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Performance of Green Manures and Phosphorus Levels in Rice-Blackgram Cropping Sequence

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A B S T R A C T

A field experiments was conducted during 2015 and 2016 to study the effect of green manures and phosphorus levels in blackgram crop at Agricultural College Farm, Bapatla. The experiment was conducted in split- split plot design on sandy clay loam soil with three main treatments three sub-treatments to*kharif* rice and three sub-sub treatments to *rabi* crop. The treatments consisted of *dhaincha* green manure crop, sunnhemp green manure crop and without green manure as main plot treatments and three phosphorus levels to rice crop comprising of 45 kg P_2O_5 ha^{-1}, 60 kg P_2O_5 ha^{-1} and 75 kg P_2O_5 ha^{-1} as sub- plot treatments and are replicated thrice. The *rabi* experiment was laid out on the same site in a split-split plot design without disturbing the soil for succeeding blackgram crop and each of the *kharif* plot was divided into three sub-sub plots to receive three levels of phosphorus (No P, 50% RDP and 100% RDP) to each plot. Growth parameters, yield attributes and yield of blackgram which received *dhaincha* green manure incorporation with 75 kg P_2O_5 ha^{-1} to *kharif* rice crop and 100% RDP to *rabi* blackgram was recorded significantly higher and it was on a par with sunnhemp green manure incorporation with 75 kg P_2O_5 ha^{-1} to *kharif* rice crop and 100% RDP to *rabi* blackgram.

Introduction

India has the largest area under pulses in the world with the area is about 190.4 lakh hectares producing 124.0 lakh tonnes with an average yield of 651.2 kg ha^{-1}. Among the pluses, blackgram (Urdbean) contributes 16.28% of the total area and 11.48 % of the total production with an average productivity of 451.6 kg ha^{-1}. Nutrient management is an important aspect in increasing the productivity of pulses. Phosphorus is a key nutrient for increasing productivity of pulses (Deo and Khaldelwal, 2009). The adequate supply of phosphorus to legume is more important than that of nitrogen, because it has beneficial effect on root development, nodulation, growth and yield.

A large portion of phosphorus remaining after the first crop is not fixed but is indeed available to the subsequent crops (Kundu *et al.,* 1986). Incorporation of green manures along with fertilizers leads to increased productivity of the system and sustained health for longer period.

Hence, the available literature on green manures, P levels and their residual effect on succeeding blackgram is meager, the present investigation was carried out with a view to evaluate the effect of phosphorus levels to *kharif* crop and phosphorus doses to *rabi* blackgram in rice-blackgram cropping sequence.

Materials and Methods

A field experiment was conducted during 2015 and 2016 at Agricultural College Farm, Bapatla to study the effect of green manures and phosphorus levels to *kharif* crop and phosphorus doses to blackgram crop. The experiment was conducted in split plot design on sandy clay loam soil with three main treatments and three sub-treatments during *kharif* season and split-split plot design in *Rabi* season.

The treatments consisted of *dhaincha* green manure crop, sunnhemp green manure crop and without green manure as main plot treatments and three phosphorus levels to rice crop comprising of 45 kg P_2O_5 ha^{-1}, 60 kg P_2O_5 ha^{-1} and 75 kg P_2O_5 ha^{-1} as sub- plot treatments and are replicated thrice.

The *rabi* experiment was laid out on the same site in a split-split plot design without disturbing the soil for succeeding blackgram crop and each of the *kharif* plot was divided into three sub-sub plots to receive three levels of phosphorus (No P, 50% RDP and 100% RDP) to each plot.

Nitrogen, phosphorus and potassium were applied through urea, single super phosphate and murate of potash, respectively. Recommended agronomic management practices and plant protection measures were followed during crop growth periods. The data recorded and were analyzed the following standard statistical analysis.

