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EVALUATING A NEW WHEAT GENOTYPE (NARC 2009) AGAINST TWO RAINFED CULTIVARS AT DIFFERENT NITROGEN TO PHOSPHOROUS PENTA OXIDE RATIOS

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ABSTRACT

A newly developed wheat variety NARC 2009 performed significantly superior to wheat cultivar GA 2002, however, it was statistically at par with Wafaq 2001. The experiment was laid out using randomized complete block design (RCBD) with split plot arrangement to evaluate a wheat genotype NARC 2009 in comparison to wheat cultivars (cvs.) GA 2002 and Wafaq 2001 in interaction with three nitrogen to phosphorous penta oxide ($N:P_2O_5$) ratios (58-58, 85-58 and 115-85). Non-significant effect of $N:P_2O_5$ ratios was set up for grain yield representing 58-58 kg ha^{-1} as an economical ratio. Highest grain yield of 5120 kg ha^{-1} was achieved with NARC 2009 hence resulting in 28 percent greater yield than cv. GA 2002 (4007 kg ha^{-1}). Variation in growth and yield was presumably ascribed to genetic make up of the genotypes.

Key Words: Advance line, genotype, nitrogen to phosphorous penta oxide, grain yield

INTRODUCTION

Wheat varieties respond differentially to the available nutrients in accordance with their genetic make up and physiological need (Alam *et al*. 2007; Chandra *et al*. 1992). A host of wheat varieties have been developed but many of these have lost their adaptability to site specific environmental conditions. Each variety has its own requirements for particular agro-ecological conditions to have optimum growth and grain yield (Qasim *et al*. 2008). They vary in growth and yield primarily influenced by heredity.

Nitrogen to phosphorous penta oxide ($N:P_2O_5$) ratio is crucial. A healthy plant with optimum nutrition has an additional resistance to the insect pests and diseases. Appropriate nutrition can increase crop yield by producing vigorous growth as reflected by increase in plant stature; biomass and economic output (Saleem *et al*. 2008). However, if soil has sufficient quantities of essential nutrients, there may be no need to apply chemical fertilizers. The quantity of fertilizer applied to plants must be warily managed to make it certain that nutrients are available throughout the growing season and the vegetative and reproductive development is not restricted (Tranaviciene *et al*. 2007).

A recently approved wheat variety namely NARC 2009 is a genotype developed for rainfed areas of Pakistan but a very little information is available regarding its growth and yield attributes. Hence, in view of the restricted accessible particulars regarding new genotype and related impact of the genotypes and essential nutrients in enhancing wheat yield, the study was undertaken to evaluate NARC 2009 in comparison to cultivars GA 2002 and Wafaq 2001 at varying $N:P_2O_5$ ratios to make out whether it can play any significant role in enhancing grain yield under rainfed conditions of Pakistan.

MATERIALS AND METHODS

The experiment was conducted at National Agricultural Research Centre (NARC), Islamabad (33° 42' N, 73º 10' E) during 2008-09 to evaluate a newly developed wheat genotype NARC 2009. Wheat genotype, NARC 2009 was compared with cv. GA 2002 and cv. Wafaq 2001 at different $N:P_2O_5$ ratios for various growth, yield and development parameters under rainfed conditions. Weather data were collected from Pakistan Meteorological Department, Islamabad. Soil was sandy loam having a pH of 7.75, organic matter (OM) of 0.96 %, Olsen-P of 9.68 mg kg^{-1} and nitrogen 1.92 %.

Crop was sown on November 4, 2008 with a seed drill adjusted for six rows at 25 cm row spacing using the seed rate of 120 kg ha^{-1}. The plot size was 1.5 m x 9 m. The trial was laid out in randomized complete block design (RCBD) with split plot arrangement having three replications. The treatments were three $N:P_2O_5$ ratios (58:58, 85:58 and 115:85 $N:P_2O_5$ kg ha^{-1}) which were kept in main plots and three genotypes i.e. GA 2002, Wafaq 2001 and NARC 2009 that were placed in sub plots. All other agronomic measures were kept standardized.

