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Research Article

FOOD FODDER INTERCROPPING AND PHOSPHORUS MANAGEMENT IN OAT (*AVENA SATIVA* L.), CHICK PEA (*CICER ARIETINUM* L.), LENTIL (*LENS CULINARIS* MEDIKUS.), GREEN GRAM (*VIGNA RADIATA* L. WILCZEK), RICE (*ORYZA SATIVA* L) CROPPING SEQUENCE UNDER LATERITIC SOIL

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Abstract

A field experiments was conducted under lateritic soil, at Kankutia, dist.- Birbhum, W.B., India during 2006 – 2008 in farmers field to study the effect of food fodder intercropping and phosphorus management in oat + chick pea / lentil - green gram - rice cropping sequence under lateritic soil. Sole cropping of oat recorded highest green forage yield (32.1 t/ha). The row ratio, 2:1 of oat + pulses (chick pea / lentil) gave significantly higher fodder than their 1:1 series and SSP showed better effect (28.86 t/ha) than PRP (26.14 t/ha). Chickpea as sole gave the highest grain yield (13.8 q/ha). But the row ratio 1:1 showed better effect on grain yield of pulses than 2:1 series. The water-soluble SSP produced significantly higher grain yield of pulses than Purulia rock phosphate. Purulia rock phosphate resulted in significantly higher yield of green gram (667 kg/ha) than SSP (555 Kg/ha). Intercropping of oat + lentil (1:1) gave significantly highest grain yield of rice. Oat + lentil (1:1) –green gram – rice gave maximum net return and benefit - cost ratio (1.36). Use of PRP gave higher net return and B/C ratio (1.21). Oat + lentil (1:1) with PRP were found the best treatment.

Keywords: Cropping system, Soil fertility, Phosphorus, Forage, Pulse, Economics

INTRODUCTION

While studying oats, peas, senji and vetch grown in rabi at Pune and intercrop in 1:1, 2:1 or 1:2 rows of oats (fodder): legumes (food) at Jhansi it was reported that dry matter yield was highest in oats grown alone, although yields of some intercrops with peas or senji were not statistically different[1]. It was reported that the integration of forage legumes into the low input, cereal based farming system may be the key to sustaining soil, crop and livestock production[2]. The residual effect of cereal + legume intercropping or mixed cropping system improved the soil fertility status, crumb structure and soil condition favorable for crop growth[3]. In the recent past there has been considerable interest in research on utilization of ground phosphate rock as a source of phosphorus as direct P-fertilizer for acid management. It was found that Rajasthan rock phosphate and Mussoorie rock phosphate were 92.43 and 93.18 percent as efficient as supper phosphate with regard to the total uptake of P and grain yield rice[4]. It was also reported that in a sandy loam acidic soil, Mussoorie rock phosphate, when applied @ 30 kg/ha to the rice, gave the higher grain (21.5 q/ha) and straw yield (25.4 q/ha) of succeeding wheat than those of single super phosphate[5]. Further it was observed that yield of crop was greater with triple super phosphate in the first year due to better solubility of P, but rock phosphate showed a better efficiency in the second year[6]. Keeping the idea in view an investigation was undertaken to study the growth, productivity, economics, nutrient uptake and soil fertility status after cultivation of forage oat and pulses in different cropping systems under forage + pulse- green gram- rice cropping sequence for the evaluation of crop productivity and soil fertility under lateritic belt of West Bengal.

MATERIALS AND METHODS

The field experiments were conducted at the Farmers Field of the village Kankutia, Birbhum, West Bengal, India during 2006 to 2008 under lateritic acid soil (pH- 5.7, N- 0.0345, avail. P- 9.26 kg/ha and avail. K- 129.3 kg/ha). The experiment was started with water soluble single super phosphate and insoluble Purulia rock phosphate @ 60 kg P_2O_5 on fodder oat (*Avena sativa* L. var. 'Kent'), Chickpea (*Cicer arietinum* L. var. 'B-108') and lentil (*Lens culinaris* Medikus Var. 'B-77') as sole and intercropping systems during winter season of the year 2006-07 and 2007-2008. The subsequent crops like green gram (*Vigna radiata* L. Wilczek. Var. 'B-105') without any fertilizer in summer and rice (*Oryza sativa* L. var. 'IR-36') with 30 kg N, 60 kg K_2O /ha as a general dose and no phosphorus in rainy season were grown in the same layout to study the residual effect of treatments applied in the first crops. The experiment during winter season was laid out in randomized block design taking two phosphate sources Purulia Rock Phosphate (PRP) containing

20 % P_2O_5 and Single Supper Phosphate (SSP) containing 16 % P_2O_5 as first factor and seven cropping system (sole oat, sole chick pea, sole lentil, oat + chick pea (1:1), oat + lentil (1:1), oat + chick pea (2:1) and oat + lentil (2:1) as second factor each in 5 m X 3 m plots with three replications). There were all together 42 plots, which were specified by bunds and ridges on all sides. The factorial randomized block design laid out for winter crops was maintained during summer and rainy seasons in residual studies.

