Indian Journal of Agronomy **58** (1): 15–18 (March 2013)

Research Paper

Influence of preceding crops and nutrient management on productivity of wheat (*Triticum aestivum*)–based cropping system

V.P. USADADIYA[1] AND R.H. PATEL[2]

B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat 388 110

Received: March 2012; Revised accepted : August 2012

ABSTRACT

A field experiment was conducted during 2007-08 and 2008-09 at Anand to study the productivity and soil fertility as affected by preceding crops and nutrient management in wheat [*Triticum aestivum* (L.) emend. Paol & Fiori] based cropping system. The experiment was laid out in a split plot design with three replications, keeping three preceding crops maize [*Zea mays* (L.)], soybean [*Glycine max* (L.) Merr.] and greengram [*Vigna radiata* (L.) Wilczek] in main plots and two levels of vermicompost (0 and 2.0 t/ha vermicompost), two nitrogen levels (60 and 120 kg N/ha) and two levels of phosphorus (0 and 17.6 kg P/ha) in sub-plots. Growing soybean and greengram as the preceding crops resulted significantly higher grain and straw yields of wheat than preceding maize crop. Among the different cropping sequences, maximum system productivity in terms of wheat grain equivalent yield (WGEY) was recorded with soybean–wheat, which was 20.3 and 43.9% higher than that of greengram–wheat (6.85 t/ha) and maize–wheat (5.73 t/ha). Nutrient management in wheat crop produced the highest grain yield (3.60 t/ha), straw yield (5.39 t/ha) and harvest index (39.6%) of wheat under 2.0 t/ha vermicompost, which was 4.9% more over control (3.43 t/ha). Application of 120 kg N/ha and 17.6 kg P/ha were optimum for securing maximum grain yield of wheat (3.67 t/ha) and net returns (₹38,469/ha). Soybean–wheat crop sequence secured maximum net returns, WGEY, production efficiency and land use efficiency, when crop fertilized with 120 kg N and 17.6 kg P/ha.

Key words : Cropping system, Nutrient management, Production efficiency**,** Vermicompost, Wheat grain equivalent yield.

Wheat is one of the most important staple food grain crops cultivated next to rice both in area and production, but it stands first in productivity amongst the cereals. Wheat generally follows rainy season crops *viz.*, paddy, maize, sorghum and pearlmillet, which are highly nutrients exhaustive. Cereal - cereal is the most important cropping system which meets the food pool of the nation. However, the cultivation of cereals in a year on the same piece of land leads to imbalance in the soil fertility, resulting in decline in yield of both the crops. To obtain an optimum yield, use of more and more fertilizers every year affects the soil fertility. Legumes and crop residues assume a special significance in maintaining soil fertility. Exhaustive crops/cropping systems deteriorates the soil health by excessive mining native of fertility leaving hardly any crop residue which is necessary to maintain desire level of organic matter. Therefore, the nature and selection of the preceding crops deserve greater importance, while formulating fertilizer recommendation in crop production.

Integrated use of organic and inorganic fertilizers in different proportions has been found to be quite promising not only in maintaining higher productivity, but also for providing greater stability in crop production (Nambiar and Abrol, 1992). High yielding dwarf varieties of wheat respond not only to heavy doses of nitrogen, but also equally to phosphorus application and give the highest yield when both nitrogen and phosphorus fertilizers are adequately applied. The present study was therefore undertaken to investigate the influence of preceding crops on succeeding wheat crop and nutrient requirement on growth and yield of wheat.

MATERIALS AND METHODS

A field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand during *kharif* and *rabi* seasons of 2007-08 and 2008-09. The soil of experimental site was loamy sand in texture, having pH 7.9, total nitrogen (607.8 kg/ha), medium in available phosphorus (18.3 kg/ha) and high in available

