Indian Journal of Agronomy **51** (2) : 97–99 (June 2006)

Direct and residual effects of organic and inorganic sources of nutrients under urdbean *(Vigna mungo)*–wheat *(Triticum aestivum)* cropping sequence in foot-hills of Uttaranchal

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Received : June 2005

ABSTRACT

A field experiment was conducted during 2002–03 to 2003–04 at Pantnagar, to study the direct and residual effects of organic and inorganic sources of nutrients under urdbean [*Vigna mungo* (L.) Hepper]–wheat *(Triticum aestivum* L. emend. Fiori & Paol.) cropping sequence. Plant height in urdbean varied significantly with the application of farmyard manure @ 5 tonnes/ha and phosphorus @ 40 kg P_2O_5/ha over their respective control. Farmyard manure @ 5 tonnes/ha also resulted in significantly higher number of pods/plant, grain and biological yields than no-farmyard manure application. However 20 and 40 kg P_2O_5/ha,being at par, recorded significantly higher grain yield than the control. Yield attributes, yield and harvest index in wheat were not influenced by improved because the residual effect of farmyard manure and phosphorus applied to urdbean, whereas 75 and 100% of recommended level, being at par, resulted in significantly higher values of yield attributes and yield compared to 50% of recommended level. On economic point of view, 75% of recommended fertilizer level resulted in the highest net return and also gave at par wheat-grain-equivalent yield to 100% of recommended level. Total nutrient uptake of the system and soil-nutrient status after urdbean–wheat sequence also increased significantly because of the direct and residual sources of nurients.

Key words : Direct effect, Net returns, Nutrient status, Residual effect, Urdbean, Wheat

Inclusion of legumes in crop sequence increases the soil fertility and consequently the productivity of succeeding cereal crops. Farmyard manure (FYM) although not useful as a sole source of nutrients, is however a good complementary and supplementary source with mineral fertilizers (Chaudhary *et al.,* 2004). Phosphorus is the second most critical plant nutrient over all, but for pulses it assumes primary importance owing to its important role in root proliferation and thereby atmospheric nitrogen fixation. The management of farmyard manure and phosphorus is considered for cropping system as a whole rather than for individual crop because they cannot be fully utilized by the crop to which these are added and a substantial amount is left into the soil for subsequent crops and their residual effects thus become an important dimension for their management (Ali and Mishra, 2000). As information on these aspects is lacking in urdbean–wheat crop sequence, the present investigation was carried out in foothills of Uttaranchal.

MATERIALS AND METHODS

The experiment was conducted at Crop Research Centre of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttaranchal), during the rainy *(kharif)* and winter *(rabi)* seasons of 2002–2004. The soil was sandy loam with 7.2 pH, low in available N (186.4 kg/ha) and medium in organic carbon (0.64%), available P (15.6 kg/ha) and available K (236.9 kg/ha). The treatments comprised 2 levels of farmyard manure (0 and 5 tonnes/ha) and 3 levels of phosphorus (0, 20 and 40 kg P_2O_5/ha) applied to urdbean and 3 levels of fertilizer (50, 75 and 100% of recommended dose (RD), i.e. 150 kg N + 60 kg P_2O_5+60 kg K_2O/ha) applied to wheat. The experiment was laid out in split–plot design and replicated 4 times. The site was same for 2 years. Well-decomposed farmyard manure having 0.42, 0.21 and 0.43% of total N, P_2O_5 and K_2O, respectively, was applied about 1 week before sowing of urdbean as per treatment during both the years. 'PU 35' urdbean was sown in the second week of August and 'HD 2687' wheat was sown in the second and third week of December during both the years. Seed rate used for urdbean and wheat was 15 and 100 kg/ha with a row spacing of 30 and 22.5 cm respectively. Rainfall during the crop periods of rainy and

winter season was 581.4, 192.6 and 1,048.8, 36.0 mm during 2002–03 and 2003–04 respectively.

RESULTS AND DISCUSSION

Effect on urdbean

Growth: Application of farmyard manure @ 5 tonnes/ha significantly increased plant height at maturity compared to without farmyard manure. Improvement was mainly owing to the fact that farmyard manure application would help in conversion of unavailable nutrients to available form through increased microbial activity and enabled the crop to remove plant nutrients in high quantity resulting in better growth and more dry-matter accumulation.

Phosphorus 40 kg/ha being at par with 20 kg P_2O_5/ha, resulted in significantly more plant height than the control. This might be owing to important role of phosphorus in better root proliferation and nodule development which ultimately led to better growth of plants (Ali and Mishra, 2000).

Yield: Farmyard manure @ 5 tonnes/ha resulted in significantly higher grain and biological yields than the control. Higher yields might be owing to better growth and metabolism of carbohydrates which readily translocated to the reproductive parts under farmyard manure application. Similar results were also reported by Yadav *et al.* (2003).

Phosphorus levels of 20 and 40 kg P_2O_5/ha,being at par, recorded significantly higher grain yield than the control. Biological yield did not vary significantly due to phosphorus application. These results are in conformity with those of Singh (2004).

Table 1. Effect of farmyard manure and phosphorus on growth and yield of urdbean (pooled mean of 2 years)

Treatment	Plant height (cm)	Pods/ plant	Yield (q/ha)	
			Grain	Biological
FYM (tonnes/ha)				
0	60.3	34.9	13.66	35.77
5	64.5	39.1	14.93	38.86
CD (P=0.05)	4.1	4.0	0.87	3.02
Phosphorus (kg P_2O_5/ha)				
0	59.3	35.3	13.56	35.57
20	63.5	36.8	14.52	37.77
40	63.9	38.9	14.84	38.03
CD (P=0.05)	4.5	NS	0.95	NS

Effect on wheat

Yield attributes: The data on pooled mean basis revealed that yield attributes, farmyard manure and phosphorus application to previour crop of urdbean with the exception of (Table 2). However, a level of 100% being at par with 75% of recommended level of fertilizers to wheat resulted significantly higher values of all attributes than 50% or recommended level.