RESULTS AND DISCUSSION

Direct effect on crop yield

The perusal of the data (Table 1) on green forage yield revealed that the highest green forage yield (32.1 t/ha) was obtained by sole cropping of oat and was superior to all cropping system. Further 2:1 row ratio of oat + pulses gave significantly higher fodder yield than 1:1 series irrespective of pulse crops. This might be due to higher population of forage oat in 2:1 series as compared to 1:1 series. But variation in intercrop did not produce any significant effect on the yield of fodder oat. Similar trend of results on intercropping were also obtained by different workers[7,8]. The effect of SSP and PRP was found at par in both the year but water soluble SSP gave significantly higher forage yield than PRP in pooled analysis. This might be due to higher availability of phosphorus from SSP at the first cut (60 DAS) of the fodder crop. But at the time of second or final cut (113 DAS) the differential effect of phosphorus sources disappeared resulting in equivalent forage yield from both the sources. Interaction effect of intercropping and sources of phosphorus was found not significant. The data on grain yield of pulse crops (Chick pea and lentil) clearly showed that the highest grain yield was obtained from sole chick pea and the lowest yield was obtained from lentil in association with fodder oat at 2:1 row ratio. But 1:1 row ratio was found significantly better in producing grain yield of pulses than those under 2:1 row ratio. This was caused by the less competition from associated oat crop in 1:1 series than that of 2:1 series where fodder oat suppressed the pulses[9]. SSP produced significantly higher grain yield of pulses than PRP. This might be due to the greater availability of P from SSP as compared to PRP at the initial growth period when the crop had high demand for available P.

Residual effect on succeeding crops

The results (Table 2) clearly showed that maximum residual effect in terms of grain yield of green gram was obtained by oat + lentil (1:1) followed by sole lentil. Intercropping of oat + pulses gave better residual effect on green gram at 1: 1 series than 2:1 row ratio .

Table 1: Effect of cropping systems and phosphorus sources on yield of forage oat and pulses

Treatment	Green forage yield of oat (t/ha)			Seed yield of pulses (t/ha)		
	2006-07	2007-08	Pooled	2006-07	2007-08	Pooled
Cropping system (C)						
Sole oat	30.09	34.19	32.14	-	-	-
Sole chickpea	-	-	-	1.42	1.34	1.38
Sole lentil	-	-	-	1.03	0.86	0.94
Oat + chickpea (1:1)	19.73	22.86	21.30	1.01	0.93	0.97
Oat + lentil (1:1)	20.12	22.85	21.49	0.77	0.63	0.70
Oat + chickpea (2:1)	26.54	30.88	28.72	0.68	0.70	0.70
Oat + lentil (2:1)	27.08	30.62	28.85	0.47	0.46	0.46
S. Em. (+)	0.44	0.67	0.38	0.04	0.05	0.03
CD (P = 0.05)	1.31	1.99	1.13	0.12	0.13	0.08
Phosphorus Sources (P)						
PRP	24.52	27.75	26.14	0.86	0.78	0.82
SSP	24.90	28.81	28.86	0.93	0.86	0.90
S. Em. (+)	0.28	0.42	0.24	0.02	0.03	0.02
CD (P = 0.05)	NS	NS	0.71	0.07	0.08	0.05

PRP = Purulia Rock Phosphate (20 % P_2O_5); SSP = Single Super Phosphate (16 % P_2O_5)

Table 2: Residual effect of cropping systems and phosphorus sources on yield of summer green gram and kharif rice

Treatment	Seed yield of summer green gram (kg/ha)			Seed yield of kharif rice (t/ha)		
	2006-07	2007-08	Pooled	2006-07	2007-08	Pooled
Cropping system (C)						
Sole oat	524	467	496	2.89	2.84	2.86
Sole chickpea	622	625	624	2.94	2.96	2.95
Sole lentil	661	672	667	3.15	3.04	3.10
Oat + chickpea (1:1)	610	647	629	3.05	2.93	2.99
Oat + lentil (1:1)	652	689	671	3.40	3.35	3.38
Oat + chickpea (2:1)	579	590	585	3.08	3.00	3.04
Oat + lentil (2:1)	595	616	606	3.14	3.11	3.13
S. Em. (+)	25	28	23	0. 16	0.15	0. 15
CD (P = 0.05)	74	81	69	0. 48	0. 44	0. 46
Phosphorus Sources (P)						
PRP	669	663	667	3.19	3.06	3.13
SSP	542	566	555	3.02	3.04	3.03
S. Em. (+)	14	15	13	0.09	0.08	0.09
CD (P = 0.05)	40	44	37	NS	NS	NS

