ORGANIC AND INORGANIC FERTILIZERS INCREASE WHEAT YIELD COMPONENTS AND BIOMASS UNDER RAINFED CONDITION

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ABSTRACT

The aim of this study was to determine whether modification to currently recommended inorganic fertilizers application (NPK) in combination with organic fertilizers in the form of farmyard manure (FYM) can improve wheat yield components and biomass under rainfed condition. Field trials were conducted during 2003-04 and 2004-05 under rainfed conditions at Cereal Crops Research Institute Pirsabaq, NWFP, Pakistan. Nine different combinations of NPK (control, 40-30-30, 40-30-60, 40-60-30, 40-60-60, 80-30-30, 80-30-60, 80-60-30 and 80-60-60 kg ha^{-1} and four different levels of FYM (control, 15, 30 and 45 t ha^{-1}) using a wheat variety (Haider-2000) were studied. Experiment was laid out in randomized complete block (RCB) design with split plot arrangement replicated four times. FYM was allotted to main plots while combinations of NPK were applied to subplots. Different levels of NPK and FYM alone or in combination had significant effect on emergence m^{-2}, spikes m^{-2}, grains $spike^{-1}$, biological yield (kg ha^{-1}) and thousand grain weight. Maximum emergence m^{-2} (83.5), grains $spike^{-1}$ (55.8) thousand grain weight (35.16) and biological yield (10008 kg ha^{-1}) were recorded at 80-60-60 NPK ha^{-1}. Maximum spikes m^{-2} (201.6) were recorded at 80-60-30 kg NPK ha^{-1}. Farmyard manure at 45 t ha^{-1} produce the maximum spikes m^{-2} (191.2), grains $spike^{-1}$ (54.4), thousand grain weight (34.69) and biological yield (10000 kg ha^{-1}), while no significance difference was recorded for these parameters between 30 and 45 t FYM ha^{-1}. It is concluded that 80-60-60 kg NPK ha^{-1} and 30 t FYM ha^{-1} have produced maximum wheat yield components and biomass under rainfed condition.

Key Words: FYM, NPK, biomass, wheat

INTRODUCTION

Nearly one fifth of the total wheat acreage in Pakistan is under rainfed, which contributes about 10-12 % of the total wheat production of the country (Rashid *et al.*, 2003). In NWFP wheat is planted on 57 to 60 % of the total wheat growing area under rainfed land with an average yield of 900-1200 kg ha^{-1} (MINFAL, 2005).

Optimal crop growth requires a non-limiting supply of resources such as water and nutrient (Reynolds *et al.* 1998; Midmore *et al.* 1984). The favorable effects of inorganic fertilizers (NPK) under rainfed and irrigated conditions on crop development and yield components have been reported by Iqtidar *et al.* (2006), Mossedaq and Smith (1994), Ayoub *et al.* (1994), Alvarez *et al.* (2004), Hossain *et al.* (2002), Lloveras *et al.* (2001) and Brown and Petrie (2006).

The application of farmyard manure (FYM) to soil has been practiced for many centuries, and its application to soil have increased crop yield, improved soil fertility, increased soil organic matter, increased microbiological activities and improved soil structure for sustainable agriculture for further years (Blair *et al.* 2005; Kundu *et al.* 2006). However, the proper combination of both organic and inorganic fertilizers have better effects on crop growth and development and yield component of wheat than alone (Budaruddin *et al.* 1999; Hossain *et al.* 2002; Manna *et al.* 2005).

The objectives of this study were to assess wheat yield components and biomass through optimum organic and inorganic fertilizers application under rainfed condition.

