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ORGANIC FARMING IN WHEAT CROP UNDER ARID CONDITION OF PAKISTAN

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Worldwide demand of organic product is increasing; Pakistani farmer's awareness is also increasing towards organic farming due to high cost of synthetic fertilizers and demand of organic food. This study aimed at examining organic farming in wheat (*Triticum aestivum* L.). A wheat cultivar Fareed-2006 was planted on November 20, 2007 at Adoptive Research Farm Karor, Layyah. Organic manures from five different sources viz. green manure (GM), farm yard manure (FYM), poultry litter (PL), press mud (PM) and sewage sludge (SS) each at the rate of 20 ton ha^{-1} were used in the experiment. Seven treatments were established having one control and one with recommended NPK. Recommended NPK gave maximum productive tillers (274.8), number of grains per spike (52.10), biological yield (9.61 ha^{-1}) and economic yield (3.84 t ha^{-1}) while minimum was observed in control. The same treatment (recommended NPK) gave maximum net benefit ($1189.85 ha^{-1}), however in marginal analysis SS at the rate of 20 ton ha^{-1} gave maximum marginal rate (1139.98.20%) of return while recommended NPK gave minimum (225.91%) marginal than organic farming due to high cost of input.
Keywords: Wheat, organic farming, sources of organic manures, economic and marginal analysis

INTRODUCTION

Wheat is the third most produced cereal crop in the world after corn and rice (Wajid, 2004). In Pakistan, wheat is grown on area of 9042 thousand hectares with total production of 23864 thousand tons and an average yield of 2649 kg ha^{-1} (Govt. of Pakistan, 2010). Wheat grains are used in numerous ways in a number of industries for commercial products; it is also source of feed for cattle and poultry.

Organic farming is accurate for integrated production systems and recent increase in the organic farming has created a new market for fertilizers permitted for use in organic farming and when some products are allowed in organic agriculture, commercial opportunities become available (Rodrigues *et al.*, 2006). Organic manure is a key component of the soil and crop yield because it carries out many functions in agro ecosystem (Weil and Magdoff, 2004). Organic outputs are beneficial for the overall health of the agri-environment (Defra, 2002). But organic manure management and storage are major problem in the organic farming (Petric *et al*., 2009).

Organic fertilizers including farmyard, sheep and poultry manures may be used for crop production as a substitute of the chemical fertilizers. Poultry manure may be used as an organic amendment to restore degraded soils (Sanchez-Monedero *et al.,* 2004). The poultry manure is relatively a cheap source of both macro and micronutrients and can increase soil nitrogen, soil porosity and improve soil microbial activity. As poultry waste contains a high concentration of nutrients so addition of small quantity of poultry manure in an integrated nutrient management system could meet the shortage of FYM to some extent (Ghosh *et al.,* 2004). Similarly animal waste and green manures are used to replace nitrogen and other elements and to build up soil organic matter content (Lampkin, 2002). Municipal solid waste compost, farmyard manure and chemical fertilizers are beneficial for wheat growth, soil composition and soil bacterial characteristics under arid climate (Cherifa *at al*., 2009) while progressive accumulation of soil organic matter could increase the risk of soil nitrogen losses (Aronsson and Torstensson, 1998). Similarly press mud can serve as a good source of organic manure (Bokhtiar *et al.,* 2001) however integrated use of press mud and urea 1:1 ratio at 180 kg ha^{-1} is beneficial for crop production (Sharma *et al.*, 2002).

Wheat is one of the cereal crops which is most commonly grown in organic farming systems (Burnett and Rutherglen, 2008). Economic value of certified organic grains have been lashing many transition decisions related to the organic farming (Delate and Camberdella, 2004) while chemical fertilizers consume a large amount of energy and money. However, an organic farming system with or without chemical fertilizers seems to be possible solution for these situations (Prabu *et al.,* 2003). The integration of organic and synthetic sources of nutrients not only supply essential nutrients but also has some optimistic relations leading to increased crop yield and reduced environmental threats (Ahmad *et al.*, 1996).