PRP = Purulia Rock Phosphate (20 % P_2O_5); SSP = Single Super Phosphate (16 % P_2O_5)

Table 3: Effect of the cropping system and phosphorus sources on soil fertility status after harvest of each crop under fodder + pulse – green gram – rice cropping sequence

Treatment	2006-07			2007-08		
	Oat + pulse	Green gram	Rice	Oat + pulse	Green gram	Rice
Nitrogen Status						
Cropping system	(initial value – 0.034 % N)					
Sole oat	0.035	0.037	0.025	0.027	0.040	0.026
Sole chickpea	0.044	0.048	0.032	0.039	0.047	0.031
Sole lentil	0.046	0.056	0.033	0.040	0.052	0.031
Oat + chickpea (1:1)	0.044	0.051	0.031	0.038	0.051	0.031
Oat + lentil (1:1)	0.042	0.057	0.039	0.048	0.053	0.035
Oat + chickpea (2:1)	0.037	0.047	0.030	0.036	0.047	0.029
Oat + lentil (2:1)	0.039	0.048	0.028	0.036	0.047	0.029
Phosphorus Sources						
PRP	28.4	19.3	12.1	31.9	23.4	11.5
SSP	23.8	16.5	11.7	29.3	20.7	11.4
Available Phosphorus status (P kg/ha)						
Cropping system	(initial value – 9.26 kg/ha)					
Sole oat	24.1	16.0	10.6	28.1	19.4	10.8
Sole chickpea	26.5	18.2	11.8	30.9	21.1	11.2
Sole lentil	27.0	18.1	12.4.	32.8	23.3	11.8
Oat + chickpea (1:1)	25.6	18.0	12.9	30.2	21.9	11.6
Oat + lentil (1:1)	28.8	19.9	13.1	32.8	24.2	12.3
Oat + chickpea (2:1)	25.1	17.7	11.3	29.5	22.7	11.5
Oat + lentil (2:1)	25.5	17.3	11.2	30.1	21.8	11.1
Phosphorus Sources						
PRP	28.4	19.3	12.1	31.9	23.4	11.5
SSP	23.8	16.5	11.7	29.3	20.7	11.4
Available Potassium status (K kg/ha)						
Cropping system	(initial value – 129.3 kg k/ha)					
Sole oat	122.9	108.4	128.7	104.1	95.7	110.0
Sole chickpea	133.8	113.3	137.7	106.2	90.0	123.5
Sole lentil	133.1	112.3	136.9	124.6	111.1	123.6
Oat + chickpea (1:1)	134.3	116.0	136.5	111.6	100.4	121.5
Oat + lentil (1:1)	140.0	117.6	140.8	122.8	110.5	128.2
Oat + chickpea (2:1)	133.6	113.7	136.3	106.8	93.8	122.6
Oat + lentil (2:1)	133.3	111.2	137.7	116.5	100.2	116.2
Phosphorus Sources (P)						
PRP	135.9	114.9	137.0	115.8	101.9	121.1
SSP	130.1	111.5	135.7	110.7	98.6	120.5

PRP = Purulia Rock Phosphate (20 % P_2O_5); SSP = Single Super Phosphate (16 % P_2O_5)

Table 4: Effect cropping system and phosphorus sources on the economics of cultivation under fodder + pulse – green gram – rice cropping sequence

Treatments	Total cost (Rs./ ha)			Total return (Rs./ha)			Net return (Rs./ha)			Benefit / Cost ratio		
	PRP	SSP	Mean	PRP	SSP	Mean	PRP	SSP	Mean	PRP	SSP	Mean
Sole oat	24800	25850	25325	42981	42904	42943	18181	17054	17618	0.73	0.66	0.70
Sole chickpea	24550	25600	25075	52293	52505	52399	27743	26905	27324	1.13	1.05	1.09
Sole lentil	23575	24625	24100	52507	51500	52004	28932	26875	27904	1.23	1.09	1.16
Oat + chickpea (1:1)	24988	26038	25513	58387	55742	57065	33399	29704	31552	1034	1.14	1.24
Oat + lentil (1:1)	24800	25550	25175	62249	56221	59235	37449	30671	34060	1.51	1.20	1.36
Oat + chickpea (2:1)	24925	25975	25450	56740	56655	56698	31815	30680	31248	1.28	1.18	1.23
Oat + lentil (2:1)	24600	25650	25125	56140	54404	55272	31540	28754	30147	1.28	1.12	1.20
Mean	24605	25613		54471	52847		29866	27235		1.21	1.06	