MATERIALS AND METHODS

Field experiment was conducted at Cereal Crops Research Institute, Pirsabak, Nowshera, Pakistan during the years 2003-04 and 2004-05. Experiment was laid out in randomized complete block design with split plots arrangements replicated four times. Farmyard manure was allotted to main plots, while combinations of NPK were applied to sub-plots. Sources of NPK were urea, SSP, and murate of potash respectively. Four levels of FYM (0, 15, 30, 45 tons ha^{-1}) and nine combinations of NPK (0-0-0, 40-30-30, 40-30-60, 40-60-30, 40-60-60, 80-30-30, 80-30-60, 80-60-30 and 80-60-60 kg ha^{-1}) were studied. Seed of improved wheat variety Haider-2000, recommended for rainfed areas in NWFP was planted on November 18, 2003 and November 20, 2004. A uniform seed rate of 100 kg ha^{-1-} was used for the whole experiment. The size of subplot was 5 m by 1.8 m having 6 rows 5 m long and 0.3 m apart. All the nitrogen, phosphorous, potassium and FYM were applied one day before sowing and mixed with soil. Weeds were controlled manually. The crops were harvested on May 19, 2004 and May 20, 2005 during both years of experiments. Data were recorded on emergence m^{-2}, spikes m^{-2} grains $spike^{-1}$, thousand

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grain weight and biological yield. Emergence m^{-2} was recorded after the completion of germination. Number of plants in one meter long row at four different places were counted in four central rows one week after germination in each sub plot and converted into number of plants m^{-2}. Similarly spikes in one meter long row at four different places were counted in four central rows in each subplot after anthesis and converted into number of spikes m^{-2}. Number of grains $spike^{-1}$ data was recorded by counting the number of grains of ten randomly selected spikes from each sub plot in four central rows and converted into number of grains $spike^{-1}$. Thousand grains were counted from the grains of the four central rows in each subplot and weighed with the help of a sensitive electronic balance to record thousand grain weight. In order to determine biological yield, four central rows in each subplot were harvested, air dried, weighed and converted into kg ha^{-1}.

RESULTS AND DISCUSSION

Emergence m^{-2}

NPK levels and years significantly affected emergence m^{-2}. Maximum emergence m^{-2} (86.7) was recorded in 2004-05 compared with 76.2 plants emerged m^{-2} in 2003-04 (Table I). Combinations of NPK significantly increased emergence m^{-2} as compared to control plots. The two years average data showed that significant difference for emergence m^{-2} was also recorded among different levels of NPK combinations. With the increase in NPK combinations, emergence m^{-2} increased significantly and reached to the maximum (83.5) at the highest level of 80-60-60 kg NPK ha^{-1} while minimum emergence m^{-2} (79.3) was recorded from control plots (Table I).

Linear increase in emergence m^{-2} was observed with the increase in NPK combinations however, no significant difference was recorded between 80-60-60 kg NPK ha^{-1} and 80-60-30 kg NPK ha^{-1}. Individual effect of N, P and K (contrasts given at the bottom of table) showed that emergence m^{-2} increased linearly with the increase in N, P and K levels. The result of increased emergence m^{-2} with different levels of NPK are in agreement with Iqtidar *et al.* (2006) and Ayoub *et al.* (1994), who reported significant increase in emergence m^{-2} of wheat with an increase in N level combined with P and K. They also recorded maximum emergence m^{-2} at 150 to 200, 55 to 67 and 67 kg NPK ha^{-1}, respectively.

FYM showed non significant effect on emergence m^{-2}. Control plots and plots that received various levels of FYM produced similar number of plants m^{-2}. These results are in agreement with the findings of Matsi *et al.* (2003) and Badaruddin *et al.* (1999) who reported no significant increase in number of plants m^{-2} with the use of organic fertilizers (40 t ha^{-1} liquid dairy cattle manure and 10 t FYM ha^{-1}).

Spikes m^{-2}

Analysis of the data showed that Spikes m^{-2} was significantly affected by years, FYM and NPK (Table II). Maximum spikes m^{-2} (195.8) was recorded in 2004-05 while minimum spikes m^{-2} (175.8) was recorded in 2003-04. Spike m^{-2} was significantly increased with all levels of NPK than control plots however, there was no significant difference in spikes m^{-2} between 80-60-60 kg NPK ha^{-1} and 80-60-30 kg NPK ha^{-1}. Maximum spikes m^{-2} (201.6) were recorded in plots which received 80-60-30 kg NPK ha^{-1} while minimum spikes m^{-2} (163.9) were recorded in control plots. Increase in N, P and K levels also showed increase in spikes m^{-2}. Significant increase in spikes m^{-2} with the application of different levels of N, NP and NPK combinations was also reported by Iqtidar *et al.* (2006), Mossedaq and Smith (1994), Ayoub *et al.* (1994), Frederick and Camberato (1995) and Lloveras *et al.* (2001). They concluded that nitrogen fertilization increased spike density at harvest because of increased tillering.

