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Studies on yield, nutrient content and nutrient uptake of rice as influenced by phosphorus management practices

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Abstract
A field experiment was conducted during *kharif* 2016-17 and 2017-18 respectively on sandy loam soils of the Agricultural College Farm, Bapatla to study the yield, nutrient content and nutrient uptake of rice as influenced by phosphorus management practices. The experiment was laid out in split plot design in *kharif* rice and the treatments were replicated thrice. The treatments consisted of four main plots sources of phosphorus S_1 : Inorganic fertilizer phosphorus through SSP, S_2 : Green manuring *in-situ* with dhaincha @ 25 kg seed ha^{-1}, S_3 : Biofertilizer (PSB) @ 750 ml ha^{-1}, S_4 : Green manuring *in-situ* with dhaincha @ 25 kg seed ha^{-1} + Biofertilizer (PSB) @ 750 ml ha^{-1} and three subplots levels of phosphorus L_1 : 50% Recommended dose of P , L_2 : 100% Recommended dose of P and L_3 : 150% Recommended dose of P**.** Results of the experiment showed that application of *in-situ* green manuring + PSB in conjunction with inorganic fertilizer showed superior performance in terms of yield, nutrient content and nutrient uptake over alone application of inorganic fertilizer through SSP. At all the growth stages, among the phosphorus levels 150 % RDP showed significantly higher yield and nutrient uptake (kg ha^{-1}) over 50 % RDP and it was on a par with 100 % RDP during both years and pooled data.

Keywords: Yield, nutrient content, nutrient uptake, rice

Introduction
Rice (*Oryza sativa* L.) is one of the most important cereal crop. In India, rice ranks first among all the crops occupying 43.95 m ha area and production of 106.54 mt with an average productivity of 2424 kg/ha (CMIE, 2017-18). India occupies a pride place in rice production among the food crops cultivated in the world. In Andhra Pradesh, rice is grown in an area of 2.16 M ha with annual production of 7.48 M t and productivity of 3465 kg ha^{-1} (CMIE, 2017-18).

Nutrient management in rice under submerged condition is a difficult practice. Among the macronutrients NPK, phosphorus is reported to be a critical factor of many crop production systems due to its limited availability in soluble forms. It reacts with oxides/hydroxides to form stable forms that may not be available to the plant, resulting in low recovery and accumulation in soils. Phosphorus has become a major constraint to agricultural production in India because of scarce natural deposits, steep hike in price of phosphatic fertilizers due to energy crisis throughout the world and also a major portion of raw materials for phosphatic fertilizers has to be imported from foreign countries. The phosphorus deficiency is common in almost all the soils and crops (Raju and Suneetha Devi 2005) [10].

Phosphorus is an essential nutrient. It is involved in the supply and transfer of energy for all biochemical processes in plants and hence, it is called as the "energy currency of living cells". It stimulates early root growth and development, encourages more active tillering, drymatter accumulation and promotes early flowering, maturity and good grain development. Further, optimum response to added nitrogen could be obtained only when adequate amount of P is supplied. Therefore, P availability from soils to the plant is the key to sustain higher yields. Plants utilize less amounts of phosphatic fertilizers that are applied and the remaining portion is rapidly converted in to insoluble complexes in the soil. Slow mobility of applied phosphorus and its marked fixation results in low crop recoveries in the order of 20-25%. Phosphate solubilizing bacteria (PSB) solubilize insoluble phosphorus and increase its availability phosphorus in the soil and inturn the overall phosphate use efficiency.

Green manures represent a promising approach to maintain sustainable nutrient supply for crop growth. The P in green manure could potentially be delivered to the soil in a form which is readily available to plants and soil microorganisms. The present study was, therefore, designed to find out the response of rice to sources and levels of phosphorus with regard to yield, nutrient content and nutrient uptake.