Seasonal rainfall was 366 mm. Maximum average rainfall was recorded in the month of March (89.8 mm). Favourable precipitation promoted better crop growth and grain yield. The last rains that fell at the end of April and the beginning of May were probably too late to benefit the crops. Improved production might have been due to sufficient rains during the crop growing season under rainfed conditions. Water did not limit the crop growth; rainfall met the evapo-transpiration demand. Air temperature during the season was normal. Mean air temperature of November, December, January, February and March were 16.4, 11.6, 10.2, 12.1, 16.9 & 22.5 ^{o}C. Month wise maximum average temperature was recorded in the month of April (30.1 ^{o}C). Minimum average temperature was observed in the month of January (2.6 ^{o}C). Range of average solar radiation from 9.06-19.67 MJ m^{-2} day^{-1} was observed. Average humidity increased from October to December (maximum 65 %). But after December, it decreased to 46 % in April.

Observations on different growth and development parameters were recorded along with the grain yield. Half of the plot was retained for growth and development study and the remaining half plot was used for final grain yield. Spikelets $spike^{-1}$ and tillers m^{-2} were recoded at maturity. Data on spike length, plant stature, thousand-seed (1000-seed) weight, biological and grain yield were recorded for each plot and then the average was computed.

Statistical analysis was performed with the use of a computer software package, “Statistix” to analyze the data and the means were compared on least significance difference basis as described by Steel *et al*. (1997).

RESULTS

Main effect of wheat genotypes and $N:P_2O_5$ ratios was non-significant for spikelets $spike^{-1}$ (Table I). However, spikelets $spike^{-1}$ varied significantly with three wheat genotypes in interaction with different $N:P_2O_5$ (**Fig. 1**). Newly developed genotype NARC 2009 produced maximum number of spikelets.$spike^{-1}$ (23.67) in interaction with 58:58 $N:P_2O_5$ kg.ha^{-1}, whereas, minimum spikelets.$spike^{-1}$ (18.67) was recorded with a wheat genotype Wafaq-2001 at 58:58 kg $N:P_2O_5$ ha^{-1} that was statistically at par with cv. GA-2002 at the same $N:P_2O_5$ level.

Spike length varied with different genotypes; however, it was non-significantly influenced by $N:P_2O_5$ (Table I). Wheat variety NARC 2009 resulted in highest spike length of 13.23 cm, whereas, lowest spike length was recorded with Wafaq 2001 which was statistically similar to that of GA-2002 wheat genotype.

Tillers m^{-2} varied non-significantly among wheat genotypes with $N:P_2O_5$ ratios (Table I). However, it ranged from 203.33 to 222.67 tillers m^{-2} for different wheat genotypes. Interaction between $N:P_2O_5$ and genotypes affecting tilles m^{-2} was non-significant.

Significance of the role of plant stature is an important character especially under rainfed conditions keeping in view wheat straw and grain yield. Plant stature varied significantly with different wheat genotypes, however, non-significant difference was found for plant stature at different $N:P_2O_5$ (Table I). Interaction affected plant stature non-significantly. Wheat variety NARC 2009 resulted in the highest plant stature of 112.67 cm whereas lowest plant stature (103.77 cm) was recorded with cv. GA-2002 which was statistically similar to that of Wafaq 2001.

Thousand-seed (1000-seed) weight reflected no significant change with genotypes and $N:P_2O_5$ ratios (Table I). Interaction between $N:P_2O_5$ and genotypes also affected 1000-seed weight non-significantly. Thousand-seed weight ranged from 38.86 to 42.01 g.

Biological yield was non-significantly influenced by wheat genotypes and $N:P_2O_5$ (Table I). However, interaction between $N:P_2O_5$ and genotypes affecting biological yield was found significant (Fig. 2). Wheat genotype NARC 2009 in interaction with 58-58 $N:P_2O_5$ kg.ha^{-1} produced significantly topmost biomass (16000 kg ha^{-1}). Least biomass (11667 kg ha^{-1}) was recorded with GA-2002 wheat cultivar at 58-58 $N:P_2O_5$ kg.ha^{-1}. Three wheat genotypes at different $N:P_2O_5$ ratios had no effect on harvest index/HI (Table I).

