Indian Journal of Agronomy **58** (4): 611–614 (December 2013)

Research Communication

Effect of dates of sowing and fertilizer on growth and yield of wheat (*Triticum aestivum*) in an *Inceptisol* of Varanasi

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Received : December 2012; Revised accepted : October 2013

ABSTRACT

A field experiment was conducted during the winter (*rabi*) season 2010–11 at Agricultural Research Farm, BHU, Varanasi, Uttar Pradesh, to study the effect of sowing dates and fertilizer levels on growth and yield of wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.]. Sowing dates and fertilizer levels significantly affected the number of tillers, plant height, dry-matter accumulation, ear weight, ear length, grains/ear, 1,000-grain weight, grain and straw yield. Grain yield decreased with delay in the sowing dates. Maximum grain yield (3.66 t/ha) was recorded when the crop was sown on 20 November and the minimum (3.17 t/ha) when sown on 23 December.

Key words **:** Crop production, Fertilizer, Sowing dates, Wheat

Wheat is the most important cereal crop because it is the staple food of the people of India. Weather is one of the key factor influencing agricultural production and productivity. In weather factors, temperature is the driving force of plant development; day length and vernalization moderate its effect. Consequently, different varieties with different genetic make-up mature at different rates but the difference is greater when sown early. In spite of cultivation of high-yielding varieties, improved cultural practices and plant-protection measures, favourable weather is must for good harvests (Rao *et al*., 1999). Fertilizers constitute an integral part of improved crop-production technology. Proper amount of fertilizer application is considered a key to the bumper crop production (Tariq *et al.,* 2007). Inorganic fertilizers hold the key to desired increase in yield of food-grain. Studies showed a direct relationship between increased balanced fertilizer uses for higher crop yields. Past many years have shown a significant change in temperature and rainfall pattern. Therefore, it was realized to study the effect of different sowing dates and fertilizer levels to cope up with the changing weather pattern of the region. During the last 8 years, variability in onset of monsoon, decreased rainfall and slight increase in temperature has prompted to study the effect of sowing dates and fertilizer levels on growth and yield of wheat.

A field experiment was conducted during the winter of *rabi* season of 2010–11 at the Agricultural Research Farm, Institute of Agricultural Sciences, BHU, Varanasi (25° 18' N, 83° 03' E and 128.93 m above mean sea-level). District Varanasi is in semi-arid to sub humid climate zone, mean maximum temperature ranged from 39 to 42° C, while minimum temperature from 9 to 10° C. The mean annual rainfall is about 1,100 mm. The weekly mean maximum and minimum temperature during the experiment ranged from 14.2 to 37.3° C and 4.8 to 21.8° C, respectively. The soil belongs to Inceptisol, had sandy loam texture, particle density 2.68 Mg/m^3, bulk density 1.35 Mg/m^3, pH (1:2.5, soil: water) 7.3; electrical conductivity 0.27 dS/m; organic carbon 4.3 g/kg and available nitrogen 184.6 kg, phosphorus 14.2 kg and potassium 153.7 kg/ha. The experiment comprised 9 treatment combinations (3 dates of sowing: 20 November, 6 December, 23 December 2010 and 3 levels of fertilizer: 120, 60 and 60; 80, 40 and 40; 80, 40 and 00 kg N, P_2O_5 and K_2O/ha) with 3 replications under split-plot design. Date of sowing was kept in main plot and fertility levels in subplot with plot size of 5m × 3.5 m. Full dose of phosphorous and potassium and one-third nitrogen was applied at the time of sowing through diammonium phosphate, muriate of potash (MOP) and urea. Remaining nitrogen was applied in 2 equal splits at first and second irrigation.

The crop sown on 20 November achieved highest plant height, number of tillers, dry-matter accumulation/plant, being significantly higher than that sown on 6 and 23 De-

Based on M.Sc. (Ag) thesis of first author submitted to BHU, Varanasi (unpublished)

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cember (Table 1). This might be attributed to maximum length of growing period available to 20 November sown crop in comparison to 6 and 23 December sown crop. Cell division and cell expansion are more sensitive to low temperature than is photosynthesis. Temperature increase tends to stimulate growth which in turn results in a dilution of carbohydrates and chlorophyll. Thus the findings confirm those of Baloch *et al*. (2010). At 90 days after sowing, plant height was maximum with application of 120, 60 and 60 kg/ha N, P_2O_5 and K_2O and at this dose number of tillers and dry-matter accumulation was maximum. Plant height increased with an increase in fertilizer dose. Similar responses were also recorded by Niamatullah *et al.* (2011).

