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Effect of green-manure *dhaincha (Sesbania aculeata)* and phosphorus on growth, yield and phosphorus uptake by wheat (*Triticum aestivum*)

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ABSTRACT

An experiment conducted during the winter season of 1994–95 and 1995–96 showed that phosphorus application to green-manure crop of *dhaincha* (*Sesbania aculeata*) improved the growth and yield of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) and P uptake. However, the yield attributes, dry-matter production and available N and P in soil were affected more conspicuously when P applied to green-manure crop at sowing than at burying and as a consequence, increased the grain yield. Green-manuring with 30 kg P_2O_5/ha at sowing followed by 60 kg P_2O_5/ha to wheat resulted in maximum net return of the sequence.

Key words : Green-manuring, *Sesbania aculeata*, Wheat, P uptake

Phosphorus-use efficiency is very poor in wheat crop. Inclusion of legume green manure is beneficial in mobilizing native P as well as P from applied fertilizer to succeeding crop like wheat (Shinde and Sen, 1958). The present situation of phosphorus-use efficiency in cereals needs to be stepped up, utilising the new products, processes and practives. Keeping these points in view, the present investigation was planned with an objective to study the effect of *dhaincha* or prickly sesban with and without phosphorus application on growth, yield of wheat and P uptake.

MATERIALS AND METHODS

The field experiment was conducted during the winter (*rabi*) season of 1994–95 and 1995–96 at Indian Agricultural Research Institute, New Delhi. The green-manuring (*dhaincha*) treatments consisting of fallow, green-manuring alone, green-manuring supplied with 30 kg P_2O_5/ha at the time of sowing and green-manuring supplied with 30 kg P_2O_5/ha at the time of burying (50 days after sowing) were laid out in randomized block design during rainy (*kharif*) season. These treatments were allotted in main plots in succeeding

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'Kundan' wheat with 3 levels of phosphorus (0, 30 and 60 kg P_2O_5/ha) in subplot treatments, in split-plot design. The soil was sandy loam with low inorganic carbon and available nitrogen content. The available phosphorus soil had low with high amount of exchangeable potassium. It had available N 62 kg/ha, available P 13.6 kg/ha, available K 181 kg/ha, pH 7.5, E.C.D. 32 and CEC 10.20 meq/100 g. The green-manure crop was incorporated into the soil 60 days after sowing. Wheat received uniform dose of N and K @ 60 kgN and 40 kg K_2O/ha through urea and muriate of potash respectively. Phosphorus through single superphosphate was supplied to green-manure crop and wheat as treatment. The experiment was laid out in 3 replications.

RESULTS AND DISCUSSION

Soil-nutrient status after green-manuring

Soil receiving green-manure along with P @ 30 kg P_2O_5/ha at the time of sowing showed maximum available N and P after green-manuring (Table 1). A significant increase in the available soil N could be due to maineralization of organic nitrogen content in the green-manure biomass which was turned into the soil. The higher available N and P by green-manuring might be due to higher biomass production as well as higher uptake of nutrients as a result of P application to green-manure crop. Moreover, a higher availability of soil P may be on account of systematic utilization of applied P at the time of sowing of the crop. The organic P of plant has better availability on the decomposition. This is the reason of additional mobilization of soil phosphorus where 30 kg P_2O_5/ha was added to the green-manure crop at the time of sowing.

Dry matter of wheat

Dry-matter production of wheat was significantly influenced by preceding

Table 1. Effect of green-manuring on available soil nitrogen and phosphorus after green-manuring and dry-matter production of succeeding wheat crop (average data of 2 years)

Treatment	Available N (kg/ha)	Available P (kg/ha)	Dry-matter accumulation (g/m^2)		
			45 DAS	90 DAS	Harvest
Green-manuring					
Fallow	164.8	13.7	149.1	525.6	1,026.5
Green-manure (GM) without P	221.5	17.8	157.4	560.3	1,070.6
GM + 30 kg P_2O_5/ha at sowing	231.5	20.1	172.9	615.8	1,182.0
GM + 30 kg P_2O_5/ha at burying time	223.5	19.5	165.5	589.1	1,131.2
CD (P=0.05)	20.9	1.6	9.6	33.5	58.3
Phosphorus (kg P_2O_5/ha) to wheat					
0			141.3	404.6	961.7
30			165.0	588.1	1,129.2
60			177.5	631.9	1,213.0
CD (P = 0.05)			8.6	32.1	55.0

green-manure crops. Green-manure crop supplied with 30 kg P_2O_5/ha at sowing resulted in highest dry matter of wheat at all the stages. Direct application of P to wheat also had significant effect on dry-matter production. Application of 60 kg P_2O_5/ha to wheat gave the maximum dry-matter yield at all the stages and it was significantly higher than that received with 30 kg P_2O_5/ha (Table 1). Higher dry-matter production of wheat crop can be attributed to the increased number of tillers. Further, combined use of green-manure and P improved the availabiltiy of applied P as well as reserved pool of soil P for succeeding crop which in turn gave the higher dry-matter production.

