Effect of Genotype cum Compost-Fertilizer Combinations on Late Sown Wheat (*Triticum aestivum* L.) in Nepal

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Abstract

A field experiment was carried out to investigate the growth and productivity of wheat cultivars by compost-fertilizer combination under late sown condition at agronomy farm of Agriculture and Forestry University, Rampur in 2014. The purpose of this research was to identify amount of fertilizer and/or manure combination to achieve better yield performance on late sown wheat in Chitwan. Experiment laid out in split plot design with three replications considering four levels of fertilizer or manure combination as main plot factor and five wheat genotypes as the sub-plot factor while net plot size was 4x3 m^2. Effect of genotype and genotype x compost-fertilizer interaction was non-significant for grain yield. However, the ½ compost: ½ fertilizer combinations produced significantly higher grain yield than the 100% complete fertilizer and/or 100% manure. The synergistic response of the compost-fertilizer combinations may have contributed for the greater yield of wheat genotypes. This experiment clearly demonstrated the importance of compost-fertilizer combination on grain yield of wheat under late sown condition.

Keywords: Compost-fertilizer combination, grain yield, late sown wheat

Introduction

Rice-wheat rotation is an important agricultural production system adopted by the farmers in Nepal (Chatrath et al., 2007). In the summer season, farmers generally transplant rice in puddled field and subsequently after rice harvesting either they grow wheat, legume, or maize in the winter (Fujisaka et al., 1994). In general, wheat is the subsistence crops for small and marginal farmers. Despite the yield advantages of timely sown wheat over late sown, farmers are obligated to grow this crop under late sown condition. In most of the times, the field will not be ready for cultivation immediately after rice due to high soil moisture, so that farmers have to wait for few days to grow wheat on the same field. Furthermore, resource-poor farmers are confronted with some problems regarding the use of chemical fertilizer despite its beneficial effect (Wapa and Oyetola, 2014). Firstly, scarcity in timely availability of chemical fertilizers in peak wheat growing season and high cost prohibit its use by most small-holder farmers, hence, they have often resorted to using of farm yard manure. Secondly, there is also lots of soil problems associated with the use of chemical fertilizer.

Planting date is one of the most important agronomic factors for higher grain yield in wheat. Under late sown conditions, adjustment in planting date and N application affect the duration of grain filling, and grain yield (Subedi et al., 2007). The combined use of organic manures and inorganic fertilizers is the general practices of farmers to improve and maintain the fertility status of the soil. Increased use of manure may allow farmers to reduce, rather than eliminate, their commercial fertilizer applications. Inorganic fertilizer is essential to achieve better yield from wheat. Application of organic manures improves the general physical condition of soils and increases its water retaining capacity. Therefore, manure clearly substitutes for commercial fertilizers and reduce the cost of wheat production. This study was aimed to assess suitable manure-fertilizer combination for achieving better yield performance on late sown wheat in Chitwan, Nepal.

Materials and methods

Planting details

The experiment was carried out at Agronomy Farm of Agriculture and Forestry University (AFU), Rampur, Chitwan. Five wheat cultivars i.e. Vijay, Gautam, NL 1073, NL 971 and NL 1164 were sown manually on 21st of December, 2013. Each 12 m^2 plot had 12 rows of 4 m length, with an inter-row spacing of 0.25 m. Experimental plot was laid out in split plot design with three replications where fertilizer and varieties were kept in the main plot and sub-plot respectively. Four different levels of fertilizers and manure i.e. recommended dose of fertilizer (RDF) =120:60:40 NPK kg ha^{-1}; Control=without manure & fertilizer, farm yard manure (FYM) = 24 t ha^{-1}, and ½RDF:½FYM i.e., 60:30:20 NPK kg ha^{-1}: FYM 12 t ha^{-1} applied on the experimental plots. The fertilizer was applied in the form of urea, di-ammonium phosphate (DAP), and murate of potash (MoP). A total dose of phosphorus and potash applied at the time of sowing while urea added in two splits; the first ½ at planting time, and next ½ at tillering stage after irrigation. All doses of farm yard manure incorporated into the soil before sowing.

Data recording and analysis

Data for 50% flowering and 85% maturity, plant height (cm), spike length (cm) recorded from third and fourth rows of each plot. One m^2 quadrant was throwaway randomly on each plot for counting numbers of tillers m^{-2}. Thousands kernel counted from each plot and weighted to determine thousands of grains weight (g). Above ground biomass and grain yield recorded from 10 rows by leaving two border rows in each plot and converted into kg ha^{-1}. The data entered in excel, averaged before statistical analysis to determine the effect of variety, fertilizer, and manure. MSTAT-C program used for data analysis and mean separated with Duncan Multiple Range Test (DMRT) at the 5% level of significance.