The aim of present study was to inspect the effect of different organic manures on yield of wheat, to examine the effectiveness of different organic sources and to compare the economic feasibility of organic vs inorganic sources.

MATERIALS AND METHODS

The proposed study was carried out under arid climate at Adaptive Research Farm Karor, Layyah Pakistan. The experiment was laid out in randomized complete block design (RCBD) with three replications having net plot size 6 x 1.5 m. A wheat cultivar Fareed-2006 was sown by hand drill on 20th November, 2007 with seed rate of 130 kg ha^{-1}. In the experiment five organic manures were utilized namely *Sesbenia aculeate* as green manure crop (GM), farm yard manure (FYM), poultry litter (PL), press mud (PM) and sewage sludge (SS) each at the rate of 20 t ha^{-1} (and from this quantity all the organic manures completed recommended NPK). A treatment with recommended fertilizer (NPK at the rate of 160+100+50 kg ha^{-1} respectively) was also included to compare organic farming with inorganic fertilizer. Similarly a control treatment was also maintained without any fertilizer and organic manure. All organic manures were added before sowing the crop while full dose of PK and 1/3 N applied at the time of sowing; remaining N was applied in two splits. Weeds were controlled manually by hoeing and hand pulling. First irrigation was given eighteen days after sowing and succeeding irrigations were applied as per requirement of crop keeping in view the weather conditions. Others agronomic practices were kept same for all treatments. Sample from all organic sources as well as soil samples taken from the experimental field was analyzed for NPK determination (Table 1) in Animal nutrition Lab. University of Agriculture Faisalabad.

Standard procedures were followed to collect data for growth and yield parameters of the experiment. Number of fertile tillers was counted at maturity from randomly selected three sites (m^2) of each experimental unit and average was achieved. For plant height ten plants were selected randomly from each plot at maturity and plant height was measured from base of the tiller to tip of spike with a meter rod and average plant height was calculated**.** Ten mature spikes were chosen at random from each plot and spikes length, spikelets per spike and numbers of grains per spike were recorded and then average was computed. Similarly 1000-grains of every plot were counted by seed counter (108 Count-A-Pak) and weighed. The crop was harvested at maturity and sun dried for few days. Biological yield of the samples in kg was recorded for each plot and reported in t ha^{-1}. These samples were threshed manually to take grain yield. Harvest index (HI) of each plot was determined by using the formula given by Hunt (1978)

HI = (Economic yield/ Biological yield) x 100

Data collected on crop characteristics were computed for analysis of variance technique using statistical package M-Stat C. The differences among the treatments means were compared by using the least significant difference (LSD) test at 5% probability level (Steel *et al*., 1997). Similarly economic analysis and marginal rate of return were performed on the basis of cost that varied in different treatments by following the procedure devised by Byerlee (1988).

Table 1. Chemical analysis of experimental soil and organic manures

	Nitrogen (%)	Phosphorus	Potassium
Soil	0.04	6.81ppm	221.0ppm
PL	2.06	2.06%	1.84%
FYM	0.88	0.27%	0.5%
SS	3.60	2.00%	0.34%
PM	0.73	1.26%	0.72%

FYM= Farm yard manure, PL= Poultry litter, PM= Press mud and SS= Sewage sludge

RESULTS AND DISCUSSION

Present explorations were carried out to find out effect of different organic manures on wheat growth and yield. Application of NPK at the rate of 160+100+50 kg ha^{-1} showed maximum plant height (98.50 cm) due to immediate availability of nutrients from inorganic fertilizer and minimum plant height (68.81 cm) was recorded in control it was due to less availability of nutrients for plants (Table 2). Similarly all organic manures also had variable extent of increase in plant height as compared with control. Channabasanagowda *et al*. (2008) conducted a field experiment and used inorganic and organic fertilizer and recorded 86.20 cm plant height. Data concerning to productive tillers per unit area showed that effect of different organic manures was statistically same however maximum productive tillers (274.8) were recorded where NPK at the rate of 160+100+50 kg ha^{-1} was applied and minimum (192.0) was observed in control.