Material and methods

The experiment was conducted at the Agricultural College Farm, Bapatla. Initial soil sample analysis revealed that the experimental soil was sandy loam in texture, slightly alkaline in reaction (pH 7.6, 7.8), low in organic carbon (0.42, 0.43 %), low in available nitrogen (226, 230 kg ha^{-1}), low in available phosphorus (18, 20 kg ha^{-1}) and high in available potassium (483, 521 kg ha^{-1}) during 2016-17 and 2017-18 respectively. The experiment was laid out in a split plot design in *kharif* rice and the treatments were replicated thrice. The treatments consisted of four main plots sources of phosphorus S_1 : Inorganic fertilizer phosphorus through SSP, S_2 : Green manuring *in-situ* with dhaincha @ 25 kg seed ha^{-1}, S_3 : Biofertilizer (PSB) @ 750 ml ha^{-1}, S_4 : Green manuring *in-situ* with dhaincha @ 25 kg seed ha^{-1} + Biofertilizer (PSB) @ 750 ml ha^{-1} and three subplots levels of phosphorus L_1 : 50% Recommended dose of P, L_2 : 100% Recommended dose of P and L_3 : 150% Recommended dose of P. A very popular variety, BPT 5204 (Samba Mahsuri) was used for the study. The experimental field was ploughed twice by a tractor drawn cultivator, followed by a rotovator to obtain required tilth. The levelled field was then divided into the required number of main plots as per the layout plans. Dhaincha seed was broadcasted in the main plots namely S_2 (Green manuring @ 25 kg ha^{-1}) and S_4 (Green manuring *in situ* + biofertilizer (PSB) @ 750 ml ha^{-1}) in all the three replications as per the layout plans and the seeds were covered by dragging a spike toothed harrow. These main plots (Green manure plots) were divided into sub plots after incorporation of green manure by making strong bunds and irrigation was given for better decomposition before transplanting of rice crop during both the years of experimentation.

A common dose of nitrogen at 120 kg ha^{-1} was applied in the form of urea in three splits, half at basal, one fourth at active tillering and remaining at panicle initiation stage. Phosphorus in the form of single super phosphate was applied basal as per the treatments. A common dose of 40 kg K_2O ha^{-1} was applied as basal just before transplanting through muriate of potash by taking the plot size into consideration.

Results and discussion

Grain yield

Grain yield, was significantly influenced by sources and levels of phosphorus and their interaction too during both years of study and pooled data of study. The data pertaining to the grain yield of rice are presented in the (Table 1). The grain yield of various treatments was higher during the second year (2017-18) of study than that of the first year (2016-17), however the influence of different treatments was almost consistent in the both years of study and pooled data as well. During both the years significantly higher yields were recorded with the treatment that received *in-situ* green manuring + biofertilizer (PSB) *i.e.* 5656, 5896 and 5776 kg ha^{-1} during 1st, 2nd years and pooled data respectively, which was statistically on a par with *in-situ* green manuring treatment (5520, 5730 and 5625 kg ha^{-1}during 1st and 2nd years and pooled data respectively) but proved significantly superior to inorganic fertilizer through SSP and biofertilizer (PSB) alone treatment under test.

Present study results showed that *in-situ* green manuring + biofertilizer (PSB) significantly influenced the grain yield of rice. Application of *in-situ* green manuring + biofertilizer (PSB) was found to be superior in realizing maximum grain yield. It might be due to the fact that green manure biomass is a potential source of major nutrients for lowland rice and showed significant improvement in growth, yield, net returns, soil moisture retension, organic carbon and nutrient status of soil and reduction in bulk density of plough layer (Siva Jyothi *et al*., 2015) [18]. The yield increase may be due to increase in growth attributes like drymatter production and yield attributes like panicle length, total number of grains, more number of filled grains per panicle. Similar findings were also reported by Deshpande and Devasenapathy (2010) [4]. Green manure + Biofertilizer (PSB) promotes improvement in leaf photosynthetic rate, biomass production and sink formation, which increased the grain yield of rice. Besides P solubilisation activity, PSB liberates growth harmone (IAA) that might have influenced on root growth and yield. The extensive root system might have increased nutrient uptake from the surroundings which boosted plant biomass and subsequently more grain yield of rice. These results were alike with the findings of Dass *et al*. (2009) [3] and Panhwar *et al*. (2010) [8].

Among the levels of phosphorus, 150 % RDP recorded highest grain yield (5425 kg ha^{-1}, 5583 kg ha^{-1} and 5504 kg ha^{-1} over 50 % RDP (5024 kg ha^{-1}, 5164 kg ha^{-1} and 5094 kg ha^{-1}) it was remained on a par with 100 % RDP (5283 kg ha^{-1}, 5456 kg ha^{-1} and 5369 kg ha^{-1}). Similar trend was observed during first, second and pooled data of study. This might be due to adequate supply of P in soil might have favoured efficient use of P in turn brought higher grain yield. These results are in close conformity with the findings obtained by Dutta and Gogoi (2009) [6] and Ramesh Babu *et al.* (2013) [11].