Levels of FYM also significantly increased spikes m^{-2} than control plots. Maximum spikes m^{-2} (191.2) were recorded in plots which received the highest level of 45 t FYM ha^{-1} while minimum spikes m^{-2} (175.5) were recorded in control plots (Fig-1). However, no significant difference was recorded among the different levels of FYM. The favorable effect of organic and inorganic fertilizers on spikes m^{-2} was reported by Metho *et al.* (1997) and Badaruddin *et al.* (1999). Their results showed significant increase in spikes m^{-2} of wheat by using 100-70-50 kg NPK ha^{-1} with 15 t FYM ha^{-1} and 200-50-0 kg NPK ha^{-1} with 10 t FYM ha^{-1}. They concluded that the increase in spikes m^{-2} was due to increased soil fertility under organic and inorganic fertilizer.

Grains $Spike^{-1}$

Grains $spike^{-1}$ of wheat as affected by the levels of FYM, N, P and K in the two growing seasons are given in Table III. Years, NPK, FYM and FYM x NPK significantly affected grains $spike^{-1}$. Maximum grains $spike^{-1}$ (55.1) was recorded in 2004-05 while minimum grains $spike^{-1}$ (52.1) was recorded in 2003-04. Grains $spike^{-1}$ were significantly increased with each increment of NPK and maximum grains $spike^{-1}$ (55.8) were recorded in plots which received the highest level of 80-60-60 kg NPK ha^{-1} while minimum grains $spike^{-1}$ (50.2) were recorded in

control plots. Linear increase in grains spike^{-1} was observed with increase in NPK combinations. Increase in individual levels of N, P and K have also increased grains spike^{-1}. Our results agree with the findings of Iqtidar *et al.* (2006), Lloveras *et al.* (2001), Frederick and Camberato (1995), Ayoub *et al.* (1994) and Mossedaq and Smith (1994). Their results also showed that an increase in N levels have increased grains spike^{-1}. They concluded that application of nitrogen fertilizers to wheat promote tillers production and survival and number of kernel per head. Application of N has been found to delay leaf senescence, sustain leaf photosynthesis during the grain filling period and extend the duration of grainfill. FYM significantly increased grains spike^{-1} and maximum grains spike^{-1} (54.4) were recorded at highest level of 45 t FYM ha^{-1} while minimum grains spike^{-1} (52.4) were recorded in control plots (Fig-2). Interaction of FYM and NPK showed that maximum number of grain spike^{-1} (56.8) were recorded in plots which received 45 t FYM ha^{-1} and 80-60-60 kg NPK ha^{-1}, while minimum grains spike^{-1} (48.8) were recorded from control. Our results showed that combination of organic and inorganic fertilizers produced maximum grains spike^{-1}. These results are in agreement with (Metho *et al.* 1997; Hossain *et al.* 2002).

Thousand Grain Weight

Years, NPK and FYM significantly affected thousand grain weight. Maximum thousand grain weight (34.81 g) was recorded in 2004-05 while minimum thousand grain weight (33.54 g) was recoded in 2003-04 (Table IV). Two years average showed that thousand grain weight significantly increased with application of NPK as compared to control plots. Thousand grain weight increased with increase in NPK levels and maximum thousand grain weight (35.16 g) was recorded in plots which received 80-60-60 kg NPK ha^{-1}. Lowest thousand grain weight (32.22 g) was recorded in control. No significant difference was recorded for thousand grain weight between 80-60-60 kg NPK ha^{-1}, 80-60-30 kg NPK ha^{-1}, 80-30-60 kg NPK ha^{-1} and 80-30-30 kg NPK ha^{-1}. Our results are confirmed by the findings of Brown and Petrie (2006), Iqtidar *et al.* (2006), Lloveras *et al.* (2001), Frederick and Camberato (1995) and Ayoub *et al.* (1994). They also reported increase in thousand grain weight with different NP, NPK combinations and increase in N level. They concluded that higher N rates with suitable amount of moisture extended the leaf area duration, duration of photosynthates production during grain fill and finely increased individual kernel weight. FYM also significantly increased thousand grain weight. Maximum thousand grain weight (34.69 g) was recorded in plots which received 45 t FYM ha^{-1} while minimum thousand grain weight (33.69 g) was recorded in control plots (Fig-3). No significant difference was recorded among control, 15 and 30 t FYM ha^{-1} for thousand grain weight. Increase in thousand grain weight with the use of organic and inorganic fertilizers was also reported by Hossain *et al.* (2002) and Metho *et al.* (1997). Favorable effect of organic and inorganic fertilizers on thousand grain weight may be due to the increased availability of plant nutrients, improvement of soil water holding capacity and reduction of volatization of nitrogenous fertilizers to NH_3 gas (Sattar and Gaur 1989; Gill and Meelu 1982; Tran-Thuc-Son *et al.* 1995; Badaruddin *et al.* 1994).