In wheat crop number of grains per spike is an important character for determining yield and it is greatly influence by crop nutrients. The data (Table 2) showed that recommended NPK at the rate of 160+100+50 kg ha^{-1} gave maximum number of grains per spike (52.10) and in control treatment minimum grains per spike (27.26) was recorded. Different organic manures illustrated variable number of grains per spike. The 1000 grain weight play significant role in economic yield. Maximum 1000-grain weight (37.65 g) was

Table 2. Effect of different organic manures on growth and yield components of wheat

Treatment	Plant height (cm)	Productive tillers (m^{-2})	Number of grain per spike	1000-grain weight (g)	Total biomass (t ha^{-1})	Grain yield (t ha^{-1})	Harvest index (%)
T_1	68.81 g	192.0 c	27.26 g	24.80 g	4.67 f	1.12 g	23.89 f
T_2	75.38 f	226.0 b	32.67 f	29.17 f	6.19 e	1.71 f	27.62 e
T_3	98.50 a	274.8 a	52.10 a	36.61 b	9.61 a	3.84 a	40.10 a
T_4	87.87 d	230.0 b	42.62 d	32.80 d	7.27 c	2.53 d	34.72 c
T_5	92.56 c	238.3 b	48.09 b	37.65 a	9.15 b	3.44 b	37.65 b
T_6	81.19 e	220.8 b	37.54 e	31.78 e	6.96 d	2.30 e	32.96 d
T_7	95.31 b	245.5 b	45.99 c	34.83 c	8.97 b	3.11 c	34.75 c
LSD (5%)	2.34	27.64	0.73	0.41	0.25	0.0005	1.07
EMS	2.49	346.12	0.24	0.077	0.028	0.0001	0.52

Means not sharing the same letters in a column differ significantly at 5% probability.
T_1 = control, T_2 = Green manure crop, T_3 = NPK recommended, T_4 = Farm yard manure, T_5 = Poultry litter, T_6 =Sewage sludge and T_7 =Press mud each at the rate of 20 t ha^{-1}, LSD= least significant difference, EMS= error mean square

obtained where PL at the rate of 20 ton ha^{-1} (T_5) was used and minimum 1000-grain weight (24.80 g) was recorded in control (Table 2). The results of present study support the findings of Channabasanagowda *et al.* (2008). Crop plants produced biological yield by utilizing available resources. Data showed significant increase in biological yield per hectare as a result of application of different organic manures. However maximum biological yield (9.61 t ha^{-1}) was produced with the application of NPK at the rate of 160+100+50 kg ha^{-1} while minimum biological yield (4.67 ton ha^{-1}) was obtained in control (Table 2). These results are corroborating with those of Rees and Castle (2002).

Grain yield is the outcome of collective contribution of different yield components, which was affected by various growing conditions and crop managing practices. Statistical analysis of the data illustrated that different organic manures had significant effect on grain yield of the wheat crop due to different concentration of NPK in organic manures shown in Table 1. While maximum grain yield (3.84 t ha^{-1}) was found with the application of NPK at the rate of 160+100+50 kg ha^{-1}. This was attributed to more productive tillers, plant height and number of grains per spike in this treatment. Minimum grain yield (1.12 t ha^{-1}) was obtained from control in which there was no application of synthetic and organic fertilizer. All other organic manures significantly affected crop yield (Table 2). Karki, (2006) found 3.89 t ha^{-1} grain yield of wheat by using organic manure and compost. Data regarding harvest index showed significant differences among the treatments (Table 2). Maximum harvest index (40.10 %) was examined in T_3 where recommended NPK at the rate 160+100+50 kg $ha^{-1}$was applied. This treatment performed better in all yield components as compared to all other treatments while minimum harvest index (23.89 %) was observed in control.

