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Evaluation of interactive effect of nitrogen rates and row spacing on the yield of wheat

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Keywords

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yield.

Abstract

Wheat is an important cereal crop and is considerably used as a food by a large population in Pakistan. The average yield of wheat is low as compared to biological potential of the existing wheat cultivars. However potential has not been fully explored due to some management constraints. To overcome this problem this study was planned to evaluate the effect of proper nitrogen rate (114 N kg/ha, 142 N kg/ha and 170 N kg/ha) with suitable row spacing (11.25, 15 and 22.5 cm) on the yield of wheat. The study was conducted at Farmer's field Okara, Pakpattan and Sahiwal districts, and the jurisdiction of Adaptive Research station Sahiwal during Rabi 2010-11 and 2011-12. The results of the study revealed that nitrogen @170 kg/ha and row spacing of 11.25 cm performed best among all the tested treatments during both study years and at both locations.

Introduction

Wheat (*Triticum aestivum* L.) as cereal crop plays a vital role in Pakistan economy and cultivated for food and feed (Iqbal et al. 2001). Many factors responsible for low yield of wheat such as cultivation of old varieties, sowing date, low seed rate, low fertilizer rates etc. As cultivars differ significantly regarding fertile tillers m^{-2}, spike length, number of grains per spike, grain and straw yield (Naeem, 2001; Ali et al. 2010). It is used to produce a large variety of foods that include many kinds and types of breads, cakes, noodles, crackers, pasta, breakfast foods, biscuits, cookies and confectionary items. Annual wheat production in Pakistan from 2004-05 through 2009-10 averaged 22.5 million tons, about 80 percent of which was produced in Punjab (GOP, 2009-10). The scarcity of any nutrient in the soil can be a barrier for the growth of crops even when all other nutrients are in excess in the soil (Soleymani and Shahrajabian 2012).

Among all other factors responsible for low yield of wheat in our part of the world, poor crop nutrition, imbalance use of fertilizer and improper row spacing are of much importance. Zia *et al.* (1991) indicated that the use of correct fertilizer can increases yield up to 50 % in Pakistan. Time of fertilizer application can affect the N utilization efficiency by cereals (Ragheb et al., 1993). In boosting the agricultural productivity, nitrogen is apparently the most contributing fertilizer (Touchton, 1987). Ahmad and Rashid (2004) reported that the application of recommended level of NPK significantly increased the yield of wheat by 224 % over control (1302 kg ha^{-1}). Dwyer *et al.* (1991)

observed that narrow row spacing causes higher leaf photosynthesis and suppresses weeds growth compared with wider row spacing. Narrow row spacing also produces high leaf area index (LAI), which results in more interception of photosynthetically active radiation (PAR) and dry matter accumulation (DMA) (Tollenaar and Auguilera, 1992). Approximately 50 to 90 percent of N and P in the plant at flowering moves from the leaves and stem to the developing seed (Chapin, et al. 1988).

The climate of Sahiwal Division is extremely hot, reaching 45-50 degrees Celsius max in summers, and cold in winter down to 5-10 degree Celsius. The soil of the division is very fertile. The average rainfall is about 2000 mm. Sahiwal Division is in the southeast of Punjab. From Multan Division it lies between 30-40 north latitude and 73-06 longitude. It is 500 ft (150 m) above sea level**.** Keeping in view the importance of wheat crop, the present study was conducted to see the effect of different doses of phosphorus with gypsum on the grain yield of wheat in ecological zone of Sahiwal.

Materials and Methods

The study was conducted at Farmer's field Okara, Pakpattan and Sahiwal districts, and the jurisdiction of Adaptive Research station Sahiwal during Rabi 2010-11 and 2011-12. The experiment was laid out during 4th week of November 2010 at two sites (Chak No. 100/9-L Sahiwal and Chak No. 84/D Okara). The trial was repeated at two locations during 4th week of November 2011 at two sites (Chak No. 22/2-L Okara and Chak No. 7/14-L Sahiwal). The trial was laid out in split plot design with three replications in a net plot size 4x20 m. Wheat cultivar Sehar 2006 was sown using seed rate 150 kg per hectare. Urea, DAP and SOP were used as a source of nitrogen, phosphorus and potash. The following nitrogen rates kg/ha and row spacing were evaluated.

Main Plot (Nitrogen rates kg/ha)

N1 114 N kg/ha
N2 142 N kg/ha
N3 170 N kg/ha

Sub plot (row spacing)

S1 11.25 cm
S2 15.00 cm
S3 22.5 cm

All the agronomic practices were kept the same for all treatments. Observation on germination (m^{-2}), final plant height (cm), number of tillers m^{-2}, 1000 grain weight (g) and grain yield (kg ha^{-1}) were recorded using standard procedures. Data collected on different parameters were analyzed statistically by using M STAT-C programme (Anonymous,1986) for analysis of variance and means were separated using Fisher's protected least significant difference (LSD) test at 5% probability level (steel *et al*., 1997).