Biological Yield

Statistical analysis of the data showed that years, FYM, NPK and FYM x NPK significantly affected biological yield. Maximum biological yield (10165 kg ha^{-1}) was recorded in 2004-05 while minimum biological yield (9170 kg ha^{-1}) was recorded in 2003-04 (Table V). Minimum biological yield (8813 kg ha^{-1}) was recorded in control plots. Biological yield increased as the NPK levels increased and maximum biological yield (10008 kg ha^{-1}) was recorded in plots which received 80-60-60 kg NPK ha^{-1}. Increase in N, P and K levels also increased biological yield. These results are in line with the findings of Iqtidar *et al.* (2006), Alvarez *et al.* (2004), Melaj *et al.* (2003), Mossedaq and Smith (1994) and Badaruddin *et al.* (1999). They reported increase in biological yield due to different NP, NPK combinations and N levels. Significant increase in biological yield with different levels of FYM was recorded and maximum biological yield (10000 kg ha^{-1}) was recorded at the highest level of 45 t FYM ha^{-1} while minimum biological yield (9272 kg ha^{-1}) was recorded in control plots (Fig-4). Increased biological yield in manure treated plots were attributed to the enhanced soil fertility and improved soil physical conditions (Matsi *et al.* 2003). Similarly interaction of FYM and NPK showed that maximum biological yield of (10340 kg ha^{-1}) was noted in plots where 45 t FYM ha^{-1} and 80-60-60 kg NPK ha^{-1} were used, while the minimum biological yield of (8468 kg ha^{-1}) was recorded in plots where no NPK and FYM were applied. Similar results were reported by Matsi *et al.* (2003) and Badaruddin *et al.* (1994). They reported that organic and inorganic fertilizers in combinations (120-60-40-20 kg NPKS ha^{-1} with 10 t FYM ha^{-1}) or alone (120-26 kg NP ha^{-1}, 40 t ha^{-1} of cattle manure or 30 t ha^{-1} cattle slurry) have significantly increased wheat biological yield due to the improved soil physical conditions, enhanced soil fertility and improved stand establishment.

CONCLUSION AND RECOMMENDATIONS

It is concluded that a combination of 80-60-60 kg NPK ha^{-1} and 30 t FYM ha^{-1} is recommended to get maximum wheat yield components and biomass under rainfed condition.

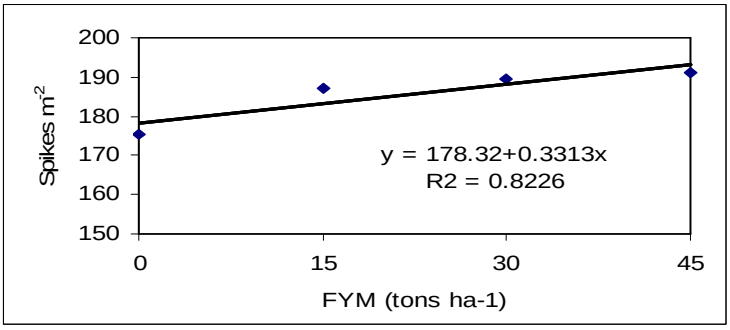

Fig-1 Spikes m^{-2} of wheat as affected by different levels of FYM. Means represent average across years and NPK levels. LSD value for FYM at $P \leq 0.05$ (average for years) = 8.904