Table 1: Grain yield (kg ha^{-1}) of *kharif* rice as influenced by phosphorus management practices

Treatments	2016-17	2017-18	Pooled data
Source of phosphorus			
S_1 - Inorganic phosphorus	4620	4649	4635
S_2- Green manuring	5520	5730	5625
S_3 - Soil application of PSB	5179	5329	5254
S_4- Green manuring + PSB	5656	5896	5776
S.Em±	73.14	79.45	75.81
CD (p = 0.05)	253.1	274.9	262.3
CV (%)	4.2	4.4	4.3
Levels of phosphorus			
L_1 - 50% RDP	5024	5164	5094
L_2 - 100% RDP	5283	5456	5369
L_3 - 150% RDP	5425	5583	5504
S.Em±	55.92	70.28	57.21
CD (p = 0.05)	167.7	210.7	171.5
CV (%)	3.7	4.5	3.7

Nitrogen Uptake

A perusal of the data (Table 2) showed significant differences in nitrogen uptake in plant at maturity (grain and straw) due to various sources and levels of phosphorus while there is significant variation in nitrogen content to grain except straw content. The same trend was followed during both years and pooled data of study. During both the years and pooled data of study, it was observed that significantly higher nitrogen uptake by grain (76.6, 81.6 and 79.1 kg ha^{-1}) and straw (50.3, 55 and 52.6 kg ha^{-1}) was obtained with treatment that received *in-situ* green manuring + biofertilizer (PSB), which was statistically on par with *in-situ* green manuring but proved significantly superior to inorganic fertilizer through SSP alone and biofertilizer (PSB) alone treatments.

Supply of inorganic fertilizer through SSP alone has resulted in the lowest nitrogen uptake by rice, during both the years and pooled data of study. The highest N uptake recorded with *in-situ* green manuring + biofertilizer (PSB) might be due to mineralization of N added by green manure and its rapid decomposition and continuous availability of plant nutrients throughout the growing period resulting in improvement in physical, chemical and biological properties of soil provides favorable condition suitable for better root growth and proliferation leads to higher absorption of nutrients and water enhanced drymatter production which resulted in higher nitrogen uptake. The uptake being the product of nutrient content and dry matter accumulation, the increase in N uptake by the crop might be due to increased availability of nitrogen and higher grain and straw yields. These findings are in agreement with the findings of Sarwad *et al*. (2005) [14] and Vennila and Jayanthi (2007) [21]. The lowest nitrogen uptake by grain (47.3, 48.5 and 47.9 kg ha^{-1}) and straw (41.8, 43 and 42.4 kg ha^{-1}) of rice was recorded with treatment, inorganic fertilizer through SSP alone during both the years and pooled data of study. This might be due to unavailable form of nutrients as explained earlier by Begum *et al*. (2009) [1] and Meena *et al*. (2014) [7].

Table 2: N content (%) and uptake (kg ha^{-1}) of *kharif* rice as influenced by phosphorus management practices