Significant effect on grain yield was caused by wheat genotypes, however, no significant difference was found among $N:P_2O_5$ levels (Table I). Interaction between $N:P_2O_5$ ratios and genotypes affecting grain yield was non-significant. Highest grain yield of 5120 kg.ha^{-1} was obtained from wheat genotype NARC 2009 which was statistically at par with Wafaq-2001. Lowest grain yield of 4007 kg.ha^{-1} was obtained from GA-2002 among three wheat genotype.

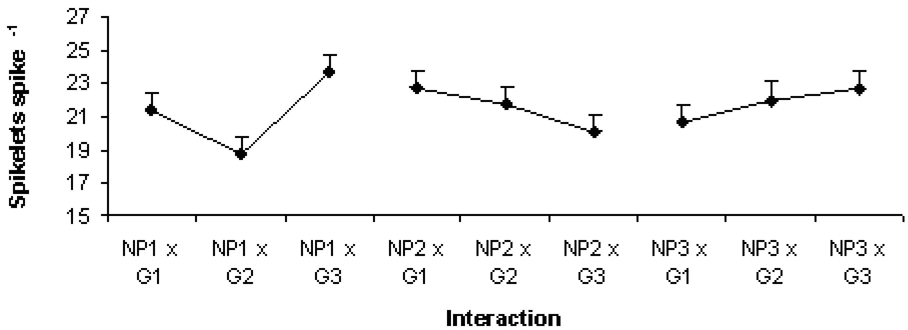

Fig.1. Interaction between $N:P_2O_5$ and genotypes affecting spikelets spike^{-1}.

Interaction = Interaction between $N:P_2O_5$ and genotype, NP1 x G1 = Interaction between 58:58 kg $N:P_2O_5$ ha^{-1} and GA 2002, NP1 x G2 = Interaction between 58:58 kg $N:P_2O_5$ ha^{-1} and Wafaq 2001, NP1 x G1 = Interaction between 58:58 kg $N:P_2O_5$ ha^{-1} and NARC 2009, NP2 x G1 = Interaction between 85:58 kg $N:P_2O_5$ ha^{-1} and GA 2002, NP2 x G2 = Interaction between 85:58 kg $N:P_2O_5$ ha^{-1} and Wafaq 2001, NP2 x G3 = Interaction between 85:58 kg $N:P_2O_5$ ha^{-1} and NARC 2009, NP3 x G1 = Interaction between 115:85 kg $N:P_2O_5$ ha^{-1} and GA 2002, NP3 x G2 = Interaction between 115:85 kg $N:P_2O_5$ ha^{-1} and Wafaq 2001, and NP3 x G3 = Interaction between 115:85 kg $N:P_2O_5$ ha^{-1} and NARC 2009.

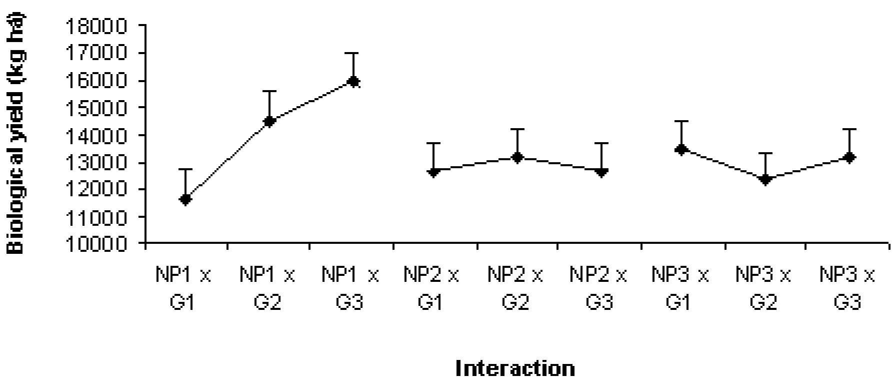

Fig.2. Interaction between $N:P_2O_5$ ratios and genotypes affecting biological yield.

