The Bioscan 15(4): 449-452, 2020
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EFFECT OF SOWING DATES AND NITROGEN LEVELS ON GROWTH, YIELD ATTRIBUTES AND YIELDS OF WHEAT (*Triticum aestivum* L.) VARIETIES UNDER SEMI-ARID CONDITIONS

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KEYWORDS
Nitrogen levels
Sowing dates
Wheat varieties
Yield

Received on :
20.08.2020

Accepted on :
10.09.2020

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ABSTRACT

A field experiment was conducted at S.K.N. college of Agriculture, Jobner during *rabi* seasons of 2015-16 and 2016-17 to evaluate the effect of 2 sowing dates (20 November and 10 December), 3 wheat varieties (Raj-4083, Raj-3777 and Raj-4037) and 4 levels of nitrogen (control, 40, 80 and 120 kg/ha). The results revealed that growth parameters, yield attributes and yield were significantly higher under 20 November sowing as compared to 10 December sowing. The decrease in grain yield due to 10 December sowing over 20 November was to the tune of 18.1 and 14.8% during 2015-16 and 2016-17, respectively. Among the varieties, Raj-4037 was found to record significantly highest growth, yield attribute, grain (4406 and 4510 kg/ha), straw (5608 and 5742 kg/ha) and biological yield (10014 and 10253 kg/ha) over Raj-4083 and Raj-3777. With increase in nitrogen level up to 120 kg/ha, there was significantly increases in plant height, total number of tillers/m row, dry matter accumulation/m row, LAI, LAD, effective tillers/m row, grains/spike, grain (4516 and 4645 kg/ha), straw (5893 and 6054 kg/ha) and biological yield (10409 and 10699 kg/ha) of wheat over control and 40 kg N/ha which was statistically at par with 80 kg N/ha during 2015-16 and 2016-17. Thus it was concluded that 20 November sowing with variety Raj-4037 and application of 80 kg N/ha was recorded significantly higher crop growth, yield attributes and yields of wheat.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is important cereal crop after rice grown under diverse agro climatic conditions in India. Wheat was grown on an area of 29.6 million ha with production of 99.7 million tonnes and productivity of 3,371 kg/ha (GOI, 2018). Weather is one of the key factor influencing agricultural production and productivity. The physiological and physical processes of plants are temperature dependent. As evident the increase in the rate of these processes corresponds to increase in yield. In general, the weather conditions to which the crop is exposed during its life cycle is considered to be principal input parameter affecting productivity despite availability of other input and improved crop husbandry. The optimum time of sowing can provide congenial conditions to have maximum light interception, best utilization of moisture and nutrients from early growth stage to grain filling stage. It governs the crop phenological development and total biomass production along with efficient conversion of biomass into economic yield. Genetic potential of different varieties vary under different climatic conditions. Being a thermo-sensitive crop, choice of suitable variety for different sowing time further gets prime importance. Because of genetic variation, different varieties of crop may differ in growth and development behaviour and response to different management practices (Singh *et al.*, 2010). The development and recommendation of high yielding adaptable varieties is considered to be the first step to generate maximum production. Growing of suitable variety at an appropriate time is essential for ensuring optimum productivity. Among essential plant nutrients, nitrogen plays key role in augmenting agricultural production and its deficiency limits crop production (Pathak *et al.*, 2003). Nitrogen is an essential constituent of plant proteins and chlorophyll and is present in many other compounds of greater physiological importance in plant metabolism *viz*., nucleotides, phospholipids, enzymes, hormones, vitamins etc. Nitrogen plays major role in early establishment of plant leaf area, increasing photosynthesis and root development to enable more efficient use of weather and water. Nitrogen is an indispensable element for optimum functioning of crops (Shivay, 2007). Therefore, in order to find out the effect of sowing dates and nitrogen on growth and productivity of wheat varieties, the present investigations were under taken.

MATERIALS AND METHODS

The field experiment was conducted during rabi season of two consecutive years, 2015-16 and 2016-17 at Agronomy Farm, S.K.N. College of Agriculture, Jobner situated at 26°05′ N latitude, 75°28′ E longitude and an altitude of 427.0 m above mean sea level. This region falls under agro-climatic zone III-A "Semi-arid Eastern Plain Zone" of Rajasthan. Soil of the experimental site were loamy sand in texture and alkaline in reaction (8.3 and 8.2), low in available nitrogen (128.9 and 132.1 kg/ha), medium in phosphorus (15.3 and 14.9 kg/ha) and potassium (148.6 and 149.1 kg/ha) during the years 2015-16 and 2016-17, respectively. The experiment was laid out in split plot design with three replications. The experiment consisted two sowing dates (20 November and 10 December), three varieties (Raj-4083, Raj-3777 and Raj-4037) assigned in main plots and four levels of nitrogen (control, 40, 80 and 120 kg/ha) in sub plots. Nitrogen was applied through urea as per treatment. The recommended dose of phosphorus (30 kg/ha) was applied through single super phosphate at the time of sowing as a basal. Other management practices were adopted as per recommendations of the crop under irrigated conditions. The periodic observation on plant height, total tillers/m row, dry matter accumulation/m row and LAI were recorded at 30 days interval. Computation on the LAI was calculated as per the procedure given by Watson (1958).

$$\mathrm{LAI} = \frac{\text{Leaf area}(\mathrm{cm}^2)}{\text{Ground area}(\mathrm{cm}^2)}$$

LAD was calculated with the formula (Power *et al.*, 1967):

$$\mathrm{LAD(days)} = \frac{A_o + A_1}{2}(t_1 - t_0)$$

Where, 'A' is leaf area index, 't' is the time in days and subscript refers to sampling. The observation interval was 30 days.

