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Effect of *kharif* season crops on the nutrients economy and productivity of succeeding wheat crop under middle Gujarat condition

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ABSTRACT

A field experiment was conducted during 2007-08 and 2008-09 at Anand to study the effect of *kharif* season crops, *viz.*, maize (*Zea mays L.*), soybean (*Glycine max* L.) and greengram (*Phaseolus radiatus* L.) and nutrients management on productivity of wheat (*Triticum aestivum* L. Flori & Paol.) - based cropping system in middle Gujarat. Growing soybean and greengram as the preceding crops resulted significantly higher grain and straw yields of wheat than preceding maize crop. Among the different wheat based cropping system 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 cropping system, respectively. Nutrient management in wheat crop produced the highest grain and straw yields of wheat under bio-organic application (vermicompost) @ 2 t ha^{-1}, which was 4.9 % more over control. Application of 100 % recommended N(120 kg ha^{-1}) recorded significantly higher yield of wheat and net realization than 50 % recommended N treatment. In case of phosphorus levels, application of 40 kg P_2O_5 ha^{-1}gave remarkably the highest yields and net return. Wheat grown after soybean secured maximum net return under wheat crop fertilized with 120 kg N and 40 kg P_2O_5 ha^{-1} without bio-organic application.

Key words : *Bio-organic, nitrogen*, phosphorus, nutrients economy, wheat

Wheat generally follows rainy season crops *viz.*, rice, sorghum, pearl millet and maize, which are highly nutrient exhaustive. Nutrient depletion intensity is variable depending upon crop species. Exhaustive crops/cropping system deteriorates the soil health by excessive mining of native fertility leaving hardly any crop residue which is necessary to maintain desired level of organic matter. The impact of lowering down of organic matter in the soil could be seen in the reducing yield level of major cereal based cropping system such as rice-wheat, maize-wheat, sorghum-wheat and pearl millet-wheat.

Growing of legume in cropping system is make a significant contribution to soil nutrient status by augmenting nitrogen and in terms of economics by reducing energy inputs of succeeding crop. Therefore, it is necessary to includes legume in cropping system, which could be beneficial for improve soil fertility and more remunerative in terms of economic profit (Meena and Bhatnagar, 2004). The nature and selection of the preceding crops deserve greater importance, while, formulating fertilizer recommendation in crop production. Wheat after rainy season legumes in general gives higher grain yield than after cereals (Jain and Jain, 1993). The need for inclusion of pulses and oilseeds for sustainable crop production has also recognized now. Therefore, an investigation was carried out to study the effect of *kharif* season crops on the nutrients economy and productivity of succeeding wheat crop.

MATERIALS AND METHODS

The field experiment was conducted at the College Agronomy Farm, Anand Agricultural University, Anand during the rainy seasons of 2007 and 2008 and *rabi* seasons of 2007-08 and 2008-09. The experiment was

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laid out in split plot design with three replications, keeping three *kharif* season crops (Maize, Soybean and Greengram) in main plot and two levels of bio-organic (Control and Vermicompost @ 2.0 t ha^{-1}) and two nitrogen levels (50 % recommended N i.e. 60 kg N ha^{-1} and 100 % recommended N i.e. 120 kg N ha^{-1}) and two levels of phosphorus (Control and 40 kg P_2O_5 ha^{-1}) in sub-plot. 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 ha^{-1}) and high in available potassium (321 kg ha^{-1}).

During the *kharif* season, maize (GM 6), soybean (GS 2) and greengram (GM 4) crops were sown in 2nd week of June at 60, 45 and 30 cm apart in rows, respectively during both the years and harvested at the physiological maturity stage. Recommended doses of fertilizers, *i.e.* 120 kg N + 40 kg P_2O_5 ha^{-1} in maize, 20 kg N + 40 kg P_2O_5 ha^{-1} in soybean and greengram were applied. 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 at 22.5 cm apart on mid of November during *rabi* season and using seed rate of 120 kg ha^{-1} under irrigated condition at the same location and crop harvested on 1st week of March. Vermicompost (contained 1.6 % N, 2.2 % P_2O_5 and 0.67 % K_2O) was applied before sowing of wheat, whereas, half dose of 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 through urea at crown root initiation stage of crop. Wheat grain equivalent yield (WGEY) and economics were calculated considering the prevailing market prices of inputs and crop produces.

RESULTS AND DISCUSSION

Effect on growth and yield of wheat

The results revealed that the growth, yield and quality attributes of wheat *viz.*, plant height, effective tillers, grains per spike, test weight and protein content were significantly increased due to preceding soybean crop as compared to maize, but which was at par with preceded greengram crop. Likewise, grain yield (3622 kg ha^{-1}), straw yield (5412 kg ha^{-1}) and harvest index (40.%) were remarkably increased under same treatment of preceding crop soybean as compared to maize, except greengram. The WGEY was highest in preceding soybean crop. Growing of soybean and greengram as the preceding crops improved