The ear length, grains/ear, ear weight and test weight were influenced significantly by the dates of sowing. The highest ear length, grains/ear, ear weight and test weight were recorded in 20 November sown wheat, followed by 6 December. All these attributes significantly decreased with delay in date of sowing. It might be due to longer and favourable period of ear formation resulting more spikelet's development and greater chances of producing long ears containing a large number of grains. Shirpurkar *et al.* (2008) also reported such results. Among the levels of fertilizer, 120, 60 and 60 kg/ha N, P_2O_5 and K_2O gave the highest ear length, grains/ear, ear weight and test weight, closely followed by 80, 40, 40 kg/ha and both were significantly higher than 80, 40 and 00 kg N, P_2O_5 and K_2O application. Potassium ion has a beneficial influence on the development of endosperm cells and hence on the single grain weight of cereals. The differences in ear length might be attributed to their difference in supply of available nutrients. Singh *et al.* (2011) also reported that the yield attributes are mainly controlled by the fertilizer dose.

The highest yield of grain 3.66 and straw 4.95 t/ha and harvest index were recorded in 20 November sown wheat (Table 1), followed by 6 and 23 December sown crop. A significant decrease in grain yield was recorded with successive delay in date of sowing, but its effect on the harvest index was found non-significant. Lower grain yield in late-sown wheat could be due to less favourable period for maturity. High temperature and hot winds forced maturity of the crop and maturation period is shortened; this can also occur if the crop is deficient of N and other nutrients, which results in decrease in grain and straw yield. The early-sown crop, on the other hand, having favourable weather conditions for longer duration recorded better growth. These results are in close conformity with the observation of Shivani *et al*. (2001). Among the fertilizer doses, the highest grain and straw yield and harvest index were recorded with application of N, P_2O_5 and K_2O @ 120, 60 and 60 kg/ha. It was significantly superior to 80, 40 and 40 kg/ha and 80, 40 and 00 kg/ha N, P_2O_5 and K_2O application. The differences in grain yield might be attributed to difference in doses of N, P and K. The lower level of N nutrition during the grain-filling period resulted in yield reduction, which was largely accounted by the smaller grains, obtained in this condition. Yadav *et al.* (2005) found that the grain yield is mainly controlled by the fertilizer dose.

Changing the sowing time influenced the amount of total protein and leaf chlorophyll content (Table 1), probably driven by the differential thermal conditions prevailing during the grain filling period. The crop sown on 20 November recorded highest protein and chlorophyll content, which was significantly higher than the crop sown on the other dates. The high temperature during growth period of 20 November sown crop induced increase in nitrogen accumulation than dry matter accumulation leading to

Table 1. Effect of dates of sowing and fertilizer levels on growth and yield parameters of wheat

Treatment	Plant height (cm)	Tillers/ running m	DM accumulation/ plant (g)	Ear length (cm)	Grains/ ear	Ear weight (g)	Test weight (g)	Yield (t/ha)		Harvest index (%)	Protein content (%)	Chlorophyll content at 60 DAS (SPAD)
	at 90 DAS							Grain	Straw			
Date of sowing												
20 Nov.	83.0	124.0	9.89	8.88	52.4	2.32	36.11	3.66	4.95	34.17	9.43	35.40
6 Dec.	80.0	119.0	9.61	8.62	49.5	2.25	34.88	3.40	4.59	33.58	9.01	34.19
23 Dec.	77.6	108.2	9.32	8.33	45.4	2.10	31.94	3.17	4.29	32.56	8.59	32.42
SEm±	0.7	1.0	0.06	0.05	0.6	0.04	0.81	0.08	0.12	0.44	0.09	0.36
CD (P=0.05)	2.9	4.2	0.24	0.20	2.6	0.16	3.17	0.35	0.47	NS	0.39	1.42
Fertilizer level (N, P_2O_5 and K_2O kg/ha)												
120,60,60	82.9	123.2	9.97	8.80	51.2	2.35	36.09	3.72	5.02	34.07	9.40	36.53
80,40,40	80.2	116.4	9.68	8.64	49.4	2.25	34.13	3.41	4.60	33.49	9.01	34.80
80,40,00	77.6	111.5	9.17	8.39	46.7	2.08	32.72	3.11	4.20	32.76	8.63	30.67
SEm±	1.0	2.4	0.08	0.10	1.0	0.04	0.85	0.05	0.07	0.23	0.17	0.95
CD (P=0.05)	3.3	7.4	0.25	0.32	3.0	0.11	2.62	0.16	0.21	0.69	0.53	2.92