Interaction = Interaction between $N:P_2O_5$ and genotype, NP1 x G1 = Interaction between 58:58 kg $N:P_2O_5$ ha^{-1} and GA 2002, NP1 x G2 = Interaction between 58:58 kg $N:P_2O_5$ ha^{-1} and Wafaq 2001, NP1 x G1 = Interaction between 58:58 kg $N:P_2O_5$ ha^{-1} and NARC 2009, NP2 x G1 = Interaction between 85:58 kg $N:P_2O_5$ ha^{-1} and GA 2002, NP2 x G2 = Interaction between 85:58 kg $N:P_2O_5$ ha^{-1} and Wafaq 2001, NP2 x G3 = Interaction between 85:58 kg $N:P_2O_5$ ha^{-1} and NARC 2009, NP3 x G1 = Interaction between 115:85 kg $N:P_2O_5$ ha^{-1} and GA 2002, NP3 x G2 = Interaction between 115:85 kg $N:P_2O_5$ ha^{-1} and Wafaq 2001, and NP3 x G3 = Interaction between 115:85 kg $N:P_2O_5$ ha^{-1} and NARC 2009.

DISCUSSION

Wheat genotype NARC 2009 performed better regarding spikelets spike^{-1} in interaction with 58:58 kg $N:P_2O_5$ .ha^{-1} which might be accredited to its response to $N:P_2O_5$ and inherent build up. Variation in spike length with different genotypes may be due to the differential behaviour of crop growth and development with varying wheat genotypes. Non-significant effect on tillers m^{-2} caused by different genotypes is in consistency to that reported by Hussain *et al*. (2006) who found that four wheat cultivars had no significant difference in tillers per meter square. The results are in partial agreement with those obtained by Hussain *et al*. (2002) who recorded statistically similar number of tillers for two wheat varieties. These results are in line with those obtained in a field experiment by Imtiaz *et al*. (2008) who determined that there was no significant difference in tillers.m^{-2} among varying nitrogen treatments. These findings are contrary to those reported by Maqsood *et al*. (2000) and Khan *et al*. (2002) who observed significant difference for tillers m^{-2} among three cultivars. This outcome might be owing to no profound disparity among the genotypes for tillers and the dissimilarity in the plant population. Relatively higher plant stature in NARC 2009 was desired especially for rainfed conditions to get benefit from the rainfall even under low rainfall conditions and to achieve more biomass for producing increased wheat straw in order to feed the livestock. The difference in plant stature among the three genotypes may be due to genetic variability. These results are in concurrence with those previously reported by Abbas *et al*. (2000), Maqsood *et al*. (2000), Khan *et al*. (2002) and Hussain *et al*. (2006), who observed diversity in plant stature among different wheat cultivars, however, these findings are differing to the results of Hussain *et al*. (2002) who found no significant difference among three wheat varieties. These findings are in conformity to those achieved by Imtiaz *et al*. (2008) who concluded non-significant differences for plant height among the three nitrogen levels. These differences might have been aroused due to differential canopy development with diverse wheat genotypes which favored increase in total dry matter and finally contributed to straw and grain yield. Effects on 1000-seed weight are in contradiction to the previously demonstrated results by Hussain *et al*. (2002), Maqsood *et al*. (2000), Khan et al. (2002) and Hussain et al. (2006), who ascribed changes in 1000-seed weight to different wheat cultivars. Preceding work of Abbas *et al*. (2000), Khan *et al*. (2002), Hussain *et al*. (2006) and Qasim *et al*. (2008) described that different wheat genotypes produced significantly unlike amounts of biomass. Significant interaction for biological yield was due to differential response of genotypes at various nutrition ratios.