Results and Discussion

Germination (m^{-2})

It is obvious from the data presented in the tables-1 and 2 that at only one place and during only 2011-12 the germination was affected by only row spacing having significant effect on the said parameter. S1 gave best germination m^{-1} than S2 and S3 both of which were statistically at par with each other. Nitrogen rates did not have significant effect on germination m^{-1} of wheat. Interaction between nitrogen rates and row spacing was non significant. It is well known fact that NPK application boosts crop growth and development. These results are in agreement with those of Rochester *et al*. (2001).

Table 1: Impact of nitrogen rates and row spacing on germination m^{-1} at Okara during 2010-11

	N1	N2	N3	Mean
S1	239	240	238	239a
S2	234	234	235	234.33b
S3	235	232	232	233bc
Mean	236a	235.33a	235a	**235.44**

Table 1: Impact of nitrogen rates and row spacing on germination m^{-1} at Okara 2011-12

	N1	N2	N3	Mean
S1	282.67	281.33	284.67	282.89 a
S2	273.67	269.33	274.00	272.33 b
S3	271.67	268.00	265	268.22 c
Mean	276a	272.89b	274.56ab	**274.48**

Table 2: Impact of nitrogen rates and row spacing on germination m^{-1} at Sahiwal 2010-11

	N1	N2	N3	Mean
S1	234	239	228	233.67a
S2	228	226	222	225.33b
S3	231	220	220	223.67bc
Mean	231.22a	228.44b	223.33c	**227.6**

Table 2: Impact of nitrogen rates and row spacing on germination m^{-1} at Sahiwal 2011-12

	N1	N2	N3	Mean
S1	285	288	285	286 a
S2	279	276	273	276 b
S3	274	273	272	273 bc
Mean	279.44a	279a	276.67ab	**278.37**

Number of tillers m^{-2}

It is apparent from the data presented in the tables-3 and 4 for number of tillers m^{-2} that only row spacing had significant effect on number of tillers m^{-2} only during 2010-11 and only at Sahiwal, where S1 produced highest number of tillers m^{-2} than S2 and S3 both of which were statistically at par with each other. Nitrogen rates had no significant effect on number of tillers m^{-2} of wheat. Interaction between nitrogen rates and row spacing was also non significant.

Table 3: Impact of nitrogen rates and row spacing on No. of tillers m^{-2} at Okara 2010-11

	N1	N2	N3	Mean
S1	339	341	344	341.33a
S2	333	334	337	334.67b
S3	327	331	332	330c
Mean	333c	335.33ab	337.67a	**335.33**

Table 3: Impact of nitrogen rates and row spacing on No. of tillers m^{-2} at Okara 2011-12

	N1	N2	N3	Mean
S1	349.33	351.33	350.33	350.33
S2	340.33	338.67	343.67	340.89
S3	334.33	337.67		336
Mean	341.33	342.56	347	**343.63**

Table 4: Impact of nitrogen rates and row spacing on No. of tillers m^{-2} at Sahiwal 2010-11

	N1	N2	N3	Mean
S1	365.67	364	371.67	367.11 a
S2	354.67	359	354.67	356.11 b
S3	343.67	347.33	358	349.67 c
Mean	354.67bc	356.78b	361.45a	**357.63**

Table 4: Impact of nitrogen rates and row spacing on No. of tillers m^{-2} at Sahiwal in 2011-12

	N1	N2	N3	Mean
S1	374	371	374	373a
S2	370	375	373	372.67b
S3	371	369	372	370.67b
Mean	371.78ab	371.56ab	373a	**372.11**

Plant height (cm)

The data offered in the tables-5 and 6 for plant height illustrates that both nitrogen rates and row spacing had significant impact on plant height of wheat at all the places and during both the years. S1 produced tallest plants than S2 and S3 at all locations during both the years while N3 resulted in maximum plant height than N1 and N2 at all locations during both the study years. There was no interactive effect of nitrogen rates and row spacing in this regard.

Table 5: Impact of nitrogen rates and row spacing on plant height (cm) at Okara during 2010-11

	N1	N2	N3	Mean
S1	111.53	113.77	116.77	114.02 a
S2	109.07	111.67	114.73	111.82 b
S3	107.83	112.60	113.43	111.28 b
Mean	109.48 c	112.67 b	114.98 a	**112.38**

Table 5: Impact of nitrogen rates and row spacing on plant height (cm) at Okara during 2011-12

	N1	N2	N3	Mean
S1	101.43	104.23	106.77	104.14 a
S2	9.93	103.23	104.83	102.45 a
S3	95.30	101.70	102.6	99.87 b
Mean	98.56 b	103.06 ab	104.73 a	**102.12**

Table 6: Impact of nitrogen rates and row spacing on plant height (cm) at Sahiwal in 2010-11

	N1	N2	N3	Mean
S1	110.5	113.20	115.5	113.07 a
S2	106.9	110.17	113.73	110.27 b
S3	105.03	108.3	110.63	107.99 c
Mean	107.48 c	110.56 b	113.29 a	**110.44**

Table 6: Impact of nitrogen rates and row spacing on plant height (cm) at Sahiwal in 2011-12

	N1	N2	N3	Mean
S1	106	110	112	109.33 a
S2	105	107	111	107.67 ab
S3	101	105	109	105.00 b
Mean	103.91 c	107.32 b	110.57 a	**107.27**

1000 grain weight (g)

It is evident from the data presented in the tables 7 and 8 for 1000 grain weight in grams that row spacing had both significant and non significant effect on the said parameter, it is significant at Okara but only during 2011-12 where S3 produced maximum grain weight, S1 produced lowest and S2 in between these two row spacing treatments. Row spacing also affected 1000 grain weight significantly at Sahiwal during 2011-12 where S3 produced maximum grain weight than S1 ans S2 both of which were statistically at par with each other.