Table 2. Effect of dates of sowing and fertilizer levels on nutrient uptake by wheat and post harvest soil properties

Treatment	Nutrient uptake (kg/ha)						Soil properties					
	Nitrogen		Phosphorus		Potassium		pH	EC	Org C.	Available (kg/ha)		
	Grain	Straw	Grain	Straw	Grain	Straw		(dS/m)	(%)	N	P	K
Dates of sowing												
20 Nov.	55.48	38.94	13.55	2.67	17.93	111.42	6.98	0.36	0.85	203	20.33	163.11
6 Dec.	49.11	34.21	11.90	2.41	15.37	103.38	7.00	0.38	0.83	202.78	19.89	159.56
23 Dec.	43.92	30.41	10.46	2.18	13.65	95.88	6.94	0.35	0.82	199.33	19.33	156.11
SEm±	1.25	1.08	0.29	0.07	0.51	1.33	0.04	0.01	0.003	2.25	0.76	1.88
CD (P=0.05)	4.90	4.25	1.12	0.28	1.99	5.21	NS	NS	0.02	NS	NS	NS
Fertilizer level (N, P_2O_5 and K_2O)												
120,60,60	56.20	38.80	14.16	2.75	18.70	122.91	6.87	0.38	0.86	215.56	22.56	169.78
80,40,40	49.27	34.36	11.63	2.37	16.68	111.08	7.01	0.35	0.84	195.89	19.00	166.00
80,40,00	43.03	30.40	10.11	2.15	11.58	76.71	7.04	0.35	0.80	193.67	18.00	143.00
SEm±	1.34	0.68	0.50	0.06	0.47	2.99	0.04	0.01	0.015	2.76	0.67	1.77
CD (P=0.05)	4.13	2.11	1.55	0.18	1.45	9.21	0.13	0.02	0.05	8.49	2.06	5.45

higher protein and chlorophyll content. This was particularly evident when compared with 6 and 23 December sown crops. Similar results were also reported by El-Gizawy (2009) and Guixia (2010). Protein and leaf chlorophyll content increased significantly with increase in application of fertilizer especially nitrogen. The maximum protein and chlorophyll content were observed with treatment having higher application of N, P_2O_5 and K_2O @ 120, 60 and 60 kg/ha and this value was significantly higher than the treatment supplied with 80, 40 and 00 kg/ha N, P_2O_5 and K_2O. Amin *et al.* (2011) also reported significantly higher protein content with higher fertilizer application.

The nutrients uptake by grain and straw (Table 2) decreased significantly with delayed sowing. The highest N, P and K uptake by grain 55.48, 13.55 and 17.93 kg/ha, respectively, and in straw 38.94, 2.67 and 111.42 kg/ha, respectively, was recorded in the wheat sown on 20 November. The uptake of nutrients by crop is mainly a function of yield of that plant material and efficient development of root system. With the delay in sowing, the growth and yield of crop reduced, resulting low uptake of nutrients. El-Gizawy (2009) also found that the nutrients uptake by grain and straw decreased with delay in sowing. Among the doses of fertilizer, the highest amount of N, P_2O_5 and K_2O uptake by grain and straw was observed with N, P_2O_5 and K_2O @ 120, 60 and 60 kg/ha. The new high-yielding varieties required higher amount of fertilizers and higher nutrient removal by plants. Similar results were reported by Amin *et al.* (2011).