Results and discussion

The tables presented below shows the response of five wheat varieties into four levels of manure and fertilizer (Table 1-4). The title rows include the days to flowering, days to maturity, plant height (cm), spike length (cm), numbers of tillers m^{-2}, thousands grain weights (g), above ground biomass (kg ha^{-1}), and grain yield (kg ha^{-1} at 12% moisture) corresponding to different level of manures and fertilizers. Similarly, the title column shows five different wheat varieties.

Days to flowering and maturity

The results presented in table 1 showed the highly significant difference on days to flowering in response to fertilizer as well as variety, and significant difference in fertilizer x variety combination. However, the highly significant difference was observed with respect to variety, and a significant difference was noted on fertilizer response in case of maturity. However, non-significant different was observed with respect to days to maturity in fertilizer x variety interaction. This result indicates that Vijay, NL 971 and NL 1164 are early maturing varieties, but Gautam and NL 1073 are late maturing type. Likewise, the flowering and maturity time of same variety was late when applied only the recommended dose of chemical fertilizer. Heading and grain filling of the late-planted wheat generally occurs in warmer periods, and this crop often has reduced the duration of grain filling and lower yield due to force maturity. These results are in agreements with the findings of Subedi et al. (2007).

Table 1. Days to flowering and maturity of wheat on an experimental trial of AFU, Rampur in 2013-14.

Variety	Days to flowering					Days to maturity				
	RDF	Control	FYM	½ RDF: ½FYM	Mean	RDF	Control	FYM	½RDF: ½FYM	Mean
Vijay	70ef	67hi	67hi	66i	68e	111	110	110	109	110c
Gautam	78a	74b	76b	73d	75b	117	115	115	113	115a
NL 1073	79a	78a	77ab	76b	78a	114	113	114	113	113b
NL 971	71e	68gh	69fg	68gh	69d	112	110	110	108	110c
NL 1164	71e	70ef	70ef	70ef	70c	113	112	113	113	113b
Mean	74a	72b	72b	71c	72	113a	112b	112b	111c	112
Fertilizer			**					*		
$LSD_{0.01-0.05}$			0.9					1.0		
Variety			**					**		
$LSD_{0.01-0.05}$			0.7					0.9		
Fert x Var			*					NS		
$LSD_{0.01-0.05}$			1.6					1.7		
CV, %			1.2					0.9		

* & **, significant at 0.05 and 0.01 level of significance respectively

Plant height and spike length

Plant height was statistically affected by different levels of compost-fertilizer combination (Table 2). Maximum plant height (98 cm) was attained when applied ½RDF:½FYM followed by 90-92 cm in RDF and FYM respectively whereas minimum plant height (78 cm) was observed from the treatment where no fertilizer was applied. The interaction of fertilizer x compost was found non-significant. However, comparatively taller plants were observed on nitrogen fertilizer applied. The research findings are in coordinate with Chandra et al. (1992).

The difference was observed significant relating to fertilizer application on spike length (Table 2). The result pointed out that spike length of wheat variety was observed maximum (9.3 cm) when applied ½RDF:½FYM and minimum (7.3 cm) spike length was observed under control condition. In general, longer spike length observed in a full dose of recommended fertilizer and/or ½RDF:½FYM as compared to control and/or compost only. The spike length also increased linearly with each successive addition of nutrients to the soil. On the other hand, there was no difference in spike length according to the variety. These results are in agreement with Hussain et al. (2001) and Iqbal et al. (2012). They concluded that spike length of wheat was increased significantly with increasing fertilizer levels.

Table 2. Plant height and spike length of wheat under varietal cum fertilizer trial of Rampur in 2013-14.