Treatments	2016-17				2017-18				Pooled data			
	Grain		Straw		Grain		Straw		Grain		Straw	
	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})
Source of phosphorus												
S_1 - Inorganic phosphorus	1.02	47.3	0.73	41.8	1.04	48.5	0.74	43.0	1.03	47.9	0.74	42.4
S_2- Green manuring	1.27	70.1	0.75	49.9	1.30	74.5	0.78	53.4	1.29	72.3	0.77	51.6
S_3 - Soil application of PSB	1.15	59.4	0.74	46.0	1.17	62.2	0.76	48.9	1.16	60.8	0.75	47.4
S_4- Green manuring + PSB	1.35	76.6	0.76	50.3	1.38	81.6	0.80	55.0	1.37	79.1	0.78	52.6
S.Em±	0.02	2.09	0.01	1.42	0.02	2.31	0.01	1.63	0.02	2.19	0.01	1.50
CD (p = 0.05)	0.09	7.2	NS	4.9	0.09	8.0	NS	5.6	0.09	7.6	NS	5.2
CV (%)	6.3	9.9	5.5	9.0	6.1	10.4	4.8	9.7	6.2	10.1	4.9	9.2
Levels of phosphorus												
L_1 - 50% RDP	1.15	58.3	0.73	44.4	1.18	61.3	0.76	47.0	1.16	59.8	0.74	45.7
L_2 - 100% RDP	1.19	63.6	0.75	48.0	1.22	67.2	0.78	51.1	1.20	65.4	0.76	49.6
L_3 - 150% RDP	1.25	68.1	0.75	48.6	1.28	71.6	0.78	52.1	1.26	69.8	0.77	50.3
S.Em±	0.04	2.11	0.01	0.93	0.04	2.23	0.01	1.12	0.04	2.16	0.01	0.91
CD (p = 0.05)	NS	6.3	NS	2.8	NS	6.7	NS	3.3	NS	6.5	NS	2.7
CV (%)	11.7	11.5	3.8	6.8	11.5	11.6	3.7	7.7	11.6	11.5	3.7	6.5
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Among the levels of phosphorus, 150 % RDP (68.1 and 48.6 kg ha^{-1}) recorded highest nitrogen uptake by grain and straw followed by 100 % RDP (63.6 and 48 kg ha^{-1}) and significantly superior to 50 % RDP (58.3 and 44.4 kg ha^{-1}). This might be due to higher concentration of N in both grain and straw and drymatter accumulation that lead to higher N uptake. Similar trend was observed during second year and pooled data of study. These findings are in agreement with the findings of Sanusan *et al*. (2009) [13] and Sekhar *et al.* (2014) [15].

Phosphorus Uptake

Phosphorus content and uptake (Table 3.1, 3.1a, 3.1b) by rice significantly differed at 30, 60, 90 DAT and at maturity (grain and straw) by different treatments sources of phosphorus and levels of phosphorus, while there was significant variation among the treatments *i.e.* for phosphorus content during both the years of study. At 30 DAT, significantly the higher phosphorus uptake was noticed with treatment that received *in-situ* green manuring + biofertilizer (PSB) (3 kg ha^{-1}), which remained statistically on par with *in-situ* green manuring (2.8 kg ha^{-1}) but proved significantly superior to inorganic fertilizer through SSP alone (1.3 kg ha^{-1}) and biofertilizer (PSB) alone treatments (1.9 kg ha^{-1}). Similar trend was observed in other stages *i.e.* 60, 90 DAT and at maturity during both the years and pooled data.

The increased P uptake observed with *in-situ* green manuring + biofertilizer (PSB) might be due to the increased P solubilization and its availability for crop growth. Phosphorus in the insoluble form is solubilized by the action of organic acids released in to the soil due to decomposition of green manure that was supplied to the soil. These results are in close conformity with the results obtained by Vinay Singh (2006) [22]. The lowest phosphorus uptake at all growth stages of rice was recorded by the treatment which remained inorganic fertilizer through SSP at all stages of crop growth *i.e.* 30, 60, 90 DAT and at maturity (grain and straw) during both the years and pooled data of study. This might be due to low drymatter accumulation at respective stages of crop growth.

Table 3: P content (%) of *kharif* rice at different growth stages as influenced by phosphorus management practices

Treatments	2016-17			2017-18			Pooled data		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Source of phosphorus									
S_1 - Inorganic phosphorus	0.09	0.13	0.16	0.11	0.14	0.16	0.10	0.13	0.16
S_2- Green manuring	0.12	0.19	0.22	0.16	0.21	0.24	0.16	0.20	0.23
S_3 - Soil application of PSB	0.11	0.15	0.18	0.13	0.17	0.19	0.13	0.16	0.18
S_4- Green manuring + PSB	0.15	0.20	0.22	0.17	0.22	0.24	0.16	0.21	0.23
S.Em±	0.010	0.004	0.004	0.010	0.005	0.005	0.004	0.004	0.004
CD (p = 0.05)	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.01	0.02
CV (%)	15.8	7.9	6.1	11.1	7.8	7.3	9.6	7.4	6.4
Levels of phosphorus									
L_1 - 50% RDP	0.10	0.16	0.18	0.13	0.18	0.20	0.13	0.17	0.20
L_2 - 100% RDP	0.12	0.16	0.18	0.14	0.18	0.20	0.13	0.17	0.20
L_3 - 150% RDP	0.14	0.18	0.19	0.16	0.19	0.22	0.15	0.19	0.21
S.Em±	0.004	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
CD (p = 0.05)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV (%)	13.7	5.9	6.2	8.4	5.4	4.7	7.3	5.7	5.1
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3a: P uptake (kg ha^{-1}) of *kharif* rice at different growth stages as influenced by phosphorus management practices