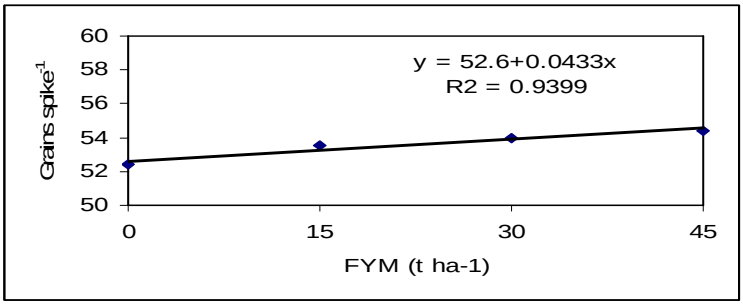

Fig-2 Grains $spike^{-1}$ of wheat as affected by different levels of FYM. Means represent average across years and NPK levels. LSD value for FYM at $P \leq 0.05$ (average for years) = 0.8122

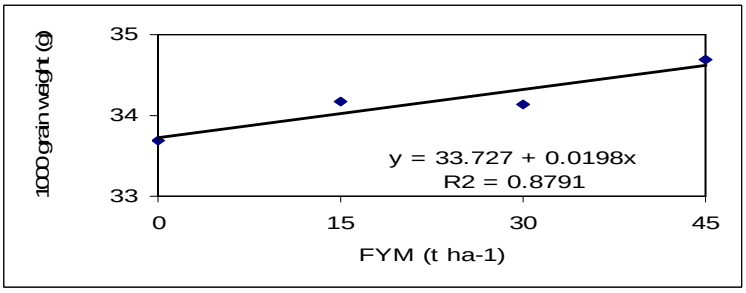

Fig-3 Thousand grain weight (g) of wheat as affected by different levels of FYM. Means represent average across years and NPK levels. LSD value for FYM at $P \leq 0.05$ (average for years) = 0.649

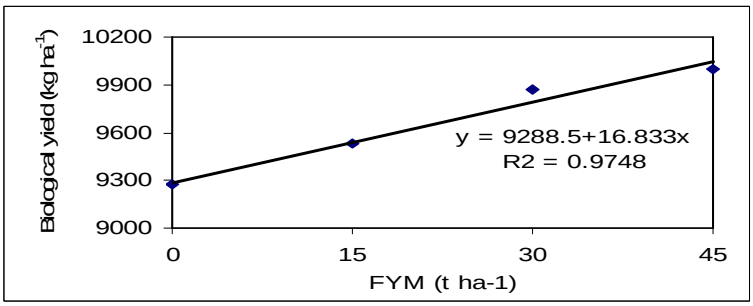

Fig-4 Biological yield (kg ha^{-1}) of wheat as affected by different levels of FYM. Means represent average across years and NPK levels. LSD value for FYM at $P \leq 0.05$ (average for years) = 280.5

Table I ***Emergence m^{-2} of wheat as affected by FYM and NPK levels during two growing seasons***

NPK (kg ha^{-1})	FYM (tons ha^{-1})				Mean
	0	15	30	45	
		Year 2003-04			
0-0-0	73.5	72.0	72.5	72.5	72.6
40-30-30	74.3	74.0	74.5	73.5	74.1
40-30-60	75.8	74.8	75.0	74.8	75.1
40-60-30	75.8	75.8	76.3	76.0	75.9
40-60-60	76.8	76.5	76.5	76.8	76.6
80-30-30	77.0	76.5	77.5	77.5	77.1
80-30-60	77.0	77.8	78.0	78.0	77.7
80-60-30	78.0	77.8	78.3	78.5	78.1
80-60-60	78.5	79.0	78.5	78.0	78.5
Mean	76.3	76.0	76.3	76.2	76.2b
		Year 2004-05			
0-0-0	86.0	86.0	86.0	86.0	86.0
40-30-30	86.0	86.0	86.0	86.0	86.0
40-30-60	85.8	84.8	85.0	84.8	85.1
40-60-30	85.8	85.8	86.3	86.0	85.9
40-60-60	86.8	86.3	86.5	87.0	86.6
80-30-30	87.3	86.8	87.5	87.5	87.3
80-30-60	87.8	87.8	88.3	88.3	88.0
80-60-30	88.3	88.0	88.5	88.5	88.3
80-60-60	88.5	89.0	88.5	88.3	88.6
Mean	86.9	86.7	86.9	86.9	86.7a
		Average			
0-0-0	79.8	79.0	79.3	79.3	79.3 g
40-30-30	80.1	80.0	80.3	79.8	80.0 f
40-30-60	80.8	79.8	80.0	79.8	80.1 f
40-60-30	80.8	80.8	81.3	81.0	80.9 e
40-60-60	81.8	81.4	81.5	81.9	81.6 d
80-30-30	82.1	81.6	82.5	82.5	82.2 c
80-30-60	82.4	82.8	83.1	83.1	82.8 b
80-60-30	83.1	82.9	83.4	83.5	83.2 ab
80-60-60	83.5	84.0	83.5	83.1	83.5 a
Mean	81.6	81.4	81.6	81.5	