[1]Corresponding author Email: vpusdadia@yahoo.com

[1]Associate Research Scientist (Agronomy); [2]Associate Director of Research

potassium (267.5 kg/ha). The experiment was laid out in a split plot design with 3 replications, keeping three preceding crops (maize, soybean and greengram) in main plots and two levels of bio-organic (0 and 2.0 t/ha vermicompost), two nitrogen levels (60 and 120 kg N/ha) and two levels of phosphorus (0 and 17.6 kg/ha) in subplots. Maize 'GM-6', soybean 'GS-2' and greengram 'GM-4' were sown during the *kharif* season with recommended practices. Preceding crops were sown on 11 June and harvested at the physiological maturity stage. Recommended doses of fertilizer, i.e. 120 kg N + 17.6 kg P (maize), 30 kg N + 26.4 kg P (soybean) and 20 kg N + 17.6 kg P (greengram)/ha were applied through urea and single super phosphate. Half the N and full quantities of phosphorus in maize and full N and phosphorus in soybean and greengram were applied at the time of sowing. The remaining N was top dressed at knee high stage of maize. Wheat 'GW-496' was sown during *rabi* season on 15 November under irrigated condition at the same location. The crop was harvested on 3 March during both the years. Vermicompost which contained 1.6% N, 0.96% P and 0.56% K was applied before sowing of wheat, whereas half the N and full dose of phosphorus as per treatments were applied through urea and single super phosphate at the time of sowing. The remaining N was top dressed in two equal splits, first at crown root initiation and second at spike initiation stage of crop. Harvest index was calculated by using the formula; economic yield divided by biological yield multiplied by 100. The land use efficiency was worked out by total duration of crops in individual crop sequence divided by 365 multiplied by 100 and production efficiency values were obtained by total net returns of a sequence divided by total duration of crop sequence (Tomar and Tiwari, 1990). Wheat grain equivalent yield was worked out by converting the economic yield of maize, soybean and green gram on the basis of marketable price ratio for each crop and wheat and expressed in t/ha.

RESULTS AND DISCUSSION

Effect of preceding kharif crops on wheat

The results revealed that the growth, yield and quality of wheat *viz.*, plant height, effective tillers, grains per spike, test weight, chlorophyll content in leaves and protein content were significantly increased due to preceding soybean crop as compared to maize, but these were at par with preceded greengram crop (Table 1). Likewise, the preceding crop soybean and greengram being at par showed their significant superiority over preceding maize in respect to grain yield of wheat. Infect the preceding legumes played an important role in restoring the soil fertility in terms of N and other biological parameters due to atmospheric N_2 fixation through symbiotic process, which in turn improved the yield of succeeding crop (wheat) compared with that of preceded cereal (maize). These results are closely resembled with those of Kumar *et al.*, (2008). The maximum grain yield (3.69 t/ha) was recorded in the preceded soybean followed by after greengram. The value of harvest index of wheat preceded by soybean crop was significantly highest (40.02%). Considering the economics, the highest net returns/year was recorded in soybean–wheat sequence (49,310/ha) and benefit: cost ratio was also obtained higher (2.35) under the same crop sequence. The next best sequence in terms of economics was greengram–wheat. This may be due to high price fetched to the produce during the experimental period.

Effect of nutrient management on wheat

Application of vermicompost significantly influenced all the growth and yield attributes, chlorophyll content in leaves and protein content in grain (Table 1). The growth parameters like plant height and tillers per plant were observed more under the vermicompost applied treatment than control, while yield attributing characters viz., grains per spike and test weight were also recorded significantly higher under the same level of vermicompost. In case of quality parameters, such as chlorophyll content and protein per cent in grain were obtained significantly higher under the treatment of vermicompost applied @ 2 t/ha. Grain and straw yields of wheat was also noted higher under application of vermicompost. This might be due to rapid decomposition of vermicompost resulting in increased availability and uptake of nutrients during the critical physiological growth stages, of crop thereby more growth and yield attributes. While, net returns and B:C ratio were secured maximum under without application of vermicompost due to higher price of vermicompost. Similar results were also observed by Malik *et al.*, (2009).

Nitrogen levels had significant effect on almost all attributes studied during the course of investigation (Table 1). Application of 120 kg N/ha showed its significant superiority over lower level of nitrogen. It had recorded significantly the higher plant height, number of effective tillers, grains per spike, test weight, chlorophyll content in leaves and protein content in grain and the harvest index as compared to 60 kg N/ha. The application of 120 kg N/ha significantly increased the grain yield of wheat over 60 kg N/ha. The maximum grain yield (3.67 t/ha) and straw yield (5.34 t/ha) were produced in the higher level of nitrogen (120 kg N/ha). The grain yield being the function of cumulative effect of yield attributes, increased significantly by 0.31 t/ha due to additional application of 60 kg N/ha. The increase in yield attributes might be ascribed to supply of nitrogen at higher level, resulting in to increased

photosynthetic activities and translocation of photosynthates, which promoted the growth, better partitioning of photosynthates in yield attributes and eventually produced more yield (Sen *et al.*, 2003).

