to be non-significant in all treatments.

At 30 DAT, the potassium content in straw was significantly higher under treatment T_3 followed by treatment T_4 which was at par with T_3 but recorded higher potassium content in straw than rest of the treatments. At 60 DAT, the maximum potassium content in straw was recorded under treatment T_3 followed by treatments T_4, T_2 and T_1 which were at par with each other but recorded significantly superior over treatment T_0. At harvest, Potassium content in straw of rice was found to be non-significant in all treatments.

Maximum nitrogen uptake by grain recorded in treatment T_4 followed by treatments T_3, T_1, and T_2 which were statistically at par with each other but significantly superior over T_0. Treatment T_3 recorded the highest nitrogen uptake by straw of rice followed by treatments T_2, T_4 and T_1 which were statistically at par with each other but found significantly superior over the treatment T_0. The highest total nitrogen uptake by rice was recorded in treatment T_3 followed by treatments T_4, T_1, and T_2 which were statistically at par with each other but recorded significantly superior over T_0. Treatment T_0 recorded the lowest total nitrogen uptake by rice than rest of the treatments. Which might have resulted in the application of phosphorus significantly increased the uptake of nitrogen. It was owing to possible positive interaction of nitrogen and applied phosphorus. As phosphorus fertilization augmented the higher productivity, it resulted in higher nitrogen accumulation.

The maximum phosphorus uptake by grain of rice was recorded in case of treatment T_4 followed by treatments T_3, T_1 and T_2 which were statistically on par with each other but found significantly superior over treatment T_0. The highest phosphorus uptake by straw of rice was recorded with T_4 followed by treatments T_2, T_1 and T_3 which were on par with each other but found significantly superior to the treatment T_0. The maximum total phosphorus uptake by rice was recorded with T_4 followed by treatments T_3, T_1 and T_2 which were at par with each other but found significantly superior over treatment T_0. In respect of grain, straw and total phosphorus uptake with treatment T_0 recorded the lowest phosphorus uptake by rice than rest of the treatments

The potassium uptake by grain of rice was recorded higher with treatment T_4 followed by treatments T_3, T_1 and T_2 which were at par with each other but recorded highest potassium uptake over treatment T_0. The highest potassium uptake by straw and total uptake of rice was recorded under treatment T_3 than the treatments T_4, T_2 and T_1 which were statistically on par to each other but significantly superior over treatment T_0. The lowest grain, straw and total potassium uptake were found in treatment T_0.

The data on nitrogen, phosphorus and potassium uptake by grain, straw and total uptake by rice revealed that the significant effect of phosphorus treatments over absolute control. Since uptake is a function of grain and straw yields and their nutrient content, the significant improvement in content of these nutrients coupled with increased grain and straw yields increased the uptake of nutrients substantially. These results are in accordance with those of Lal and Mahapatra (1979) [2], Annadurai and Palaniappan (1995) [1], Selvi *et al.* (2003) [5], Tamgale *et al.* (2006) [7] and Sharma *et al*. (2009) [6].

Data presented in Table 3 revealed that, At 30 and 60 DAT, treatment T_4 recorded higher available nitrogen in soil followed by the treatments T_3, T_1 and T_2 which were at par with each other but found significantly superior over absolute control. At harvest, the soil available nitrogen was not influenced significantly by different treatments under study.

At 30 and 60 DAT, the soil available P_2O_5 was recorded higher with the treatment T_4 followed by the treatments T_3 and T_1 which were on par with each other but found superior over the treatments T_2 and T_0. However, significantly lower soil P_2O_5 was recorded with the treatment T_0.

The available soil potassium at 30 DAT, was recorded significantly higher with the treatment T_4 over rest of the treatments. Treatment T_3, T_2 and T_1 which were statistically equivalent to each other but found significantly superior over absolute control. At 60 DAT, the highest value of potassium was recorded in soil with treatment T_4 followed by treatment T_3 which were at par with each other but found superior to the treatments T_1, T_2, and T_0. Available potassium in soil after harvest of rice was not differed significantly due to different treatments under study. These results confirm with the findings of Sakal *et al.* (1999) [4], Varma *et al.* (2002) [8] and Tamgale *et al.* (2006) [7].

Result presented in table 4, treatment T_4 recorded maximum gross returns (Rs. 57232.50 ha^{-1}) followed by treatments T_3 (Rs. 56015.75 ha^{-1}), T_1 (Rs. 53695.75 ha^{-1}) and T_2 (Rs. 50505.75 ha^{-1}) which were at par with each other but found significantly superior over treatment T_0. The lowest gross return was recorded under treatment T_0 (Rs. 29858.00 ha^{-1}). The treatment T_4 recorded maximum net returns (Rs. 14228.56 ha^{-1}) followed by treatments T_3 (Rs. 11915.26 ha^{-1}),

T_1 (Rs. 9030.71 ha^{-1}) and T_2 (Rs. 7325.68 ha^{-1}) which were at par with each other but found significantly superior over treatment T_0. (Rs.-4695.83 ha^{-1}). The lowest net returns was recorded under treatment T_0 (Rs. -4695.83 ha^{-1}).

The B: C ratio of rice was higher in the treatment T_4 (1.33) than remaining treatments *viz*., T_3 (1.27), T_1 (1.20 and T_2 (1.17). The lowest B: C ratio of rice was observed in treatment T_0 (0.88). These results are in accordance with those of Annadurai and Palaniappan (1995) [1], Mahadkar *et al*. (1998) [3] and Sharma *et al*. (2009) [6].