Treatments	2016-17			2017-18			Pooled data		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Source of phosphorus									
S_1 - Inorganic phosphorus	1.3	5.8	13.9	1.7	6.1	14.5	1.5	6.0	14.2
S_2- Green manuring	2.8	12.3	23.3	3.4	14.4	25.8	3.1	13.3	24.5
S_3 - Soil application of PSB	1.9	9.3	17.9	2.4	10.3	18.6	2.1	9.8	18.2
S_4- Green manuring + PSB	3.0	13.0	22.8	3.5	14.5	26.6	3.3	13.8	24.7
S.Em±	0.10	0.50	0.64	0.08	0.44	0.74	0.08	0.44	0.67
CD (p = 0.05)	0.3	1.7	2.2	0.3	1.5	2.5	0.3	1.5	2.3
CV (%)	13.1	14.8	9.8	8.3	11.7	10.3	9.5	12.4	9.9
Levels of phosphorus									
L_1 - 50% RDP	2.0	9.0	18.1	2.5	10.2	19.7	2.2	9.6	18.9
L_2 - 100% RDP	2.2	10.8	20.2	2.8	11.9	21.9	2.5	11.4	21.1
L_3 - 150% RDP	2.5	11.5	21.4	3.1	12.9	23.5	2.8	12.2	22.5
S.Em±	0.09	0.32	0.42	0.09	0.41	0.54	0.07	0.35	0.45
CD (p = 0.05)	0.3	1.0	1.3	0.3	1.2	1.6	0.2	1.1	1.4
CV (%)	13.6	11.0	7.4	11.9	12.7	8.8	10.3	11.4	7.7
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3b: P content (%) and uptake (kg ha^{-1}) in grain and straw of *kharif* rice as influenced by phosphorus management practices

Treatments	2016-17				2017-18				Pooled data			
	Grain		Straw		Grain		Straw		Grain		Straw	
	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})
Source of phosphorus												
S_1 - Inorganic phosphorus	0.19	8.9	0.05	3.1	0.20	9.4	0.06	3.7	0.20	9.2	0.06	3.4
S_2- Green manuring	0.26	14.4	0.10	6.4	0.28	16.1	0.12	8.0	0.27	15.3	0.11	7.2
S_3 - Soil application of PSB	0.23	11.9	0.08	5.0	0.24	12.8	0.09	5.8	0.24	12.4	0.09	5.4
S_4- Green manuring + PSB	0.28	16.0	0.11	7.1	0.30	17.9	0.13	8.7	0.29	17.0	0.12	7.9
S.Em±	0.01	0.39	0.01	0.43	0.01	0.42	0.01	0.42	0.01	0.40	0.01	0.42
CD (p = 0.05)	0.02	1.34	0.02	1.5	0.02	1.46	0.02	1.4	0.02	1.4	0.02	1.5
CV (%)	7.4	10.6	22.1	23.9	6.9	9.0	18.7	19.0	7.1	8.8	20.3	21.1
Levels of phosphorus												
L_1 - 50% RDP	0.23	11.7	0.08	4.7	0.25	12.9	0.09	5.7	0.24	12.3	0.08	5.2
L_2 - 100% RDP	0.24	13.1	0.08	5.4	0.25	14.9	0.10	6.6	0.24	14.2	0.09	6.0
L_3 - 150% RDP	0.26	14.2	0.09	6.1	0.27	15.5	0.11	7.3	0.27	14.8	0.10	6.7
S.Em±	0.005	0.35	0.004	0.30	0.005	0.43	0.004	0.25	0.005	0.41	0.004	0.27
CD (p = 0.05)	0.01	1.06	0.01	0.9	0.01	1.29	0.01	0.8	0.01	1.2	0.01	0.8
CV (%)	7.0	11.1	15.9	19.0	6.6	10.6	13.5	13.3	6.8	10.6	14.6	15.5
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Among the levels of phosphorus, 150 % RDP (2.5 kg ha^{-1}) recorded the highest phosphorus uptake followed by 100 % RDP (2.2 kg ha^{-1}) and found significantly superior to 50 % RDP (2.0 kg ha^{-1}) at 30 DAT. Similar trend was observed during 60, 90 DAT and at maturity (grain and straw) during both the years and pooled data of study. This might be due to decrease in per cent utilization of phosphorus with increasing P levels, as plant absorb more phosphorus under P-stress condition to meet their demand. Similar trend was observed during first, second and pooled data of study. These findings are in agreement with the findings of Selvi *et al*. (2003) [16] and Raghuveer *et al.* (2015) [9].