CV % = 6.91

LSD value for NPK at $P \leq 0.05$ (Average for years) = 0.4036

Control vs rest		N		P		K	
Control	Rest	40 kg ha^{-1}	80 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}
79.3 b	81.8 a	80.7 b	83.0 a	81.3 b	82.3 a	81.6 b	82.0 a

Means of the same category followed by similar letters are non significant at ($P \leq 0.05$) using LSD.

Table II ***Spikes m^{-2} of wheat as affected by FYM and NPK levels during two growing seasons***

NPK (Kg ha^{-1})	FYM (tons ha^{-1})				Mean
	0	15	30	45	
Year 2003-04					
0-0-0	146.5	160.5	155.0	158.0	155.0
40-30-30	157.5	166.5	163.0	165.8	163.2
40-30-60	163.5	164.3	167.8	169.0	166.1
40-60-30	165.0	176.5	175.3	179.3	174.0
40-60-60	164.5	178.0	181.8	183.3	176.9
80-30-30	171.3	179.0	186.0	185.3	180.4
80-30-60	174.5	183.3	192.8	193.8	186.1
80-60-30	177.3	193.8	196.3	198.8	191.5
80-60-60	179.0	190.3	196.0	191.5	189.2
Mean	166.6	176.9	179.3	180.5	175.8b
Year 2004-05					
0-0-0	161.0	174.3	174.8	181.0	172.8
40-30-30	169.8	182.8	181.3	186.0	179.9
40-30-60	178.8	186.3	189.0	191.5	186.4
40-60-30	178.8	194.0	197.5	199.0	192.3
40-60-60	186.0	197.8	202.3	203.0	197.3
80-30-30	192.0	198.8	205.8	210.3	201.7
80-30-60	193.0	207.8	213.5	214.8	207.3
80-60-30	199.3	212.0	216.8	218.5	211.6
80-60-60	202.3	218.5	216.3	213.5	212.6
Mean	184.5	196.9	199.7	201.9	195.8a
Average					
0-0-0	153.8	167.4	164.9	169.5	163.9 h
40-30-30	163.6	174.6	172.1	175.9	171.6 g
40-30-60	171.1	175.3	178.4	180.3	176.3 f
40-60-30	171.9	185.3	186.4	189.1	183.2 e
40-60-60	175.3	187.9	192.0	193.1	187.1 d
80-30-30	181.6	188.9	195.9	197.8	191.0 c
80-30-60	183.8	195.5	203.1	204.3	196.7 b
80-60-30	188.3	202.9	206.5	208.6	201.6 a
80-60-60	190.6	204.4	206.1	202.5	200.9 a
Mean	175.5 b	186.9 a	189.5 a	191.2 a	

CV % = 4.16
LSD value for FYM at P≤ 0.05 (Average for years) = 8.904
LSD value for NPK at P≤ 0.05 (Average for years) = 3.811

Control vs rest		N		P		K	
Control	Rest	40 kg ha^{-1}	80 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}
163.9 b	188.6 a	179.6 b	197.6 a	183.9 b	193.2 a	186.9 b	190.3 a

Means of the same entry followed by similar letters are non significant at (P ≤ 0.05) using LSD.