Table 1: NPK content (%) in grain and straw of rice as influenced periodically by different treatments

Treatments	N content (%) Grain	N content (%) Straw			P content (%) Grain	P content (%) straw			K content (%) Grain	K content (%) Straw		
		30 DAT	60 DAT	At harvest		30 DAT	60 DAT	At harvest		30 DAT	60 DAT	At harvest
T_0 - Absolute control	1.13	1.48	0.33	0.26	0.33	0.09	0.07	0.019	0.38	1.45	1.32	1.28
T_1 - 30% WSP (Suphala 15:15:15)	1.25	1.72	0.39	0.31	0.39	0.13	0.11	0.023	0.43	1.79	1.65	1.40
T_2 - 60% WSP (Suphala 20:20:00)	1.27	1.76	0.41	0.33	0.41	0.14	0.12	0.024	0.41	1.81	1.72	1.45
T_3 - 80% WSP (Suphala 20:20:00)	1.26	1.82	0.40	0.33	0.40	0.16	0.13	0.023	0.42	1.89	1.76	1.49
T_4 - 100% WSP (DAP 18:46:00)	1.25	1.83	0.41	0.31	0.41	0.17	0.15	0.025	0.42	1.88	1.74	1.43
S.E ±	0.09	0.038	0.02	0.02	0.02	0.009	0.009	0.001	0.02	0.023	0.040	0.08
C. D. at 5%	N.S.	0.118	N.S.	N.S.	N.S.	0.027	0.027	N.S.	N.S.	0.070	0.124	N.S.
General Mean	1.23	1.72	0.39	0.31	0.39	0.14	0.11	0.02	0.41	1.76	1.64	1.41

Table 2: Influence of NPK uptake (kg ha-1) at different growth periods of rice

Treatments	Nitrogen uptake (kg ha-1)			Phosphorus uptake (kg ha-1)			Potassium uptake (kg ha-1)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T_0 - Absolute control	27.61	6.94	34.55	8.18	0.53	8.71	9.53	34.50	44.03
T_1 - 30% WSP (Suphala 15:15:15)	54.61	15.90	70.50	17.30	1.22	18.52	18.74	72.82	91.57
T_2 - 60% WSP (Suphala 20:20:00)	52.01	17.09	69.10	16.77	1.26	18.03	17.10	75.11	92.21
T_3 - 80% WSP (Suphala 20:20:00)	58.62	17.36	75.98	18.56	1.18	19.74	19.36	77.88	97.23
T_4 - 100% WSP (DAP 18:46:00)	58.84	16.70	75.54	19.34	1.30	20.65	20.03	75.62	95.65
S.E ±	3.39	1.20	3.80	1.45	0.09	1.45	1.36	3.71	4.34
C. D. at 5%	10.44	3.72	11.71	4.48	0.28	4.47	4.18	11.42	13.38
General Mean	50.34	14.80	65.13	16.03	1.10	17.13	16.95	67.19	84.14

Table 3: Available nutrients status in soil

Treatments	Available N (kg ha-1)			Available P2O5 (kg ha-1)			Available K2O (kg ha-1)		
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest
T_0 - Absolute control	258.68	234.34	204.45	15.33	13.86	13.81	179.65	165.57	150.12
T_1 - 30% WSP (Suphala 15:15:15)	294.25	269.16	252.00	19.61	17.04	16.51	219.04	190.57	177.14
T_2 - 60% WSP (Suphala 20:20:00)	287.75	264.49	247.20	18.27	15.99	14.79	222.42	187.66	175.21
T_3 - 80% WSP (Suphala 20:20:00)	295.99	275.80	234.00	19.77	17.15	16.03	228.95	200.41	182.23
T_4 - 100% WSP (DAP 18:46:00)	296.28	277.74	240.15	20.10	17.52	14.98	236.77	210.16	173.88
S.E ±	4.84	4.95	21.8	0.44	0.39	0.88	2.33	3.20	14.50
C. D. at 5%	14.93	15.26	N.S.	1.37	1.19	N.S.	7.17	9.87	N.S.
General Mean	286.59	264.31	235.56	18.62	16.31	15.22	217.36	190.87	171.72

Table 4: Economics of rice as influenced by different treatments

Treatments	Gross Returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net Returns (Rs ha^{-1})	B: C ratio
T_0 - Absolute control	29858.00	34553.83	-4695.83	0.88
T_1 - 30% WSP (Suphala 15:15:15)	53695.75	44665.05	9030.71	1.20
T_2 - 60% WSP (Suphala 20:20:00)	50505.75	43180.08	7325.68	1.17
T_3 - 80% WSP (Suphala 20:20:00)	56015.75	44100.49	11915.26	1.27
T_4 - 100% WSP (DAP 18:46:00)	57232.50	43003.95	14228.56	1.33
S.E ±	2914.47	416.59	2630.43	-
C. D. at 5%	8980.38	1283.64	8083.13	-
General Mean	49461.55	41900.68	7560.87	1.17

Conclusion

It is concluded from the results revealed that the different sources of phosphorus (100% WSP) recorded higher growth, yield attributes, yield, total uptake by the crop, available soil N, available P2O5, available K2O, net returns, and B: C ratio from rice followed by (80% WSP), (30%WSP) and (60%WSP).

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