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)	Protein content in grain (%)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	WGEY of cropping system (kg ha^{-1})	Net realization (Rs. ha^{-1})
Kharif crops										
C1: Maize	106.0	110.5	32.9	37.7	10.25	3145	4935	38.88	5726	18526
C2: Soybean	110.8	119.2	34.9	40.5	11.45	3622	5412	40.02	8239	22994
C3: Greengram	109.2	117.9	34.3	39.7	11.15	3481	5393	39.27	6848	21835
CD (P=0.05)	1.98	3.51	0.76	1.07	0.32	163	211	0.59	-	-
Nutrient management in wheat crop										
Vermicompost (t ha-1)										
Vo: 0	107.9	115.1	33.7	38.8	10.75	3334	5161	39.21	6884	20259
V1: 2.0	109.4	116.7	34.4	39.8	11.15	3497	5333	39.57	6990	14435
CD (P=0.05)	1.39	1.46	0.59	0.52	0.33	137	131	NS	-	-
Nitrogen level										
N1: 50 % RD of N	106.9	114.9	33.8	38.6	10.60	3260	5156	38.70	6775	18635
N2: 100 % RD of N	110.4	116.8	34.4	40.0	11.25	3571	5338	40.80	7099	21070
CD (P=0.05)	1.393	1.46	0.59	0.52	0.33	137	131	1.021	-	-
Levels of Phosphorus (kg ha-1)										
P0: 0	108.4	115.2	33.7	38.6	10.85	3326	5152	39.18	6861	20174
P1: 40	108.8	116.6	34.5	39.9	11.00	3506	5342	39.60	7010	20822
CD (P=0.05)	NS	NS	0.59	0.52	NS	137.3	131	NS	-	-

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

Treatment	V_0		V_1	
	N_1	V_2	N_1	V_2
C1	2958	3189	2991	3442
C2	3325	3793	3326	4043
C3	3241	3500	3721	3462
C.D. (P = 0.05)	336			

physicoibiochemical properties of the soil compared with that preceding maize, which in turn improved the yield attributing parameters and yield of the succeeding wheat. These results corroborate with those of Singh *et al.* (2008).

Application of bio-organic significantly influenced the growth, yield and quality parameters of wheat *viz.*, plant height at harvest, number of effective tillers, grains spike^{-1}, test weight, chlorophyll content in leaves and protein content in grain. These attributes were recorded higher under the application of vermicompost @ 2.0 t ha^{-1}. The same treatment also recorded significantly the higher grain and straw yields of wheat were 3497 and 5333 kg ha^{-1}, respectively. The maximum WGEY was recorded under the same treatment. This could be attributed to the supply of higher content of available nutrients, presence of beneficial micro flora which have higher enzyme activity and biologically active metabolites in vermicompost (Malik *et al.*, 2009).

Nitrogen levels had significant effect on almost all attributes studied during the course of investigation. Application of 100 % recommended N showed its significant superiority over 50 % level. It had recorded significantly higher plant height, number of effective tillers, grains spike^{-1}, test weight, chlorophyll content in leaves and protein content in grain as compared to 50 % recommended N. Significantly the highest grain and straw yields of wheat and harvest index were obtained under the application of 100 % N of RD were 3571, 5338 kg ha^{-1} and 40. respectively. The WGEY was also higher under the same treatment. The increase in yield attributes might be ascribed to supply of nitrogen at higher level, ultimately increase in 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 growth and yield attributes like number of grains spike^{-1} and test weight. These attributes were noticed higher with the application of phosphorus @ 40 kg P_2O_5 ha^{-1}. However, no significant response of phosphorus was observed on plant height at harvest. Further, application of phosphorus was not found beneficial in quality parameters. Phosphorus application @ 40 kg P_2O_5 recorded remarkably higher grain and straw yields of wheat were 3506 and 5342 kgha^{-1}, respectively in pooled results. The WGEY also obtained more under the same treatment.

Interaction

In grain yield of wheat, the interaction effect among C x V x N was found significant (Table 2). The treatment combination $C_2V_1N_2$ (*kharif* preceding soybean crop with application of vermicompost, 2.0 t ha^{-1} along with 100 % N of RD) recorded significantly higher grain yield, it remained at par with treatment combinations $C_2V_0N_2$ and $C_3V_1N_1$ on pooled basis. The lowest grain yield was observed in treatment combination of $C_1V_0N_1$. In case of maize - wheat cropping system the highest grain yield was noticed in $C_1V_1N_2$ (*kharif* preceding maize crop with application of 100 % N of RD in combination with vermicompost, 2.0 t ha^{-1}) treatment interaction, which was statistically at par with $C_2V_0N_1$, $C_2V_1N_1$, $C_3V_0N_1$, $C_3V_0N_2$ and $C_3V_1N_2$ combinations. Therefore, it showed that 50 % level of N (60 kg N ha^{-1}) with or without vermicompost application yielded more or less equal wheat grain yield after legumes (soybean or greengram) as compared with 100 % N of RD with vermicompost applied to wheat crop after maize crop. The favourable effect of legumes has been reported as restorative crops. The preceding legumes added nitrogen in soil through root nodules, roots, and leaves etc. to benefit the succeeded crop, it means preceded legumes reduces the fertilizer requirement for succeeding crop and economize the nutrients. The results are in line with findings of Singh *et al.*, (2008)

Effect on economics

Among the different *kharif* crops, soybean crop fetched the highest net realization of Rs. 49310 ha^{-1}. However, preceded greengram crop occupied second position with the net realization of Rs. 37987 ha^{-1}, while, the lowest net realization was obtained under preceded maize crop.

In case of nutrient management in wheat, the maximum net realization was obtained Rs. 40629 ha^{-1} under treatment of without application of bio-organic, due to higher price of vermicompost. Application of 120 kg N ha^{-1} gave the highest net returns of Rs. 38469 ha^{-1}. The highest net realization of Rs. 37318 ha^{-1} was recorded with the application of 40 kg P_2O_5 ha^{-1}.

CONCLUSION

It is concluded that growing of wheat after soybean and fertilized with 120 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} proved to be effective and economically beneficial for attaining maximum sustainable yield of wheat in crop sequence under middle Gujarat conditions.

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