Application of phosphorus significantly influenced the yields attributes like number of grains per spike and test weight (Table 1). These attributes were noticed higher with the application of phosphorus 17.6 kg P/ha. The increase in the yield attributes might be due to the favourable effect of phosphorus on development and energy transformation in various vitally important metabolic processes in the plant. These corroborate findings of Dewal and Pareek (2004). Application of 17.6 kg P/ha also recorded significantly higher grain yield (3.60 t/ha) and straw yield (5.34 t/ha) of wheat than no application of phosphorus. Among the growth, yield attributes and quality parameters, only grains/spike and test weight recorded significant increase with the application of phosphorus (Table 1). The highest net returns and B:C ratio were obtained with the application of 17.6 kg P/ha.

Interaction

The significant interaction effect of preceding *kharif* crops × nitrogen levels on grain yield of wheat was observed (Table 2). The treatment combination preceding soybean crop with application of nitrogen @ 120 kg N/ha to wheat recorded significantly the highest grain yield of wheat, while, the lowest grain yield of wheat was noted under the treatment combination of preceding *kharif* maize crop with the application of 60 kg N/ha to wheat. Further, it was observed that the treatment combinations preceding *kharif* maize with the application of 120 kg N/ha, preceding *kharif* soybean with the application of 60 kg N/ha and preceding *kharif* greengram with the application of 60 kg N/ha were statistically remained at par in recording the grain yield of wheat. The results reveal that the treatment combinations of soybean or greengram taken as

Table 2. Interaction between preceding *kharif* crops x nitrogen levels in respect of grain yield of wheat (t/ha) and net returns (₹/ha)* (Pooled mean of 2 years)

Preceding *kharif* crops	Nitrogen levels to wheat (kg/ha)	
	60	120
Maize	2.97(10,235)	3.31(12,980)
Soybean	3.33(14,031)	3.92(19,116)
Greengram	3.38(15,544)	3.58(14,843)
SEm± = 0.083, CD (P = 0.05)= 0.238		

* Figures in parenthesis are the net return value (₹/ha)

Table 1. Growth and yield attributes, yield and quality parameters of wheat as influenced by various treatments (Pooled mean of 2 years)

Treatment	Plant height at harvest (cm)	Effective tillers/ meter row length	Grains per spike	Test weight (g)	Total chlorophyll content (mg/g)	Protein content in grain (%)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Net returns (×10³ ₹/ha)	B:C ratio
Preceding crops											
Maize	106.0	110.5	32.9	37.7	1.79	10.25	3.27	4.94	38.88	24.4	*1.66*
Soybean	110.8	119.2	34.9	40.5	1.80	11.45	3.69	5.41	40.02	49.3	*2.35*
Greengram	109.2	117.9	34.3	39.7	1.79	11.15	3.58	5.39	39.27	39.0	*2.14*
SEm±	0.61	1.04	0.23	0.37	0.002	0.09	0.05	0.06	0.18	-	-
CD (P=0.05)	1.98	3.51	0.76	1.07	0.007	0.32	0.16	0.21	0.59	-	-
Nutrient management in wheat crop											
Vermicompost (t/ha)											
0	107.9	115.1	33.7	38.8	1.78	10.75	3.43	5.16	39.21	40.6	*2.26*
2	109.4	116.7	34.4	39.8	1.81	11.15	3.60	5.33	39.57	33.8	*1.84*
SEm±	0.49	0.51	0.20	0.18	0.006	0.12	0.04	0.05	0.35	-	-
CD (P=0.05)	1.39	1.46	0.59	0.52	0.016	0.33	0.14	0.13	NS	-	-
Nitrogen levels (kg/ha)											
60	106.9	114.9	33.8	38.6	1.71	10.60	3.36	5.16	38.70	35.3	*2.03*
120	110.4	116.8	34.4	40.0	1.88	11.25	3.67	5.34	40.08	38.77	*2.07*
SEm±	0.49	0.51	0.20	0.18	0.006	0.12	0.04	0.05	0.35	-	-
CD (P=0.05)	1.39	1.46	0.59	0.52	0.016	0.33	0.14	0.13	1.02	-	-
Phosphorus levels (kg/ha)											
0	108.4	115.2	33.7	38.6	1.79	10.85	3.42	5.15	39.18	37.1	*2.06*
17.6	108.8	116.6	34.5	39.9	1.80	11.00	3.60	5.34	39.60	37.3	*2.04*
SEm±	0.49	0.51	0.20	0.18	0.006	0.12	0.04	0.05	0.35	-	-
CD (P=0.05)	NS	NS	0.59	0.52	NS	NS	0.14	0.13	NS	-	-