Results and Discussion

Plant height (cm) of blackgram

The plant height at harvest was significantly influenced by green manures incorporated and P levels to rice crop as well as P application to succeeding *rabi* blackgram during both the years of study. The maximum plant height of blackgram was recorded when the preceding rice was incorporated with *dhaincha* green manure @ 75 kg P_2O_5 ha^{-1} and found significantly superior to control at 45 kg P_2O_5 ha^{-1} during both the years of study. Significantly the highest plant height (76.3 and 81.1 cm during 1^{st} and 2^{nd} year respectively) at harvest was noticed with 100% phosphorus dose to blackgram, which was significantly superior to control. However, the treatments with 50% and 100 % RDP were on a par with each other. But, the lower plant height (70.7 and 77.1 cm) was registered by control. The beneficial effect of phosphorus through the availability of higher energy in the form of ATP molecules which might have favoured multiplication of cells enhancing the plant height there by increases the drymatter production was also reported by several researchers like Hanumanthappa and Hosamani 1989.

Drymatter accumulation (g m^{-2}) of blackgram at harvest

Drymatter production of *rabi* blackgram was significantly higher (1852 and 1855 kg ha^{-1}) when its preceding rice crop was incorporated with *dhaincha* green manure followed by sunnhemp green manure (1847 and 1845 kg ha^{-1}) incorporation. Significantly the highest drymatter accumulation of *rabi* blackgram in both the years of study was recorded when its preceding rice was applied with 75 kg P_2O_5 ha^{-1}. The lower drymatter was recorded when the *kharif* rice was supplied with 45 kg P_2O_5 ha^{-1} in both the years of study (Table 1).

Where, it was statistically comparable with 60 kg P_2O_5 ha^{-1} during both the years of study. Phosphorus availability was more at higher levels of phosphorus to blackgram crop. There was a gradual increase in the drymatter accumulation of *rabi* blackgram with increase in phosphorus application to it during the first and second years of study. The higher drymatter accumulation of *rabi* blackgram was recorded with 100 % RDP application (1862 and 1861 kg ha^{-1}) and was significantly superior to control only. The lower drymatter was registered in the control (1769 and 1745 kg ha^{-1}) during both the years of study. Applications of higher levels of phosphorus to the previous crop lead to higher residual phosphorus to the second succeeding crop. This might be the reason for the significant difference in the drymatter accumulation of *rabi* blackgram. Increased drymatter production might be due to the positive effect of phosphorus on proliferation of root system resulting in increased nutrient uptake as opined by Ajay and Vinod (2006).

Number of pods plant^{-1}

During both the years of study, significantly the higher numbers of pods were recorded in the treatment in which the preceding rice crop was incorporated with *dhaincha* green manure (55.9 and 63.0) whereas the lower numbers of pods were registered by no green manure (51.3 and 53.3) to the rice crop. Significantly the higher number of pods and the lower number of pods plant^{-1} were registered at 75 kg P_2O_5 and 45 kg P_2O_5 to *kharif* rice, respectively in first as well as second year of study. Significantly the higher (56.3 and 63.6) and lower number (50.1 and 53.5) of pods plant^{-1} of blackgram were registered with 100% RDP and control, respectively in both the years of study. The increase in the pods per plant and number of seeds per pod with the application of phosphorus might be due to the regulatory function of P in photosynthesis and carbohydrate metabolism in leaves which can be considered to be one of the major factors. The level of phosphorus during the period regulates starch/sucrose ratio in the leaves (source) and the reproductive organs (sink) as stated by Giaqinta and Quebedeaux, (1980).

Seed yield (kg ha^{-1})

The seed yield of *rabi* blackgram was significantly higher with *dhaincha* green manure (869 and 851 kg ha^{-1} during first and second years, respectively) and was followed by (863 and 848 kg ha^{-1} during first and second years, respectively) sunnhemp incorporation. No green manure to the *kharif*rice recorded significantly lower (823 and 797 kg ha^{-1}) yield. Significantly higher (876 and 851 kg ha^{-1} grain yield in 2015 and 2016) and lower seed yield (813 and 801 kg ha^{-1}) were registered with 75 kg P_2O_5 ha^{-1} and 45 kg P_2O_5 ha^{-1} phosphorus application to rice crop respectively (Table 2).

