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Effect of Preceding Crops and Nutrient Management on Growth, Productivity and Quality of Wheat in Irrigated Conditions

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***Abstract* – A field experiment was conducted during 2007-08 and 2008-09 at Anand to study the production potential and economics as influenced by wheat based cropping sequence in middle Gujarat conditions. The experiment was laid out in split plot design with three replications, keeping three preceding crops (Maize, Soybean and Greengram) in main plots and two levels of bio-organic (Control and Vermicompost @ 2.0 t ha^{-1}), two nitrogen levels (50 % N of RD i.e. 60 kg N ha^{-1} and 100 % N of RD i.e. 120 kg N ha^{-1}) and two levels of phosphorus (Control and 40 kg P_20_5 ha^{-1}) in sub-plots. Growing soybean and greengram as the preceding crop resulted significantly higher grain and straw yields of wheat than preceding maize crop. Among the different cropping sequence, the maximum wheat grain equivalent yield (WGEY) was recorded with soybean- wheat being 20.3 and 43.9 % higher than that of greengram - wheat and maize - wheat crop sequence, respectively. Nutrient management in wheat crop produced the highest grain and straw yields of wheat under vermicompost @ 2.0 t ha^{-1}, which was 4.9 % more over control. Application of 100 % N of RD (120 kg N ha^{-1} recorded significantly higher grain yield of wheat and net realization than 50 % recommended N treatment. In case of phosphorus levels the application of 40 kg P_2O_5 ha^{-1} gave remarkably the highest grain yield and net return. Soybean - Wheat crop sequence secured maximum net return, land use efficiency and production efficiency under wheat crop fertilized with 120 kg N and 40 kg P_2O_5 ha^{-1}.**

***Keywords* – Cropping System, Land Use Efficiency, Preceding Crop, Production Efficiency, Vermicompost, Wheat, Wheat Grain Equivalent Yield.**

I. Introduction

Wheat (*Triticum aestivum* L.) is one of the most important staple food grain crops cultivated next to paddy both in area and production, but it stands first in productivity amongst the cereals. Wheat generally follows rainy season crops *viz.*, rice, maize, sorghum and pearl millet, which are highly nutrients exhaustive. 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. 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).

Further cultivation of nutrient exhaustive crops in the sequence without adequate nutrient management led to deterioration in soil health as well as productivity. Under such condition, proper selection of suitable crops in the cropping system and supply of balanced nutrients through appropriate sources can not only meet the nutrient requirement of the crops but also aid in sustaining the soil fertility. Hence the present experiment was made to find out the effect of preceding crops and nutrient management on productivity of wheat crop under irrigated conditions.

II. Materials and Methods

The field experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand during 2007-08 and 2008-09 of *Kharif* and *rabi* seasons. The soil of experimental site was loamy sand in texture, having pH 7.9, low in organic carbon (0.32 %), medium in available phosphorus (42 kg P_2O_5 ha^{-1}) and high in available potassium (321 kg K_2O ha^{-1}). Keeping three preceding crops (Maize, Soybean and Greengram) in main plots and two levels of bio-organic (Control and Vermicompost @ 2.0 t ha^{-1}), two nitrogen levels (50 % N of RD i.e. 60 kg N ha^{-1} and 100 % N of RD i.e. 120 kg N ha^{-1}) and two levels of phosphorus (Control and 40 kg P_20_5 ha^{-1}) in sub-plots. The experiment was laid out in split plot design with three replications, Maize (GM-6), soybean (GS-2) and greengram (GM-4) were sown during the *Kharif* season with recommended practices. Preceding crops were sown in second week of June and harvested at the physiological maturity stage. Recommended doses of fertilizer, i.e. 120 kg N + 40 kg P_2O_5 ha^{-1} in maize, 30 kg N + 60 kg P_2O_5 ha^{-1} in soybean and 20 kg N + 40 kg P_2O_5 ha^{-1} in greengram 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 in second week of November under irrigated condition at the same location. The crop was harvested in first week of March. Vermicompost which contained 1.6 % N, 2.2 % P_2O_5 and 0.67 % K_2O 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. Wheat grain equivalent yield was calculated considering the prevailing market prices of inputs and crop produces. The sustainable yield index was worked out by