ECONOMIC AND MARGINAL ANALYSIS

The effectiveness of any production is ultimately estimated on the basis of its economic returns. Economic analysis was the basic consideration in determining treatment that gave highest net returns while marginal analysis was calculating the minor rates of return of alternative treatments, proceeding in steps from the least costly treatment to the most costly and deciding if they were acceptable to farmers (Byerlee, 1988). Economic analysis of the data (Table 3) showed that higher net benefit ($ 1189.85 ha^{-1}) was obtained with the application recommended NPK at the rate of 160+100+50 kg ha^{-1} (T_3). It was followed by the net benefit ($ 1092.28 ha^{-1}) where PL at the rate of 20 t ha^{-1} was applied. Minimum net benefit ($ 394.13 ha^{-1}) was recorded in control. Marginal analysis showed different result as compared to economic analysis (Table 4). In marginal analysis, application of SS at the rate of 20 t ha^{-1} (T_6) was at top with 1139.98% marginal rate of return due to less cost of input while NPK at the rate 160+100+50 kg ha^{-1} gave minimum (225.91%) marginal rate of return due to high cost of out put. Sarwar *et al.* (2008) conducted a field experiment by using organic manures at the rate of 12 t ha^{-1} along with fertilizer. They reported that higher yield and more income were obtained from organic farming.

Table 3. Economic analysis of wheat grain yield

	T_1	T_2	T_3	T_4	T_5	T_6	T_7	Remarks
Total grain yield	1120	1710	3840	2530	3440	2300	3110	kg ha^{-1}
Adjusted yield	1008	1539	3456	2277	3096	2070	2799	To bring at farmer's level (10% decrease)
Gross income	394.13	601.75	1351.30	890.31	1210.54	809.37	1094.41	$.10.30/40 kg
Cost of GM	-	30	-	-	-	-	-	Cost of seed, irrigation and mixing of crop($)
Cost of NPK	-	-	161.45	-	-	-	-	Price of four bags of urea & four bags of DAP
Cost of FYM	-	-	-	82.38	-	-	-	Price of 20 tone FYM +transport expenses (T.E)
Cost of PL	-	-	-	-	118.26			Price of 20 tone PL + T.E
Cost of PM	-	-	-	-		65.9		Price of ten tone PM + T.E
Cost of SS	-	-	-	-	-	-	98.84	Labor charges and T.E
Cost that vary	-	30	161.45	82.38	118.26	65.9	98.84	$. ha^{-1}
Net benefits	394.13	571.75	1189.85	807.93	1092.28	743.47	995.57	$. ha^{-1}

All prices of input and output were considered at the year of April 2007 in Pakistan

Table 4. Marginal analysis of wheat grain yield

Treatments	Cost that vary	Net benefits ($)	Change in cost	Change in net benefit	Marginal rate of return (%)
Control (T_1)	0	394.13	-	-	-
GM (T_2)	30	571.75	30	177.62	592.07
PM at the rate of 20 t ha^{-1} (T_7)	65.90	743.47	35.9	171.72	478.33
FYM at the rate of 20 t ha^{-1} (T_4)	82.38	807.93	16.48	64.46	391.14
SS at the rate of 20 t ha^{-1} (T_6)	98.84	995.57	16.46	187.64	1139.98
PL at the rate of 20 t ha^{-1} (T_5)	161.45	1092.28	19.42	96.71	497.99
NPK Recommended (T_3)	161.45	1189.85	43.19	97.57	225.91

Variable cost = The cost of inputs, labor and machinery ha^{-1} that vary between the experimental treatments.
Net benefit = Gross income-variable cost.
Marginal Rate of Return (%) = (Change in net benefit / Change in cost) x 100

CONCLUSION

Effect of different organic manures was clearly observed on which in the study, application of fertilizer and manure had a significant effect on grain yields in view of the fact that, manures used in the study had different percentage of nutrients. Result illustrated that recommended NPK gave higher yield than all other organic manures due to quick availability of nutrients to plant at all stages. Inorganic farming gave high net benefit however it gave less marginal rate of return than organic farming due to high cost of input. Among the organic manures SS at the rate of 20 t ha^{-1} gave high marginal rate of return as compared to all other manures.

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