Significantly the higher 884 kg ha^{-1} to kg 855 ha^{-1}seed yield in first year and second year of study was registered when 100% RDP was supplied which was closely followed by 50 % of RDP. However, lower seed yield (803 kg ha^{-1} and 796 kg ha^{-1} in first and second years, respectively) was recorded with the control. Per cent increase in seed yield due to 100% RDP over 50% and control was 13.3 and 26.7 per cent, respectively during first year where as 13.3 and 27.4 per cent more during the second year of experimentation. The increase in the seed yield of succeeding blackgram with phosphorus applied to rice at later stages could be ascribed, to the increased residual available phosphorus which helped in developing profuse root system resulting in increased nutrient uptake, higher drymatter accumulation and translocation of photosynthates from vegetative parts to seeds. The results confirm with the findings of Mehta *et al.,* (2010) and Dekhane *et al.,* (2011).

Table.1 Growth of blackgram as influenced by green manures and phosphorus levels applied to *kharif* rice crop and phosphorus doses to *rabi* blackgram during 2015 and 2016

	Plant height (cm)		Drymatter accumulation (kg ha^{-1})		Number of pods plant^{-1}	
	2015	2016	2015	2016	2015	2016
Green manures (M)						
Dhaincha	77.1	81.7	1852	1855	55.9	63.0
Sunnhemp	75.5	80.4	1847	1845	54.3	61.5
Without green manure	70.6	76.2	1774	1731	51.3	53.3
SEm±	0.83	0.82	18.4	18.1	0.63	0.73
CD (P=0.05)	1.32	0.83	23.2	26.7	0.84	0.82
CV (%)	1.64	0.91	22.5	28.1	1.12	1.14
P Levels						
45 kg P_2O_5ha^{-1}	71.2	77.4	1761	1738	51.9	56.7
60 kg P_2O_5ha^{-1}	75.6	80.1	1839	1834	54.4	59.4
75 kg P_2O_5ha^{-1}	76.3	80.8	1873	1859	55.3	61.8
SEm±	3.1	3.0	72	71	2.0	2.8
CD (P=0.05)	4.3	2.6	75	87	2.4	2.6
CV (%)	4.9	2.7	68	84	3.4	3.4
P doses						
No P	70.7	77.1	1769	1745	50.1	53.5
50% P	76.2	80.1	1842	1825	55.2	60.7
100% P	76.3	81.1	1862	1861	56.3	63.6
SEm±	5.5	5.1	5.2	5.2	5.4	6.3
CD (P=0.05)	9.1	5.2	6.6	7.7	7.2	7.1
CV (%)	11.5	5.8	6.4	8.1	10.9	9.8
Interaction						
MXL						
SEm±	2.33	1.41	40.1	46.2	1.31	1.41
CD (P=0.05)	NS	NS	NS	NS	NS	NS
MXD						
SEm±	2.84	1.52	39.0	48.7	2.03	1.91
CD (P=0.05)	NS	NS	NS	NS	NS	NS
LXD						
SEm±	2.82	1.52	39.0	48.7	2.02	1.91
CD (P=0.05)	NS	NS	NS	NS	NS	NS
MXLXD						
SEm±	4.91	2.71	67.6	84.3	3.43	3.42
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Table.2 Seed yield (kg ha^{-1}), haulm yield and harvest index (%) of blackgram as influenced by green manures and phosphorus levels applied to *kharif* rice crop and phosphorus doses to *rabi* blackgram during 2015 and 2016