III. Results and Discussion

Growth and yield of wheat

The results revealed that the grain yield of wheat was significantly increased due to preceding soybean crop as compared to maize crop, but these were at par with proceeded greengram crop. The grain yield (3694, 3549 and 3622 kg ha^{-1}) and straw yield (5763, 5062 and 5412 kg ha^{-1}) of wheat were remarkably increased under same treatment of preceding crop soybean as compared to maize, except greengram. In fact the crop sequence involving legumes played an important role in restoring the soil fertility in terms of N and other biological parameters due to atmospheric N fixation through symbiotic process, which in turn improved the yield of succeeding crop compared with that of the cereal – cereal crop sequence (Ramesh and Reddy, 2004).

Application of bio-organic (Vermicompost @ 2.0 t ha^{-1}) recorded significantly the higher grain and straw yields of wheat over control. Vermicompost showed better results, because of higher nutrient content. It is known, it improve the physical and biological properties of soil including supply of almost all the essential plant nutrients for growth and development of the plant.

Nitrogen levels had significant effect on almost all attributes studied during the course of investigation. Application of 100 % N of RD (120 kg N ha^{-1}) showed its significant superiority over 50 % N of RD (60 kg N ha^{-1}). It had recorded significantly the highest grain and straw yields of wheat and harvest index were obtained under the application of 120 kg N ha^{-1} over lower level of nitrogen (60 kg N ha^{-1}).

Application of phosphorus significantly influenced the yields of wheat. The grain and straw yield were recorded remarkably higher with the application of phosphorus @ 40 kg P_2O_5 ha^{-1} over control.

Effect of nitrogen

Nitrogen levels had significant effect on grain yield of wheat. Application of 100 % N of recommended dose (120 kg N ha^{-1}) showed its significant superiority over 50 % level of nitrogen. The land use efficiency and production efficiency were also higher in the higher level of nitrogen treatment.

Effect of phosphorus

Application of phosphorus significantly recorded higher grain yield of wheat (3605 kg ha^{-1}) over control. The phosphorus application was not efficiently improve the land use efficiency and production efficiency.

Crop productivity

The wheat grain equivalent yield was significantly increased due to preceding soybean crop as compared to maize crop, but this was at par with greengram. The soybean - wheat crop sequence with 100 % recommended dose of nitrogen (120 kg N ha^{-1}) produced significantly higher WGEY and profitability (Table). This might be due to higher production potential and more price of soybean than other crops tried in sequences. These results corroborate the findings of Patil *et al.,* 1995.

The value of land use efficiency was more in the soybean - wheat cropping sequence with application of 100 % N of RD and 40 kg P_2O_5 ha^{-1} to wheat crop that established its superiority due to higher total production in a crop sequence per unit time in a unit area, while, production efficiency value was also more due to higher price of the crops.

Effect on soil fertility status

The organic carbon content and available phosphorus in soil after harvest of *Kharif* crops as well as after wheat crop were significantly higher under preceding soybean crop (0.39 % and 46.5 kg ha^{-1}) as compared to maize, but it was statistically at par with greengram. This clearly indicated that inclusion of legumes in the sequence, improved the fertility status of available N in soil, while available potash remained unchanged after harvest of preceding crops as well as after wheat crop.

The effect of bio-organic on organic carbon and available phosphorus status were remarkably higher under vermicompost treatment after harvest of second year *Kharif* crops as well as after harvest of wheat due to subsequent decomposition of these materials which enhanced organic carbon content (Khadtare *et al*., 2006). Levels of nitrogen and phosphorus failed to exhibit their significant influence on nutrient status in soil after harvest of preceding crops in second year and after harvest of wheat crop.