Yield: Grain and biological yields and harvest index did not differed markedly due to residual effect of farmyard manure and phosphorus applied in urdbean. Shrivastava *et al.* (2003) also reported similar results.

A level of 75% being at par with 100% of recorded significantly higher grain and biological yields than that of 50% RDF. Maximum harvest index was observed with 75% of recommended NPK. The increase in yields with NPK could be attributed to improvement in growth, yield attributes and ultimately the yield.

Table 2. Yield attributes and yield of wheat as influenced by farmyard manure and phosphorus applied to urdbean and fertilizer levels applied to wheat (pooled mean of 2 years)

Treatment	Spikes/ m	Spike length (cm)	Grains/ spike	1,000-grain weight	Grain yield (q/ha)	Biological yield (q/ha)	Harvest index
Farmyard manure (tonnes/ha)							
0	98.3	9.76	40.08	40.76	36.75	97.06	0.379
5	102.3	9.80	40.34	40.87	37.15	98.95	0.383
CD (P=0.05)	1.7	NS	NS	NS	NS	NS	NS
Phosphorus (kg P_2O_5/ha)							
0	98.8	9.74	39.61	40.63	36.29	96.35	0.380
20	100.0	9.78	40.33	40.69	36.95	98.68	0.380
40	102.0	9.82	40.69	41.12	37.65	99.02	0.383
CD (P=0.05)	2.1	NS	NS	NS	NS	NS	NS
Fertilizer to wheat (% of recommended dose)							
50	97.1	9.64	38.52	39.47	34.48	93.25	0.374
75	101.7	9.81	40.87	41.33	38.09	99.98	0.385
100	102.6	10.08	41.24	41.63	38.29	100.83	0.384
CD (P=0.05)	1.0	0.39	0.77	0.69	1.36	3.02	NS

Table 3. System productivity, net returns, total nutrient uptake and soil-nutrient status under urdbean–wheat cropping sequence (pooled mean of 2 years)

Treatment	Wheat-grain-equivalent yield (q/ha)	Net return (Rs/ha)	Total nutrient uptake (kg/ha)			Available soil nutrients (kg/ha)		
			N	P	K	N	P	K
Farmyard manure (tonnes/ha)								
0	65.44	34,296	150.3	34.1	146.0	180.1	15.6	231.3
5	68.86	34,851	166.8	38.5	156.7	196.8	17.1	238.0
CD (P=0.05)	3.01		8.8	2.7	9.3	4.6	0.3	6.4
Phosphorus (kg P_2O_5/ha)								
0	64.77	33,089	151.4	34.3	144.2	180.4	15.9	229.0
20	67.94	35,091	158.1	36.8	153.9	185.9	16.5	235.3
40	68.81	35,540	165.8	38.2	157.0	199.1	16.6	238.8
CD (P=0.05)	3.12		10.1	3.1	11.3	5.7	0.4	7.8
Fertilizer to wheat (% of recommended dose)								
50	64.51	33,400	147.8	33.8	140.6	182.4	15.3	227.5
75	68.12	35,503	161.7	37.4	155.5	187.5	16.6	236.3
100	68.32	34.817	165.7	42.1	158.3	190.0	17.1	239.4
CD (P=0.05)	2.53		7.6	5.3	8.4	3.5	0.3	3.9
Initial values						186.4	15.6	236.9

System analysis

Maximum wheat-grain-equivalent yield was recorded with farmyard manure @ 5 tonnes/ha and it was significantly higher than that obtained under no-farmyard manure treatment (Table 3). This treatment also gave higher net return than the control. Phosphorus @ 20 and 40 kg P_2O_5/ha, being at par, resulted in significantly higher wheat-grain-equivalent yield over the control. Highest net return was recorded with 40 kg P_2O_5/ha. Wheat fertilized with 75% recommended level of NPK which was at par with 100% significantly increased the system productivity in terms of wheat-grain-equivalent yield 50% of recommended level. Net returns were also highest under this treatment.

Total nutrient uptake under urdbean–wheat cropping sequence revealed that farmyard manure @ 5 tonnes/ha significantly increased the total N, P and K uptake in comparison to control (Table 3). Phosphorus levels of 20 and 40 kg P_2O_5/ha, being at par, resulted in significantly higher total uptake of N, P and K over the control. The probable reason for this increase was that farmyard manure applied to urdbean, upon decomposition, might have improved nutrient availability in soil and thus benefited the wheat. Secondly, higher yield levels obtained with farmyard manure and phosphorus application than the control also resulted to more uptake of nutrients from soil. Highest uptake of N, P and K was observed under 100% of which was statistically at par with 75% but significantly higher than 50% of RD. Higher uptake at maximum fertility level might be due to more nutrient content and yields which extract more nutrients from soil.

Application of 5 tonnes/ha farmyard manure increased the available N, P and K status of soil significantly than the control. Similarly, application of 40 kg P_2O_5/ha also improved available nutrient status after 2 cycles of urdbean–wheat corpping sequence. The recommended level of fertilizer to wheat also improved the nutrient status of soil. The data showed only slight improvement in nutrient status after wheat as compared to initial values which might be due to the fact that legume in a legume–wheat cropping system improved the nutrient status of soil and wheat lowered it. These results are in close conformity with Shrivastava *et al.* (2003).

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