Potassium Uptake

The data on potassium content and uptake at harvest (grain and straw) are furnished in (Table 4) which showed that there was significant differences in potassium content in grain and non significant in straw among the phosphorus sources but among the levels of phosphorus, non significant in grain and straw and significantly in potassium uptake in response to different treatments at grain and straw. Potassium uptake followed the similar trend as that was noticed in respect of N at harvest (grain and straw) during both the years and pooled data of study. At harvest, uptake of potassium by straw is greater than grain. The findings are in close conformity with results obtained by Singh *et al*. (2006) [17] and Sampath *et al*. (2017) [12]. The treatment which received *in-situ* green manuring + biofertilizer (PSB) proved its superiority by registering the highest potassium uptake but remained statistically alike with *in-situ* green manuring and proved significantly superior to inorganic fertilizer through SSP and soil application with PSB. The lowest potassium uptake at harvest (grain and straw) of rice was recorded with the treatment *i.e* inorganic fertilizer through SSP during both years and pooled data of study. Higher K uptake recorded by *in-situ* green manuring + biofertilizer (PSB) might be due to better availability of nutrients and reduced P fixation. Similar findings were also reported by Stalin *et al*. (2006) [19] and Dushyant Panday *et al*. (2015) [5]. Potassium uptake increased with increase levels of phosphorus. It may be due to higher potassium content and drymatter production which ultimately lead to higher potassium uptake by increasing phosphorus levels. The findings close accordance with those of Suryavanshi *et al*. (2008) [20].

Table 4: Potassium content (%) and uptake (kg ha^{-1}) in grain and straw of *kharif* rice as influenced by phosphorus management practices

Treatments	2016-17				2017-18				Pooled data			
	Grain		Straw		Grain		Straw		Grain		Straw	
	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})	Content (%)	Uptake (kg ha^{-1})
Source of phosphorus												
S_1 - Inorganic phosphorus	0.28	13.0	1.16	66.0	0.29	13.3	1.19	68.8	0.28	13.1	1.17	67.4
S_2- Green manuring	0.33	18.3	1.20	79.7	0.36	20.5	1.24	84.6	0.34	19.4	1.22	82.2
S_3 - Soil application of PSB	0.30	15.7	1.17	72.4	0.32	17.1	1.19	75.9	0.31	16.4	1.18	74.2
S_4- Green manuring + PSB	0.35	20.1	1.21	80.9	0.39	23.1	1.27	88.1	0.37	21.6	1.24	84.5
S.Em±	0.01	0.77	0.02	2.13	0.01	0.87	0.02	2.35	0.01	0.79	0.02	2.18
CD (p = 0.05)	0.04	2.7	NS	7.4	0.04	3.0	NS	8.1	0.04	2.7	NS	7.5
CV (%)	12.0	13.8	4.5	8.6	11.3	14.1	5.0	8.9	11.1	13.4	4.3	8.5
Levels of phosphorus												
L_1 - 50% RDP	0.32	16.0	1.19	71.9	0.34	17.6	1.21	75.2	0.33	16.8	1.20	73.5
L_2 - 100% RDP	0.31	16.7	1.19	76.0	0.33	18.5	1.22	80.4	0.32	17.6	1.20	78.2
L_3 - 150% RDP	0.32	17.7	1.18	76.4	0.35	19.5	1.23	82.4	0.33	18.6	1.21	79.4
S.Em±	0.01	0.68	0.02	1.86	0.01	0.77	0.02	1.98	0.01	0.72	0.02	1.67
CD (p = 0.05)	NS	2.0	NS	5.6	NS	2.3	NS	5.9	NS	2.2	NS	5.0
CV (%)	12.4	14.0	6.2	8.6	11.6	14.4	6.7	8.6	12.0	14.2	5.8	7.5
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

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