Variety	Plant height (cm)					Spike length (cm)				
	RDF	Control	FYM	½RDF: ½FYM	Mean	RDF	Control	FYM	½RDF: ½FYM	Mean
Vijay	93	75	94	99	90	9.0	6.4	8.3	8.9	8.2
Gautam	91	82	95	96	91	9.9	7.8	8.0	9.6	8.8
NL 1073	88	80	94	97	90	8.6	7.3	8.6	9.1	8.4
NL 971	87	79	88	98	88	8.1	7.7	8.6	9.4	8.4
NL 1164	92	77	88	99	89	8.9	7.2	8.6	9.2	8.5
Mean	90b	78c	92b	98a	90	8.9a	7.3b	8.4a	9.3a	8.5
Fertilizer			**					*		
$LSD_{0.01-0.05}$			2.6					1.1		
Variety			NS					NS		
$LSD_{0.01-0.05}$			5.4					0.7		
Fert x Var			NS					NS		
$LSD_{0.01-0.05}$			9.9					1.5		
CV, %			7.3					9.3		

* & **, significant at 0.05 and 0.01 level of significance respectively

Numbers of tillers and grain weight

Numbers of tillers are most important yield contributing factors. It was statistically affected by the interaction between variety and fertilizer (Table 3). The maximum numbers of tillers (278-285m^{-2}) were recorded on NL 1073, NL 1164 and Vijay along with the application of RDF, FYM, and ½RDF:½FYM, respectively while minimum plant population (188-220 m^{-2}) was observed under control condition irrespective of the genotype. Non-significant effect of fertilizer and variety was found. It indicates that numbers of tillers differ according to the interaction between genotype and manure-fertilizer combination. Similar kinds of results also explained by Iqbal et al. (2012).

Grain weight was statistically affected by varieties and fertilizer but no interaction was observed between any of these factors (Table 3). Irrespective of genotypes, FYM application had produced significantly higher grain weight (45 g) than control or RDF (41 g) and response of variety also significant. Vijay produced the bold grain (50 g) followed by Gautam (44 g) and NL 971 as well as NL 1073 produced the smaller grains (38 g). The interaction of genotypes and fertilizer was not significant but seed weight reduced significantly in all genotypes under recommended dose of fertilizer and/or control condition. This result contrasts with the earlier finding of Awasthi and Bhan (1993), Maqsood et al. (2002), and Iqbal et al. (2012). Here, observed thousands grain weight was enhanced by increasing farm yard manure level and variety. The difference in grain weight of the varieties was attributed to the difference in their genetic makeup.

Table 3. Grain weight and tillering behaviour of wheat under agronomic trial at Rampur in 2013-14.

Variety	No. of tillers m^{-2}					Thousands of grains weight (g)				
	RDF	Control	FYM	½RDF: ½FYM	Mean	RDF	Control	FYM	½RDF: ½FYM	Mean
Vijay	227a	210b	223a	278a	235	48	46	53	53	50a
Gautam	211b	220a	190b	215b	209	42	45	47	41	44b
NL 1073	285a	188b	215b	215b	226	37	35	40	41	38c
NL 971	232a	216b	236a	222a	226	36	37	41	38	38c
NL 1164	232a	213b	282a	246a	243	39	40	47	40	42b
Mean	237	209	229	235	228	41b	41b	45a	43ab	42
Fertilizer			NS					*		
$LSD_{0.01-0.05}$			56.8					2.8		
Variety			NS					**		
$LSD_{0.01-0.05}$			25.9					2.5		
Fert x Var			*					NS		
$LSD_{0.01-0.05}$			67.9					4.9		
CV, %			13.7					7.0		

* & **, significant at 0.05 and 0.01 level of significance respectively

Biomass and grain yield

Biological yield represents the overall growth performance of the crop. The analysis of variance showed that there is a significant difference on fertilizer in regard to above ground biomass yield (Table 4). It is highly inclined by fertilizer application. There was not a difference between the varieties and variety x fertilizer interaction in relation to biomass. The maximum biomass (6398 kg ha^{-1}) yield was observed on ½RDF:½FYM followed by RDF (6208 kg ha^{-1}) and minimum biomass (4279 kg ha^{-1}) on control trailed by FYM (4870 kg ha^{-1}). Increased in biomass production might be increased plant height and grain yield by increasing nitrogen. These results are in agreement with the earlier findings of Zia-ul-Islam et al. (2002) and Iqbal et al. (2012).

