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Effect of row spacing and farmyard manure with increasing levels of nitrogen, phosphorus and potassium on yield and nutrients uptake in rice(*Oryza sativa*)–wheat (*Triticum aestivum*) cropping sequence*

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To obtain the maximum yield/unit area through continuous technological advancement, viz intensive cropping, greater use of chemical fertilizers and adopting appropriate plant-protection measures, many cropping sequences have been tested in the different parts of the country. The information on the collective influence of chemical fertilizers, farmyard manure and row spacing in rice (*Oryza sativa* L.)–wheat (*Triticum aestivum* L. emend. Fiori & Paol.) sequence on Inceptisol of Jammu province is rather poorly understood and scanty. Therefore an attempt was made to study the effect of different variables, viz chemical fertilizers, farmyard manure and row spacing on crop yield and nutrients uptake in rice–wheat sequence.

A field experiment with rice–wheat sequence on an Inceptisol soil was conducted during 1995–96 and 1996–97. The experimental site had *p*H 7.1, electrical conductivity 0.38 dS/m, organic carbon 0.52 % and available N, P and K 268, 12 and 135 kg/ha respectively. The experiment was laid out in split-plot design with 12 treatments and 4 replications. There were 4 main plots which were further subdivided into 3 subplots. The spacing and manure levels were kept in main plots and graded levels of NPK in subplots. The recommended doses of N, P and K for rice and wheat were 120, 26.40 and 33.20 kg/ha and 120, 26.40 and 24.90 kg/ha respectively. The NPK doses were supplied through urea, single super-phosphate and muriate of potash respectively. The crops were sown at 2 spacings of 20 cm × 15 cm and 15 cm ×15 cm. Grain yield was recorded plot-wise. Plant samples (grain and straw) from each plot were analysed for total NPK by using standard methods (Jackson 1965).

Grain yields of rice and wheat increased significantly with the increasing levels of NPK up to an additional 25% over the recommended doses (Table 1). Further increase in fertilizers dose decreased the grain yield of both the crops. The increase in grain yield may be attributed to the increased vegetative growth and higher availability of nutrients at grand growth period, more synthesis of carbohydrates and their translocation (Muthuswamy *et al.* 1990 , Minhas and Sood 1994). Superimposition of the farmyard manure over the inorganic fertilizers had a significant effect on the crop yields of rice and wheat,being 4.92 and 7.05% higher compared with the treatment without farmyard manure. Bhandari *et al.* (1992) and Kumar and Yadav (1995) also reported improvement in yield owing to farmyard manure application. Spacing also had significant positive influence on the grain yield of wheat crop. Closer spacing enhanced the productivity of wheat by 5.67% over the wider spacing. Closer spacing helped in increasing the crop yield owing to the development of intensive rooting system and higher utilization of water and nutrients uptake by crops from a larger volume of soil compared with the normal spacing (Reddy *et al.* 1987). However, spacing could not affect grain yield of rice.

Total uptake of NPK by rice and wheat increased significantly due to 25% higher doses over recommended doses of NPK (Table 1). The increase in the uptake of nutrients with the increasing doses of NPK may owing to better availability of these nutrients because of added supply and prolific root system developed by the balanced nutrients applications, resulting in better absorption of water and nutrients. These findings are in agreement with those of Brar *et al.* (1995). The effect of farmyard manure was beneficial in enhancing the uptake of NPK by both the crops compared with no farmyard manure. The increase in uptake of NPK due to farmyard manure application is probably owing to improvement in soil environment, which encouraged the proliferation of roots thereby facilitating more withdrawal of water and nutrients from larger area and greater depth. Moreover, farmyard manure after decomposition releases these nutrients, which become available to the plants and thus increase the uptake of nutrients. The effect of spacing on the uptake of NPK was significant in wheat crop. Closer spacing increased the uptake of NPK by wheat crop over wider spacing. It may be due to higher yield obtained under the

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Table 1 Grain yield and nutrient uptake as influenced by graded levels of fertilizers, farmyard manure and row spacing in rice–wheat cropping sequence (mean data of 2 years)