Economics

The economics based on crop sequence the maximum net return was obtained Rs. 22994 ha^{-1} under soybean – wheat crop sequence. The wheat crop fertilized with 100 % N of RD and 40 kg P_2O_5 ha^{-1} was recorded the highest cost benefit ratio (2.38) under the same treatment.

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Table 1: Growth, yield and quality parameters of wheat as influenced by various treatments

Treatment	Plant height at harvest (cm)	Effective tillers m^{-1} row length	Grains $spike^{-1}$	Test weight (g)	Total chollophy content in leaves (mg g^{-1})	Protein content in grain (%)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Sustaina-ble yield index	WGEY of cropping system (kg ha^{-1})	Net realization (Rs. ha^{-1})
Preceding crops											
Maize	106.0	110.5	32.9	37.7	1.79	10.25	3145	4935	0.84	5726	18526
Soybean	110.8	119.2	34.9	40.5	1.80	11.45	3622	5412	0.94	8239	22994
Greengram	109.2	117.9	34.3	39.7	1.79	11.15	3481	5393	0.92	6848	21835
CD (P=0.05)	1.98	3.51	0.76	1.07	0.007	0.32	163	211	-	-	-
Nutrient management in wheat crop											
Bio-organic											
No organic	107.9	115.1	33.7	38.8	1.78	10.75	3334	5161	0.81	6884	20259
Vermicompost @ 2.0 t ha^{-1}	109.4	116.7	34.4	39.8	1.81	11.15	3497	5333	0.86	6990	14435
CD (P=0.05)	1.39	1.46	0.59	0.52	0.016	0.33	137	131	-	-	-
Nitrogen levels											
50% recommended N	106.9	114.9	33.8	38.6	1.71	10.60	3260	5156	0.83	6775	18635
100 % recommended N	110.4	116.8	34.4	40.0	1.88	11.25	3571	5338	0.86	7099	21070
CD (P=0.05)	1.393	1.46	0.59	0.52	0.016	0.33	137	131	-	-	-
Phosphorus levels											
0 kg P_2O_5 ha^{-1}	108.4	115.2	33.7	38.6	1.79	10.85	3326	5152	0.83	6861	20174
40 kg P_2O_5 ha^{-1}	108.8	116.6	34.5	39.9	1.80	11.00	3506	5342	0.83	7010	20822
CD (P=0.05)	NS	NS	0.59	0.52	NS	NS	137.3	131	-	-	-

Table 2: Grain yield of wheat as influenced by C x N interaction (Pooled)

Treatments	Grain yield (kg ha^{-1})	
	N_1: 50 % recommended N	N_2 : 100 % recommended N
C_1 : Maize	2975	3315
C_2 : Soybean	3326	3918
C_3 : Greengram	3381	3581
CD (P = 0.05)	238	

Table 3: Effect of Nutrient status in soil after harvest of preceding *Kharif* crops and cropping system

Treatment	Organic carbon (%)		Available phosphorus (kg ha^{-1})		Available potash (kg ha^{-1})	
	2007	2008	2007	2008	2007	2008
Preceding crops (cropping system)						
Maize	0.31	0.34	41.6	42.5	303.9	302.4
Soybean	0.37	0.39	45.6	46.5	308.0	306.5
Greengram	0.36	0.38	43.0	44.0	307.1	305.6
CD (P=0.05)	0.010	0.009	0.776	0.776	NS	NS
Nutrient management in wheat crop						
Bio-organic						
No organic		0.37		44.4		304.4
Vermicompost @ 2.0t ha^{-1}		0.38		44.4		305.2
CD (P=0.05)		0.009		NS		NS
Nitrogen levels						
50% recommended N		0.37		44.2		304.6
100% recommended N		0.37		44.5		305.0
CD (P=0.05)		NS		NS		NS
Phosphorus levels						
0 kg P_2O_5 ha^{-1}		0.37		44.3		304.4
40 kg P_2O_5 ha^{-1}		0.37		44.4		305.2
CD (P=0.05)		NS		NS		NS