Yield attributes and yield

Green-manure crop supplied with 30 kg P_2O_5/ha at sowing or at burying time increased the effective tillers/m^2, grains/ear and test weight (Table 2). However, former was statistically superior to latter for grain yield. Green-manure crop supplied with 30 kg P_2O_5/ha at sowing registered the maximum grain yield and 23.1, 8.6 and 4.8% higher over no green-manuring, green-manuring without P and green-manuring with P application (30 kg P_2O_5/ha) at burying time respectively. The levels of P in wheat also had significant impact on grain yield. Direct application of 60 kg P_2O_5/ha to wheat recorded significantly highest grain yield, which was 28.5 and 8.4% higher over the control and 30 kg P_2O_5/ha respectively.

The comparative increased vigour and growth of green-manure crop due to P application at sowing during rainy season (*kharif*) led to better soil fertility and thus gave boost to yield attributes which in turn resulted increased grain yield. The biological dinitrogen coupled with more available P in soil affected positively the growth and yield of the succeeding wheat

Table 2. Effect of green-manuring on yield attributes, yield, net return and P uptake by wheat (average data of 2 years)

Treatment	Effective tillers/m^2	Grains/ ear	1,000-grain weight (g)	Yield (q/ha)	P uptake (kg/ha)	Net return (Rs/ha)	Benefit: cost ratio
Green-manuring							
Fallow	260.3	32.4	48.6	41.1	14.8	15,413	2.00
Green-manure (GM) without P	269.0	34.2	50.4	46.6	16.7	15,253	1.45
GM + 30 kg P_2O_5/ha at sowing	275.2	36.0	51.0	50.6	19.3	16,493	149
GM + 30 kg P_2O_5/ha at burying time	274.0	35.0	50.1	48.3	17.8	15,465	1.40
CD (P = 0.05)	8.9	1.3	2.2	1.9	0.8		
Phosphorus (kg P_2O_5/ha) to wheat							
0	262.0	32.0	48.0	40.3	15.0	13,233	1.43
30	271.0	35.0	51.0	47.8	17.4	16,206	1.64
60	277.0	36.3	51.4	51.8	19.0	17,529	1.68
CD (P = 0.05)	7.3	1.1	1.8	1.6	0.7		

crop. These findings are in agreement with those of Dahama and Sinha (1985). The encouragement of early vegetative growth due to P application resulted in production of more number of effective tillers/m^2, grains/ear and test weight. This favourable effect of P application could be explained as less competition for the available metabolites in the grain due to relatively decreasing number of grains/ear at increasing level of phosphorus. The results corroborate the findings of Patil *et al.* (1991).

Phosphorus uptake

Green-manure crop supplied with P significantly influenced the P uptake by wheat (Table 2). Green-manure crop supplied with 30 kg P_2O_5/ha at sowing registered significantly highest P uptake, which was 30.4, 15.6 and 8.4% higher over fallow, green-manuring only and green-manuring with 30 kg P_2O_5/ha at burying time respectively. The same pattern was witnessed in the case of levels of phosphorus application. Highest P uptake was found under 60 kg P_2O_5/ha and it was significantly higher than the control and 30 kg P_2O_5/ha (Table 2). The increment was 26.7 and 9.2% over the control and 30 kg P_2O_5/ha respectively. These findings are in agreement with those of Jaggi and Minhas (1989). Green-manuring and application of 30 kg P_2O_5/ha at sowing, followed by 60 kg P_2O_5/ha in wheat was the best for affecting the P uptake by wheat.

Economics

Mean net return and benefit : cost ratio, were maximum due to the green-manuring and 30 kg P_2O_5/ha at sowing.(Table 2). The mean net return owing to 30 and 60 kg P_2O_5/ha over the control was of Rs 2,973 and Rs 4,296/ha respectively. Increase in P application from 30 to 60 kg/ha resulted, low additional return with benefit : cost ratio of 1.68.

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