	Seed yield (kg ha^{-1})		Haulm yield (kg ha^{-1})		Harvest index (%)	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**
Dhaincha	869	851	1362	1248	41.5	42.0
Sunnhemp	863	848	1353	1273	41.2	41.2
Without green manure	823	797	1287	1153	40.8	40.1
SEm±	8.3	8.3	14.0	11.6	0.33	0.14
CD (P=0.05)	15.6	12.6	22.1	25.4	NS	0.5
CV (%)	16.6	14.7	20.0	25.5	4.2	1.7
P levels						
45 kg $P_2O_5ha^{-1}$	813	801	1278	1177	41.1	41.1
60 kg $P_2O_5ha^{-1}$	866	844	1352	1261	41.0	41.2
75 kg $P_2O_5ha^{-1}$	876	851	1371	1270	41.3	41.0
SEm±	32	32	55	46	0.44	0.72
CD (P=0.05)	51	41	72	83	NS	NS
CV (%)	50	44	60	77	5.5	8.4
P doses						
No P	803	796	1282	1165	40.6	41.3
50% P	867	845	1349	1257	41.3	41.2
100% P	884	855	1370	1287	41.5	40.7
SEm±	5.0	5.2	5.5	5.0	0.62	0.73
CD (P=0.05)	9.5	7.8	8.6	10.7	NS	NS
CV (%)	10.1	9.2	7.8	10.7	7.2	9.2
Interaction						
MXL						
SEm±	27.1	21.8	38.3	44.0	0.81	1.23
CD (P=0.05)	NS	NS	NS	NS	NS	NS
MXD						
SEm±	28.8	25.4	34.7	44.2	1.02	1.32
CD (P=0.05)	NS	NS	NS	NS	NS	NS
LXD						
SEm±	28.8	25.4	34.7	44.2	1.04	1.34
CD (P=0.05)	NS	NS	NS	NS	NS	NS
MXLXD						
SEm±	49.9	44.0	60.1	76.6	1.73	2.22
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Haulm yield (kg ha^{-1})

Significantly higher haulm yield (1362 and 1248 kg ha^{-1} during both years, respectively) of blackgram was recorded when the preceding rice was incorporated with *dhaincha* green manure which was closely followed by sunnhemp incorporation (1353 and 1273 kg ha^{-1} during first and second years, respectively) treatment. Without green manure incorporation plot registered the lower (1287 and 1153 kg ha^{-1}) haulm yield.

Significantly the higher (1371 and 1270 kg ha^{-1} haulm yield in 2015and 2016 respectively) and the lower haulm yield (1278 and 1177 kg ha^{-1} during both the years) were registered with 75 kg P_2O_5 ha^{-1} and 45 kg P_2O_5 ha^{-1} phosphorus application to rice crop, respectively

Significantly the higher (1368 and 1278 kg ha^{-1} during 1st and 2nd year respectively) haulm yield was registered when 100% RDP was supplied which was closely followed by 50 % of RDP followed this treatment. However, lower haulm yield (1281and 1167 kg ha^{-1} in first and second years, respectively) was recorded with control. The role of phosphorus as part of chlorophyll pigment, its roll in enzymatic reactions is well documented. This might have resulted in higher growth characters, yield attributes and finally the higher haulm yield. Similar reports of increased haulm yield of *rabi* blackgram at higher doses of phosphorus was also reported by Ghulam (2011)

Harvest index (%)

During the 2nd year of study, the green manure incorporation only had a significant influence on harvest index. Significantly the highest harvest index (41.5 and 42.0) recorded with *dhaincha* green manure incorporation to rice crop which was remained statistically on par with sunnhemp incorporation. The lowest harvest index was obtained with control. No interaction was found to be significant during both years of study.

Similarly, among the P doses to blackgram, application of 50% and 100% RDP proved to be significantly superior to control but both of them did not differ significantly. None of the interactions were not show significant variation in harvest index.

Overall, the field studies conducted for two consecutive years clearly indicated that incorporation of green manures preceding to rice crop and application with 75 kg P_2O_5 ha^{-1} to *kharif* rice crop and 100% RDP to *rabi* blackgram treatment had a significant influence in increasing productivity and profitability in rice - blackgram sequence. Therefore from this study, it was concluded that application of green manures with 60 kg P_2O_5 ha^{-1} to *kharif* rice crop and 50 % RDP to succeeding *rabi* blackgram is the best and the most profitable cropping sequence in the study area.

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