Maize grain: ₹10.00/kg, Soybean grain: ₹30.00/kg, Greengram grain : ₹40.00/kg, Wheat grain: ₹10.00/kg, Straw: ₹0.50/kg

Table 3. System productivity, land use efficiency and production efficiency of cropping system (Pooled mean of 2 years)

Crop sequence	Grain yield (t/ha)		WGEY of crop sequence (t/ha)	Land use efficiency (%)	Production efficiency (₹//day/ha)
	Preceding *kharif* crops	Wheat			
Maize–Wheat	3.04	3.27	5.73	54.79	114.0
Soybean–Wheat	1.85	3.69	8.24	57.53	227.7
Greengram–Wheat	1.12	3.60	6.85	52.05	198.3

WGEY–Wheat grain equivalent yield

preceding crop followed by wheat with 60 kg N/ha, instead of maize as preceding crop followed by wheat with 120 kg N/ha could be economized in terms of nitrogen requirement for obtaining equal yield of wheat. Therefore, it showed that 60 kg nitrogen could be economized for growing wheat after legume crop particularly soybean or greengram rather than maize. The favourable effect of legumes has been reported as restorative crops. The preceding legumes added nitrogen in soil through root nodules and residues of roots and leaves *etc.* to benefit the succeeding crop (Singh *et al.*, 2008).

Impact of crop sequences on production efficiency

Among the three crop sequences, soybean–wheat crop sequence produced maximum wheat grain equivalent yield than maize–wheat and greengram–wheat sequences (Table 3). Further, the value of land use efficiency was noticed higher in the soybean–wheat cropping sequence (57.53%) than maize–wheat (54.79%) and greengram–wheat sequence (52.05%). Similarly, soybean–wheat sequence also recorded the higher production efficiency (227.7/day/ha) than rest of two crop sequences (Table 3). This may be due to higher total production in a crop sequence per unit time in a unit area.

Base on two years experimentation and interaction between preceding *kharif* crops and nitrogen, it can be concluded that growing of wheat crop after soybean fertilized with 120 kg N/ha proved to be most economically beneficial by obtaining maximum productivity in crop sequence. Further, it is pertinent to conclude that 60 kg N/ha could be economized for growing of wheat after preceding *kharif* soybean or greengram instead of maize crop. In case of phosphorus and vermicompost applied to wheat, 17.6 kg P/ha and vermicopmost @ 2 t/ha obtained maximum yield of wheat.

REFERENCES

Dewal, G.S. and Pareek, R.G. 2004. Effect of phosphorus, sulphur and zinc on growth, yield and nutrient uptake of wheat. *Indian Journal of Agronomy* **49**(3): 160–62

Kumar, S., Singh, A., Rana, N.S. and Panwar, G.S. 2008. Production potential, profitability and sustainability of different wheat based cropping systems in semi-*rabi* region of Uttarakhand. *Indian Journal of Agricultural Sciences* **78**(3): 248–50

Malik, B.S., Paul, S., Ahlawat, A.K., Singh, A M. and Shivay, Y.S. 2009. Productivity and quality of wheat grown with different fertilization conditions. *Indian Journal of Agronomy* **54**(8): 636–40

Nambiar, K.K.M. and Abrol, I.P. 1992. Long term fertilizer experiment in India–An overview. *Fertilizer News* **34**(4): 11–26

Sen, A., Pandey, M.D., Sharma, S.N. Singh, R.K. Kumar, A., Shukla, P. and Srivastava, V.K. 2003. Surface seeding of wheat as affected by seed rate and nitrogen level. *Indian Journal of Agricultural Sciences* **73(**9): 509–11

Singh, R., Singh, B and Patidar, M. 2008. Effect of preceding crops and nutrient management on production of wheat (*Triticum aestivum*) based cropping system in arid region. *Indian Journal of Agronomy* **53**(4): 267–72

Tomar, S.S. and Tiwari, A.S. 1990. Production potential and economics of different crop sequence. *Indian Journal of Agronomy* **35(**1): 30–35