Table III ***Grains spike^{-1} of wheat as affected by FYM and NPK levels during two growing seasons***

NPK (kg ha^{-1})	FYM (tons ha^{-1})				Mean
	0	15	30	45	
		Year 2003-04			
0-0-0	47.3	48.3	49.8	49.5	48.7
40-30-30	49.5	50.3	50.3	50.8	50.2
40-30-60	50.0	51.5	51.5	51.8	51.2
40-60-30	50.3	51.8	52.5	52.5	51.8
40-60-60	51.3	52.0	52.8	53.3	52.3
80-30-30	51.5	52.5	53.3	54.0	52.8
80-30-60	52.3	53.5	53.8	54.0	53.4
80-60-30	53.0	53.5	54.3	55.0	53.9
80-60-60	53.3	54.3	54.5	55.3	54.3
Mean	50.9	51.9	52.5	52.9	52.1b
		Year 2004-05			
0-0-0	50.3	51.3	52.8	52.5	51.7
40-30-30	52.5	53.3	53.3	53.8	53.2
40-30-60	53.0	54.5	54.5	54.8	54.2
40-60-30	53.3	54.8	55.5	55.5	54.8
40-60-60	54.3	55.0	55.8	56.3	55.3
80-30-30	54.5	56.0	56.3	57.0	55.9
80-30-60	55.3	56.5	56.8	57.0	56.4
80-60-30	56.0	56.5	57.3	58.0	56.9
80-60-60	56.3	57.3	57.5	58.3	57.3
Mean	53.9	55.0	55.5	55.9	55.1a
		Average			
0-0-0	48.8 t	49.8 s	51.3 qr	51.0 r	50.2 I
40-30-30	51.0 r	51.8 pq	51.8 pq	52.3 op	51.7 h
40-30-60	51.5 qr	53.0 mn	53.0 mn	53.3 lmn	52.7 g
40-60-30	51.8 pq	53.3 lmn	54.0 ijk	54.0 ijk	53.3 f
40-60-60	52.8 no	53.5 klm	54.3 hij	54.8 fgh	53.8 e
80-30-30	53.0 mn	54.3 hij	54.8 fgh	55.5 cde	54.4 d
80-30-60	53.8 jkl	55.0 efg	55.3 def	55.5 cde	54.9 c
80-60-30	54.5 ghi	55.0 efg	55.8 cd	56.5 ab	55.4 b
80-60-60	54.8 fgh	55.8 cd	56.0 bc	56.8 a	55.8 a
Mean	52.4 c	53.5 b	54.0 ab	54.4 a	

CV % = 4.82
LSD value for FYM at P≤ 0.05 (Average for years) = 0.8122
LSD value for interaction at P≤ 0.05 (Average for years) = 0.6237
LSD value for NPK at P≤ 0.05 (Average for years) = 0.3119

Control vs rest		N		P		K	
Control	Rest	40 kg ha^{-1}	80 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}
50.2 b	54.0 a	52.9 b	55.1 a	53.4 b	54.6 a	53.7 b	54.3 a

Means of the same category followed by similar letters are non significant at ($P \leq 0.05$) using LSD.

Table IV ***Thousand grain weight (g) of wheat as affected by FYM and NPK levels during two growing seasons***

NPK (Kg ha^{-1})	FYM (tons ha^{-1})				Mean
	0	15	30	45	
Year 2003-04					
0-0-0	30.55	31.75	31.00	31.70	31.25
40-30-30	32.55	33.00	31.75	32.95	32.56
40-30-60	32.80	33.25	32.25	33.45	32.94
40-60-30	32.05	32.50	32.75	33.95	32.81
40-60-60	33.30	34.25	34.25	33.95	33.94
80-30-30	33.55	34.50	34.00	34.70	34.19
80-30-60	34.30	34.00	34.75	34.95	34.50
80-60-30	34.05	34.50	35.00	35.45	34.75
80-60-60	34.30	34.75	35.00	35.45	34.88
Mean	33.05	33.61	33.42	34.06	33.54b
		Year 2004-05			
0-0-0	32.05	33.50	33.50	33.70	33.19
40-30-30	33.05	33.75	34.00	34.95	33.94
40-30-60	33.55	34.25	35.00	35.20	34.50
40-60-30	34.55	34.25	35.00	35.45	34.81
40-60-60	35.05	35.00	35.25	35.95	35.31
80-30-30	35.30	35.25	35.25	35.45	35.31
80-30-60	35.05	35.75	35.25	35.45	35.38
80-60-30	35.05	35.50	35.00	35.95	35.38
80-60-60	35.30	35.25	35.50	35.70	35.44
Mean	34.33	34.72	34.86	35.31	34.81a
Average					
0-0-0	31.30	32.63	32.25	32.70	32.22 e
40-30-30	32.80	33.38	32.88	33.95	33.25 d
40-30-60	33.18	33.75	33.63	34.33	33.72 c
40-60-30	33.30	33.38	33.88	34.70	33.81 c
40-60-60	34.18	34.63	34.75	34.95	34.63 b
80-30-30	34.43	34.88	34.63	35.08	34.75 ab
80-30-60	34.68	34.88	35.00	35.20	34.94 ab
80-60-30	34.55	35.00	35.00	35.70	35.06 a
80-60-60	34.80	35.00	35.25	35.58	35.16 a
Mean	33.69 b	34.17 ab	34.14 ab	34.69 a	