Post harvest soil (Table 2) of wheat did not show any significant change in pH and electrical conductivity with respect to dates of sowing. However, organic carbon content of soil decreased significantly with the delay in sowing date, as plant vegetative growth decreased due to reduced growing period of crop, which produced less roots and leaves biomass that determined organic carbon status of soil. Maximum organic carbon content was recorded in earliest sown crop. This was statistically at par with 6 December and significantly higher than the 23 December sown crop. Usually organic carbon is mainly controlled by added organic manures and humus content of soil but it was also affected by added fertilizers as it affects the production of crop residue and root biomass. The available nitrogen, phosphorus and potassium contents in post harvested soil (Table 2) were not significantly influenced by the dates of sowing. The level of available nutrients increased significantly with each successive increase in fertilizer levels in soil. The higher content of available N, P and K, was observed with 120, 60 and 60 as compared with application @ 80, 40 and 00 kg of N, P_2O_5 and K_2O/ha. Amount of added fertilizers determines the availability of nutrients to the crop and its content in post harvest soil.

The study revealed that crop sown on 20 November with application of 120, 60 and 60 kg/ha of N, P_2O_5 and K_2O had maximum height, number of tillers, dry matter/plant, grain and straw yield, nutrients, chlorophyll, protein content and nutrient uptake by wheat in Varanasi region of eastern Uttar Pradesh.

REFERENCES

Amin, G.A.M., Geweifel, H.G., Gomaa, M.A., El-kholy, M.A. and Mohamed, M.H. 2011. Effect of sowing methods and fertilization on yield analysis and grain quality of wheat under new reclaimed sandy soil. *Journal of Applied Sciences Research* **7**(12): 1760–67.

Baloch, M.S., Shah, I.T.H., Nadim, M.A., Khan, M.I. and Khakwani, A.A. 2010. Effect of seeding density and planting time on growth and yield attributes of wheat. *Journal of Animal and Plant Sciences* **20**(4): 239–40.

El-Gizawy, N.K.B. 2009. Effect of planting date and fertilizer appli-

cation on yield of wheat under no till system. *World Journal of Agricultural Sciences* **5**(6): 777–83.

Guixia, Y.G. 2010. Effect of Sowing Date and Density on Grain Yield and Nutrition Quality and Physiological Index of Winter Wheat. *Journal of Triticeae Crops* **4**: 20–25.

Niamatullah, M., Khan, M., Khan, M.Q., Sadiq, M., Zaman, K.U., Hayat, C.S. and Rehman, S. 2011. Impact of NPK applications on the number of productive tillers and cost benefit analysis of wheat in Hill-Torrent irrigated area of D.I. Khan Division, Khyber Pakhtoonkhwa. *The Journal of Animal and Plant Sciences* **21**(2): 211–14.

Rao, G.G., Rao, Kesava, S.N., Rao, A.V.R., Ramakrishna, Y.S. and Victor, W.S. 1999. Resources characterization of Drylands: Climate (In) Fifty Years of Dryland Agricultural Research in India Singh *et al*., (Eds.) CRIDA, Hyderabad.

Shirpurkar, G.N., Wagh, M.P. and Patil, D.T. 2008. Comparative performance of wheat genotypes under different sowing dates. *Agricultural Science Digest* **28**(3): 231–32.

Shivani, Verma, U.N., Kumar, S., Pal, S.K. and Thakur, R. 2001. Growth analysis of wheat (*Triticum aestivum*) cultivars under different seeding dates and irrigation levels in Jharkhand. *Indian Journal of Agronomy* **48**(4): 282–86.

Singh C.M., Sharma, P.K., Kishor P., Mishra, P.K., Singh, A.P., Verma, R. and Raha, P. 2011. Impact of integrated nutrient management on Growth, Yield and Nutrient Uptake by Wheat (*Triticum aestivum* L.). *Asian Journal of Agricultural Research* **5**(1): 76–82.

Tariq, J.M.T., Arif, M., Akbar, H. and S. Ali. 2007. Response of wheat to source, type and time of nitrogen application. *Sarhad Journal of Agriculture* **23**(4): 871–79.

Yadav, M.P., Aslam, M. and Kushwaha, S.P. 2005. Effect of integrated nutrient management on rice (*Oriza sativa*)–wheat (*Triticum aestivum*) cropping system in Central Plain Zone of Uttar Pradesh. *Indian Journal of Agronomy* **50**(2): 89–93.