Treament	Rice				Wheat			
	Grain yield (tonnes/ha)	Nutrient uptake (kg/ha)			Grain yield (tonnes/ha)	Nutrient uptake (kg/ha)		
		N	P	K		N	P	K
*Fertilizers (NPK %)**								
100	5.749	106.5	16.30	116.0	3.595	89.5	10.5	77.2
125	6.151	111.5	18.10	123.0	3.990	97.7	12.5	85.4
150	6.144	107.5	17.30	117.0	4.010	96.5	12.4	82.5
CD (P=0.05)	0.207	5.0	1.10	6.2	0.135	5.5	1.1	5.!
FYM (tonnes/ha)								
0	5.863	106.0	16.1	118.0	3.733	95.8	11.5	75.5
5	6.152	110.5	18.5	125.0	3.996	100.2	12.8	86.2
CD(P=0.05)	0.169	3.5	0.5	4.0	0.112	4.0	1.2	8.5
Row spacing (cm × cm)								
20 × 15	5.975	108.7	16.4	121.0	3.757	91.3	11.6	78.2
15 × 15	6.041	108.5	17.5	123.0	3.970	98.5	12.5	85.8
CD(P=0.05)	NS	NS	NS	NS	0.116	5.2	0.8	4.5

* 100% represents the recommended dose of NPK; FYM, farymard manure

Table 2 Balance sheet of N, P and K in rice–wheat cropping system

Treatment	N (kg/ha)			P (kg/ha)			K (kg/ha)		
	Added	Removal	Balance	Added	Removal	Balance	Added	Removal	Balance
NPK (%)									
100	240	196.0	+44.0	120	26.80	+93.20	70.0	183.2	−123.2
125	300	208.7	+91.3	150	30.12	+119.85	87.5	208.4	−126.9
150	360	204.0	+156.0	180	29.70	+150.30	105	199.5	−94.5
FYM (tonnes/ha)									
0	300	201.8	+98.6	150	27.60	+122.40	87.5	193.5	−106.0
5	370	210.7	+159.3	163	31.30	+131.70	169.5	211.2	−41.7
Row spacing (cm × cm)									
20 × 15	300	200.0	+100.0	150	28.30	+122.00	87.5	199.2	−111.7
15 × 15	300	207.0	+93.0	150	30.00	+120.00	87.5	288.0	−141.3

treatment of closer spacing.

The increasing doses of NPK resulted positive balance of N and P. The values were 44.0, 91.3 and 156; and 93.2, 119.8 and 150.3 kg/ha at 100, 125 and 150% N,P and K/ha respectively (Table 2). There is ample evidence to show that three-fourths of the applied P is not utilized by the crop, which leaves a positive balance of P in the soil (Minhas and Sood 1994). Application of nutrients to soil for a particular crop would depend on losses due to leaching, volatilization, fixation and residual effect of nutrients applied to preceding crops. The net negative balance of K was 123.2 and 126.9 kg/ha at 100 and 125% NPK respectively. It decreased 294.5 kg/ha at 150% NPK/ha. This clearly shows the positive effect of the higher NPK doses on the nutrient balance in soil. A negative balance of K in soil occurred due to its luxury consumption from soil reserves.

The positive balance of N was 98.2 kg/ha without application of farmyard manure, but it improved to 159.3 kg/ha with 5 tonnes/ha farmyard manure application. In case of P also there was a positive balance of 122.4 kg/ha in the soil without application of farmyard manure but it also improved to 131.7 kg/ha with 5 tonnes/ha farmyard manure application. The farmyard manure application decreased the negative balance of K from 106 to 41.7 kg/ha. A negative balance of K under unmanured treatments may be due to their removal by the crops exceeded the quantity added. The build up of P in the soil occurred because only a fraction of the added P was taken up by the crops and the rest remained in the soil.

Likewise, there was a positive balance of 100 and 93 kg N, 122 and 120 kg P but a negative balance of 111.7 and 121.3 kg/ha K under normal and closer spacing respectively, showing that the nutrients were exhausted to a much more extent under closer spacing than under normal spacing (Minhas and Sood 1994).

SUMMARY

An experiment was conducted with rice (*Oryza stiva* L.)–wheat (*Triticum aestivum* L. emend. Fiori & Paol.). The grain yield of rice and wheat as well as nutrients uptake increased significantly with increasing levels of NPK up to additional 25% over the recommended doses. Farmyard manuare @ 5 tonnes/ha also increased the grain yields of both the crops and nutrients uptake. Closer spacing had significant effect on yield and nutrients uptake in wheat. Nutrient balance sheet of the soil was positive for N and P and negative for K.

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