Grain yield of wheat is the function of its yield components in response to the manure-fertilizer application, the genetic architecture of the genotypes and planting time of the crop. It is highly influenced by crop nutrition. There was highly significant difference in yield with respect to the compost-fertilizer application (Table 4). The effect of variety and variety x fertilizer interaction was non-significant. It showed that grain yield of wheat was influenced by compost-fertilizer combination rather than variety or variety x fertilizer interaction. The significantly highest grain yield (2584 to 2229 kg ha^{-1}) was obtained from ½RDF:½FYM and RDF respectively whereas lowest grain yields (1295 to 1867 kg ha^{-1}) was received from Control and FYM application respectively. Maximum grain yield might be because of more numbers of tillers per unit area, longer spike, more numbers of grains per spike and more test of the grains. This is because of the synergistic response of compost-fertilizer combination on increasing test weight, spike length, and numbers of tillers. Similar results were also obtained by Pandy et al. (2001), Singh et al. (2002), and Iqbal et al. (2012). The synergistic response of the compost-fertilizer combinations may have contributed for the greater yield of wheat varieties. Similar kinds of finding also recorded by Sikora and Azad (1993).

Table 4. Biomass and grain yield of wheat genotypes under varietal cum fertilizer trial at agronomy farm of AFU in 2013-14.

Variety	Biomass yield (kg ha^{-1})					Grain yield (kg ha^{-1})				
	RDF	Control	FYM	½RDF: ½FYM	Mean	RDF	Control	FYM	½RDF: ½FYM	Mean
Vijay	6206	4622	4711	7100	5660	2298	1441	1749	2610	2024
Gautam	6283	4117	5122	6206	5432	2140	1337	1934	2668	2020
NL 1073	6472	3939	4567	5750	5182	2127	1224	1913	2520	1946
NL 971	5917	4339	4972	6039	5317	2311	1207	2110	2448	2019
NL 1164	6161	4378	4978	6894	5603	2269	1267	1629	2673	1960
Mean	6208a	4279b	4870b	6398a	5439	2229b	1295d	1867c	2584a	1994
Fertilizer			*					**		
$LSD_{0.01-0.05}$			1285					282.5		
Variety			NS					NS		
$LSD_{0.01-0.05}$			576					262.7		
Fert x Var			NS					NS		
$LSD_{0.01-0.05}$			1525					522.4		
CV, %			12.7					15.8		

* & **, significant at 0.05 and 0.01 level of significance respectively

Correlation between the traits

The association between any two variables is known as simple correlation (Bhutto et al., 2016). The simple phenotypic correlation coefficient was calculated among the examined traits as shown in Table 5. There was very strong and positive association among the traits such as days to flowering and maturity; grain weight *vs* numbers of plants per m^2; grain yield *vs* plant height, spike length, and biomass yield. The phenotypic correlations between plant height, spike length, biomass, and grains yield were highly positively associated; which revealed that increase in plant height, spike length and biomass will cause the corresponding increase in grain yield in late sown wheat. Similar findings were reported by Bhutto et al. (2016).

Table 5. Correlation between the traits of wheat as evaluated under agronomic trial at Rampur in 2013-14.

Traits	Days to flowering	Days to maturity	Plant height (cm)	Spike length (cm)	No. of plants m^{-2}	Biomass (kg ha^{-1})	Thousands grain weight (g)
Days to maturity	0.778**						
Plant height (cm)	0.138	0.187					
Spike length (cm)	0.153	0.235	0.603**				
No. of plants m^{-2}	-0.159	-0.092	-0.009	-0.093			
Biomass (kg ha^{-1})	-0.052	0.018	0.548**	0.620**	0.097		
Thousands of grains weight	-0.465**	-0.144	0.049	-0.037	0.322*	0.097	
Grain yield (kg ha^{-1})	0.018	-0.002	0.542**	0.495**	0.236	0.656**	0.004

* & **, significant at 0.05 and 0. 01 level of significance respectively

The negative and statistically highly significant association was found only between grain weight and days to flowering. It indicates that late flowering support in the development of small size seed in wheat. Force maturity of wheat grains due to the heat wave in late sown wheat results into a development of small grains in wheat. Our findings are in conformity with Subedi et al. (2007), who reported that heat wave reduced grain size in wheat.

Conclusion

This experiment clearly demonstrated the effect of the compost-fertilizer combination under late sown conditions. First of all, plant height increased linearly with each successive increase in an amount of the manure and/or fertilizer combination. Hence, it can be assumed that fertilizer application can ensure positive effect in plant height. Secondly, it can be supposed that fertilizer and/or manure application can influence positively on the development of spike length in wheat. Thirdly, above ground biomass yield on late sown wheat is directly influenced by fertilizer application. Finally, yield trend showed that combined application of compost-fertilizer increases the yield of the wheat. Therefore, there is the need for the combined use of organic and inorganic fertilizers to get profitable grain yield from late sown wheat in the study area.

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