Table 1. Evaluation of NARC 2009 in comparison to GA-2002 and Wafaq-2001

Treatment	**Spikelet spike^{-1}**	**Spike length (cm)**	**Tillers m^{-2}**	**Plant stature (cm)**	**1000-seed weight (g)**	**Biological yield (kg ha^{-1})**	**Harvest index (%)**	**Grain yield (kg ha^{-1})**
$N:P_2O_5$ ratios (kg.ha^{-1})								
58-58	21.22	12.62	204.0	108.5	41.80	14056	33.8	4761
85-58	21.44	11.96	221.33	107.3	40.45	12833	37.9	4825
115-85	21.78	11.92	216.44	105.8	39.46	13022	33.7	4388
LSD (5%)	NS	NS	NS	NS	NS	NS	NS	NS
Genotype								
GA 2002	21.56	12.06 ab	222.67	103.8 b	38.86	12611 b	31.8	4007 b
Wafaq 2001	20.78	11.22 b	215.78	105.2 b	40.85	13333 ab	36.3	4847 a
NARC 2009	22.11	13.23 a	203.33	112.7 a	42.01	13967 a	37.4	5120 a
LSD (5%)	NS	1.39	NS	5.74	NS	1300.2	NS	679.40
Interaction	NS	NS	NS	NS	NS	*	NS	NS

Means in a column not sharing a letter in common differ significantly at ($p<0.05$)
Interaction = Interaction between genotype and $N:P_2O_5$
NS = Non-significant; * = Significant ($p<0.05$)

Harvest index did not change with different wheat genotypes and $N:P_2O_5$ ratios. These results are inconsistent with those of Khan *et al*. (2002) who observed significant effect on HI with the different wheat genotypes. These findings might be due to different values for biological and grain yields with the no eventual effect on HI for varying genotypes. No effect on grain yield caused by different by $N:P_2O_5$ ratios is in agreement with those of Kidanu *et al*. (1999) and Imtiaz *et al*. (2008) who determined non-significant differences in grain yield with varying levels of nitrogen fertilizer application, however, these findings are differing from the outcome of Liaqat *et al*. (2003) and Shen *et al*. (2004) who depicted a significant influence of nitrogen treatments on grain yield. These results are in line with those narrated by Maqsood *et al*. (2000), Hussain *et al*. (2002), Khan *et al*. (2002) and Hussain *et al*. (2006) who recorded the significant variation among the genotypes for grain yield. Thus the use of right cultivar is supportive in stabilization of crop yields. Regression curve of grain yield of best genotype (NARC 2009) indicated that the use of such a cultivar had a grain yield of more than 5100 kg.ha^{-1}, when local check cultivar (GA-2002) was producing only 4007 kg.ha^{-1}, hence, NARC 2009 resulted in 28 percent higher grain yield compared with GA-2002.

Interactions between $N:P_2O_5$ and genotypes were non-significant except spikelets spike^{-1} and biological yield. Various $N:P_2O_5$ ratios did not produce any significant effect on grain yield and yield contributing parameters. Increase in grain yield was mainly caused by genotypes and was not the result of interaction with $N:P_2O_5$ ratios.

Highest grain yield produced with the cultivation of NARC 2009 may be attributed to the increase in thousand-seed weight, spike length and plant stature. Positive and linear relationships established between grain yield and 1000-seed weight, and grain yield and plant stature expressed the linear increase in grain yield with the enhancement in 1000-seed weight and plant stature. The reasons for variation in producing growth and yield characters might be due to genetic make up of the genotypes primarily influenced by heredity (Alam *et al*., 2007).

Conclusion

As an apposite genotype of wheat for rainfed areas, wheat genotype NARC 2009 resulted in higher grain yield, spikelets.spike^{-1}, spike length, plant stature, 1000-seed weight and biological yield. The genotype NARC 2009 gave 28 % higher grain yield than that of GA 2002. However, NARC 2009 was statistically at par with wheat cultivar Wafaq 2001. Non-significant effect of different $N:P_2O_5$ specified that using $N:P_2O_5$ at the lowest rate viz. 58-58 kg ha^{-1} is an economical ratio among the tested ones. Wheat genotype NARC 2009 and cultivar Wafaq 2001 are recommended to cultivate for rainfed areas of Pakistan to enhance wheat grain and straw yield using $N:P_2O_5$ @ 58:58 kg ha^{-1}.

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