PRP = Purulia Rock Phosphate (20 % P_2O_5); SSP = Single Super Phosphate (16 % P_2O_5)

Among the legumes, lentil had greater residual benefits than that of chickpea. The results showed beneficial effect on legumes either sole or intercropping system on improving the productivity of succeeding crop. This might be due to better restoration of soil fertility that enhanced the productivity of the succeeding crop. Similar differential response by different legumes is also studied by other worker[10]. The results also revealed that application of Purulia Rock Phosphate exerted significantly higher residual effect on increasing yield of green gram (667 kg/ha) than that of single super phosphate (555 kg/ha) during both the years as well as pooled analysis. This might be due to the differential nature in solubility of the two sources of phosphorus. SSP, being water soluble in nature, sparingly supplied phosphate to the soil immediately after application and most of them got fixed by the iron and aluminum ions present in the acid soil. Thus it provide very little phosphate to the next crop; whereas, PRP, being insoluble in nature, slowly dissolute and supplied phosphate for a long time and left greater amount of phosphate to be utilized by the succeeding crops[11,12]. The third crop, rice under folder oat + pulse – green gram – rice cropping sequence, showed by poor residual effect on its productivity. The maximum grain yield of rice (3.4 and 3.55 t/ha respectively) was recorded from the plots where oat + lentil (1:1) intercropping was done in the previous winter season under the above cropping sequence. The results corroborate the findings of another worker[13]. The different sources of phosphorus did not show much residual effect on improving the grain yield of rice in any of the two years.

Effect on soil fertility status

Studies on NPK status of the soil in fodder oat + pulses – green gram – rice cropping system showed an increase in nitrogen, phosphorus and potassium content after the harvest of each crop against the initial status (Table 3). Further increase in NPK status legumes and oat + legumes intercropping suggested the beneficial role of the legumes in improvement of the soil fertility. Earlier some workers also noticed an increase in nitrogen content in soil after growing legumes and legumes + non- legumes than that on non legumes alone[14]. It was found that P status was improved in soil after harvesting of intercropping pearl millet[15]. Similarly, while working on alley cropping of Gliricidia with maize, a scientist obtained increased exchangeable K status of the soil along with N and P. Some depletion of nitrogen and phosphorus was observed for successive crop removal and as such the values decreased from first crop to third crop so far nitrogen and phosphorus status of the soil was concerned[16]. The general manuring of nitrogen in rice could not be treated in soil after the harvest of rice due its high mobility and leaching along with usual crop removal. However, oat + lentil at 1:1 ratio maintained comparatively higher N and P in soil. Regarding phosphorus some PRP left greater residual value of available phosphorus (28.4 and 31.9 kg P/ha) in the soil for the next crop than that of SSP after harvesting of oat + pulses during both the years. This might be due to differential nature of solubility of PRP and SSP. Purulia rock phosphate being insoluble in nature released available phosphate slowly into the soil through a longer period due to gradual dissolution in acid soil[11,12].

Economics

The perusal of the data (Table 4) clearly indicated that intercropping system of fodder oat + pulses followed by green gram and rice yielded more net return and benefit / cost ratio than sole oat – green gram – rice cropping sequence. Among the intercropping systems, oat + lentil (1:1) followed by green gram rice gave the maximum net return (Rs. 34060/- per ha) and benefit / cost ratio (1.36) than that of other systems. Contribution of lentil either in sole cropping or in intercropping with the fodder oat might be due to higher price of lentil than click pea. Earlier some workers also showed higher benefits in legume + non- legume intercropping than sole non- legumes[17]. Use of PRP gave higher net return and B/C ratio than that pf SSP due to its low cost and higher residual effect on succeeding crops. Some worker also reported comparatively higher economic return by rock phosphate than SSP in rice, wheat and rice – wheat cropping systems[18,19]. Oat + lentil (1:1) intercropping systems are with Purulia rock phosphate followed by green gram rice was found more economical (B/C ratio of 1.51) in the lateritic belt of West Bengal, India.