CV % = 2.53
LSD value for NPK at P≤ 0.05 (Average for years) = 0.4271
LSD value for FYM at P≤ 0.05 (Average for years) = 0.649

Control vs rest		N		P		K	
Control	Rest	40 kg ha^{-1}	80 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}
32.22 b	34.42 a	33.85 b	35.98 a	34.17 b	34.67 a	34.22 b	34.61 a

Means of the same entry followed by similar letters are non significant at (P ≤ 0.05) using LSD.

Table V ***Biological yield (kg ha^{-1}) of wheat as affected by FYM and NPK levels during two growing seasons***

NPK (kg ha^{-1})	FYM (tons ha^{-1})				Mean
	0	15	30	45	
		Year 2003-04			
0-0-0	7968	8695	8304	8283	8313
40-30-30	8545	8276	9234	9258	8828
40-30-60	8760	9017	9340	9525	9161
40-60-30	8798	9110	9360	9656	9231
40-60-60	8860	9166	9440	9681	9287
80-30-30	8911	9209	9527	9718	9341
80-30-60	8944	9227	9660	9731	9391
80-60-30	9024	9256	9773	9808	9465
80-60-60	9093	9304	9800	9840	9509
Mean	8767	9029	9382	9500	9170b
		Year 2004-05			
0-0-0	8968	9695	9304	9283	9313
40-30-30	9545	9276	10242	10256	9829
40-30-60	9760	10017	10340	10525	10161
40-60-30	9798	10110	10360	10656	10231
40-60-60	9860	10166	10440	10681	10287
80-30-30	9911	10209	10277	10718	10279
80-30-60	10044	10227	10660	10731	10416
80-60-30	10024	10256	10773	10808	10465
80-60-60	10093	10299	10800	10840	10508
Mean	9778	10028	10355	10500	10165a
		Average			
0-0-0	8468 w	9195 t	8804 v	8783 v	8813 g
40-30-30	9045 u	8776 v	9738 kl	9757 k	9329 f
40-30-60	9260 s	9517 o	9840 i	10025 f	9661 e
40-60-30	9298 r	9610 n	9860 i	10156 e	9731 d
40-60-60	9360 q	9666 m	9940 g	10181 e	9787 c
80-30-30	9411 t	9709 l	9902 h	10218 d	9810 c
80-30-60	9494 o	9727 kl	10160 p	10231 d	9903 b
80-60-30	9524 o	9756 k	10273 c	10308 b	9965 a
80-60-60	9593 n	9801 j	10300 bc	10340 a	10008 a
Mean	9272 b	9528 b	9869 a	10000 a	

CV % = 8.07
LSD value for FYM at P≤0.05 (Average for years) =280.5
LSD value for NPK at P≤ 0.05 (Average for years)=50.22
LSD value for interaction at P≤ 0.05 (Average for years) =31.76

Control vs rest		N		P		K	
Control	Rest	40 kg ha^{-1}	80 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}	30 kg ha^{-1}	60 kg ha^{-1}
8813b	9774 a	9627 b	9922 a	9676 b	9873 a	9709 b	9840 a

Means of the same category followed by similar letters are non significant at (P ≤ 0.05) using LSD.

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