Nitrogen rates had also significant as well as non significant effect on studied parameter. 1000 grain weight was significantly affected by the nitrogen rates at Okara but only during the year 2011-12 where N3 resulted in highest grain weight than N1 and N2 both of which were statistically at par with each other. Thousand grain weight was also significantly affected by the nitrogen rates at Sahiwal but only during the year 2010-11 where N3 resulted in highest grain weight, N1 produced lowest and N2 produced higher than N1 but lower than N3.

No interactive effect of nitrogen rates and row spacing was observed on 1000 grain weight as in the case of all other parameters.

Table 7: Impact of nitrogen rates and row spacing on 1000 grain Wt. (cm) at Okara in 2010-11

	N1	N2	N3	Mean
S1	46.33	48	51.33	48.55
S2	47.67	48.67	52.33	49.56
S3	47	49	52.66	49.55
Mean	47	48.56	52.11	**49.22**

Table 7: Impact of nitrogen rates and row spacing on 1000 grain Wt. (cm) at Okara in 2011-12

	N1	N2	N3	Mean
S1	35	37	39.33	37.11 c
S2	37.33	38.33	40	38.55 b
S3	38.67	39.33	43	40.33 a
Mean	37 b	38.22 b	40.78 a	**38.67**

Table 8: Impact of nitrogen rates and row spacing on 1000 grain Wt. (cm) at Sahiwal in 2010-11

	N1	N2	N3	Mean
S1	35.67	39.33	43	39.33
S2	36.33	40.33	43.33	40
S3	37.67	41.33	45.33	41.44
Mean	36.56 c	40.33 b	43.89 a	**40.26**

Table 8: Impact of nitrogen rates and row spacing on 1000 grain Wt. (cm) at Sahiwal in 2011-12

	N1	N2	N3	Mean
S1	36	37	38	37 b
S2	37	38	39	38 b
S3	39	41	43	41 a
Mean	37.33	38.78	40.22	**38.7**

Grain yield (kg ha^{-1})

The data presented in the tables-9 and 10 for grain yield demonstrated that both nitrogen rates and row spacing had significant impact on grain yield of wheat at all the places and during both the years except at Sahiwal during 2010-11 where only row spacing had non significant effect on the grain yield of wheat. Where had significant effect, S1 resulted in highest grain yield than S2 and S3 while N3 resulted in maximum plant height than N1 and N2 at all locations during the both years. There was no interactive effect of nitrogen rates and row spacing in this regard.

Table 9: Impact of nitrogen rates and row spacing on 1000 grain yield (kg/ha) at Okara, 2010-11

	N1	N2	N3	Mean
S1	4100	4590	4866.67	4518.89 a
S2	3933	4400	4640	4324.33 b
S3	3786.67	4246.67	4496.67	4176.67 c
Mean	3940 c	4412.22 b	4667.78 a	**4340**

Table 9: Impact of nitrogen rates and row spacing on 1000 grain yield (kg/ha) at Okara, 2011-12

	N1	N2	N3	Mean
S1	4093.33	4363.33	4533.33	4330.00 a
S2	3933.33	4160	4353.33	4148.89 b
S3	3750	4036.67	4170	3985.56 c
Mean	3925.56 c	4186.67 b	4352.22 a	**4154.82**

Table 10: Impact of nitrogen rates and row spacing on 1000 grain yield (kg/ha) at Sahiwal, 2010-11

	N1	N2	N3	Mean
S1	3463	3900	4430	3931a
S2	3380	3840	4530	3916.67a
S3	3277	3817	4433	3842.33ab
Mean	3373.33 c	3852.22 b	4446.44 a	**3890.66**

Table 10: Impact of nitrogen rates and row spacing on 1000 grain yield (kg/ha) at Sahiwal, 2011-12

	N1	N2	N3	Mean
S1	4267	4553	4977	4599.00 a
S2	4130	4423	4783	4445.33 b
S3	4043	4250	4763	4352.00 c
Mean	4146.67 c	4408.89 b	4841.11 a	**4465.56**

Conclusion

From the results of this study it is concluded that nitrogen @170 kg/ha performed best among other nitrogen rates and row spacing of 11.25 cm performed best among other tested row spacing in agro ecological conditions of Okara and Sahiwal. Interaction between nitrogen rates and row spacing had no significant effect in this study.

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