CONCLUSION

From the above study it may be concluded that the fodder oat can be profitably cultivated with lentil in 1:1 row ratio. Use of Purulia rock phosphate had some additional advantages in enhancing productivity, maintaining soil fertility and stability under the crop sequence of forage + pulse – green gram rice in the lateritic belt.

REFERENCES

1. Tripathi SN and Gill AS. Intercropping of Oat with forage legumes. Indian Journal of Agricultural Research 1991; 25(4): 227-230.
2. Kouame C, Hoefs S, Powell JM, Roxas D and Renard C. Intercrop Stylosanthes effects on millet yields and animal performance in the sahel. Proceeding of the joint feed Resources Network Workshop. Addis Ababa (Ethiopia). ILCA; 1992. p. 137-146.
3. Maity S and Mukherjee AK. Productivity, profitability and fertility building Grassland Management and Research in Nort-East India Ed. Chakrobarty T, Palli Siksha Bhavana (Institure of Agriculture), Visva Bharati University; 1998. p. 214-222.
4. Mathews RP and John AL. Phosphate rock for direct application in rice soils of Kerala. Proc. National Seminar on Rock Phosphate in Agriculture held at Tamil Nadu; 1985. 1986.
5. Medhi DN, Baroova SR, Sharma AC and Deka Medhi B. Residual effect of integrated phosphorus management of rice on wheat. Annals of Agricultural Research 1995; 16(4): 515-517.
6. Bado VB and Hieen V. Agronomic efficiency of natural rock phosphate of Burkina Faso, in uyp land rice on Okisols. Cachiers d'Etedus *et.* De. Researchers Francophones Agricultures 1998; **7**(3): 236–238.
7. Yadav GL and Sharma BL. Effect of intercropping and mixing of Cowpea (*Vigna unguiculata*) with pearlmillet (*Pennisetum glancum*) on germ forage yield. Indian Journal of Argonomy 1995; 40(3): 497-498.
8. Chakraborty T and Mandal S. Compatibility of grasses and legumes in controlled pasture under lateritic soil of West Bengal. GEOBIOS 1999; 26(2-3): 111-114.
9. Sharma KK and Sharmah NN. Effect of planting geometry on productivity and economic feasibility of food-forage intercropping systems under rain fed condition in Assam. Annals of Agricultural Research 1995; 16(1): 70-73.
10. Bandopadhyay SK. Measurement of symbiotic nitrogen fixation by legumes in sorghum (*Sorghum bicolor*) + legume intercrops. Indian Journal of Agronomy 1992; 37(1): 211-213.
11. Biswas DR and Narayanasamy G. Direct and residual effectiveness of partially acidulated phosphate rocks as P fertilizer in a Cowpea – wheat cropping sequence. Journal of Indian Society of Soil Science 1998; 46(3): 406 – 412.
12. Ghosal PK, Chakroborty T, Bhattacharya B and Bagchi DK. Effect of different sources of phosphorus on rice productivity and balance sheet of phosphorus in lateritic soil of Chotanagpur Plateau region. Proceedings of National Symposium Frontiers of Forage and Grassland Management Research in North East India; 2001. p. 90 -92.
13. Singh RK, Kumar NY, Roy Barman KN and Roy AC. Intercropping in Areca gardens in North Bengal. Indian Farming 1982; 32(9): 13 -16.
14. Hazra CR and Tripathi SB. Effect of S fertilization on some selected forage crops for yield and quality. Proceeding in Diamond Jubilee Seminar Journal of Indian Society of Soil Science. New Delhi; 1994. p. 421-423.
15. Hazra CR and Behari P. Effect of legume intercropping in rain fed pearlmillet on forage yield, micro climate and soil fertility. Range Management and Agroforestry 1993; 14(2): 125-130.
16. Visco RG. Effect of *Gliricidia sepium* hedge row number and pruning frequency on soil physical properties and maize (Zea mays. L), performance in an alley cropping system. Manual, College of Longman (Philipines); 1994. p. 120.
17. Chatterjee BN, Mukherjee AK, Bhattacharya KK and Mandal SR. Feasibility of growing forage crops in sequence with two other arable crops. Forage Research 1978; 4(1): 61-65.
18. Bhandari P. Use of rock phosphate as fertilizer – Effect of phosphate carries on rice – mung cropping sequence and availability of P_2O_5 in soil. M.Sc. (Ag) Agronomy. Thesis. Palli Siksha Sadana (College of Agriculture), Visva-Bharati, Sriniketan; 1980.
19. Chattyopadhyay SD. Studies on the nature of solubility of Purulia Rock Phosphate and is effect on mung-wheat cropping sequence. Ph.D. thesis (Agronomy), Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati; 1985.

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