For the purpose of recording dry matter accumulation/m row length, the samples were dried in the air for few days and finally in oven at 65ºC temperature till constant weight. At maturity, after leaving the two border rows on each side as well as 50 cm along the width of each side, a net plot area of 3.0 m x 1.35 m was harvested separately for recording the yield. After sun drying, the dried bundles of individual net plots were weighed separately to record biological yield, then threshed and winnowed manually. The experimental data for various growth parameters and yield were statistically analyzed by using the F-test. The significance of treatment effects were computed with the help of critical difference (CD) at P = 0.05 by determining the difference between mean values of treatments.

RESULTS AND DISCUSSION

Growth parameters

Sowing dates

Significant differences were exhibited with date of sowing on growth parameters (Table 1). Date of sowing significantly influenced the growth parameters *viz*. plant height, total number of tillers/m row length, dry matter accumulation/m row length, leaf area index (LAI), and leaf area duration (LAD). Crop sown on 20 November recorded significantly higher plant height (7.9% and 10.5%), total number of tillers/m row length (5.1% and 4.6%), dry matter accumulation (24.2% and 23.7%), LAI (19.1% and 18.9%), and LAD (16.6% and 17.1%) during 2015-16 and 2016-17, respectively over 10 December sown crop. This was attributed due to maximum period available to 20 November sown crop in comparison to late sown crop, resulting in taller plant. In late sown crop, dry matter accumulation/m row length was decreased. This was mainly because of production of more number of tillers/m row length at 20 November sowing (Shahzad *et al.*, 2007 and Pankaj *et al.*, 2015).

Varieties

Wheat varieties showed significant difference for leaf area duration (Table 1). The highest LAD was recorded in Raj-4037 which was significantly superior over Raj-3777 but statistically at par with Raj-4083 during both the years. The magnitude of increases with Raj-4037 was 5.8 and 6.1 days over Raj-3777 during 2015-16 and 2016-17, respectively. Plant height, total number of tillers/m row length, dry matter accumulation/m row length and LAI at 30 DAS were not differ significantly among the tested varieties during both the years. The inherent

Table 1: Effect of sowing dates, varieties and nitrogen levels on growth parameters of wheat

Treatment	Plant height (cm) at 30 DAS		Total no. of tillers/m row at 30 DAS		Dry matter accumulation/m row (g) at 30 DAS		LAI at 30 DAS		LAD (Day) at 30-60 DAS	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2015-16	2015-16	2016-17
Sowing dates										
20-November	20.6	21	109.2	109.6	18.5	18.8	0.262	0.264	36.5	36.9
10-December	19.1	19	103.9	104.8	14.9	15.2	0.22	0.222	31.3	31.5
SEm +	0.3	0.3	1.5	1.6	0.3	0.3	0.004	0.004	0.47	0.55
CD (P = 0.05)	1	0.9	4.8	4.7	0.8	0.8	0.012	0.012	1.48	1.72
Varieties										
Raj-4083	19.7	20	106.7	107.5	16.8	17	0.24	0.242	34.6	34.9
Raj-3777	20.3	20.2	104.8	105.2	16.3	16.7	0.235	0.24	30.6	30.8
Raj-4037	19.5	19.8	108.1	108.9	17	17.2	0.248	0.246	36.4	36.9
SEm +	0.4	0.4	1.9	1.9	0.3	0.3	0.005	0.005	0.58	0.7
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	1.81	2.11
Nitrogen levels (kg/ha)										
0	18.3	18.4	103.1	103.6	14.4	14.7	0.216	0.217	30.2	30.4
40	19.5	19.7	106.6	107.1	16.4	16.7	0.239	0.241	33.7	33.7
80	20.6	20.6	108	109	17.8	18.1	0.251	0.253	35.4	36.6
120	21.1	21.3	108.5	109.2	18.2	18.4	0.258	0.26	36.3	36.5
SEm +	0.4	0.4	1.3	1.4	0.2	0.3	0.005	0.005	0.59	0.6
CD (P = 0.05)	1	1.1	3.6	3.9	0.7	0.8	0.014	0.014	1.69	1.61

Table 2: Effect of sowing dates, varieties and nitrogen levels on yield attributes and yield of wheat

Treatment	Number of effective tillers/m row length		Number of grains /spike		Grain yield (kg/ha)		Straw yield (kg/ha)		Biological yield (kg/ha)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Sowing dates										
20-November	114.9	114.9	44.8	45.5	4219	4300	5739	5878	9958	10178
10-December	92.4	95.8	30	30.4	3573	3745	4765	4942	8338	8687
SEm +	1.3	1.6	0.7	0.7	45	44	85	91	153	161
CD (P = 0.05)	4.2	5.1	2.1	2.1	142	139	266	287	480	506
Varieties										
Raj-4083	105.4	106.8	37.4	38	3790	3918	5180	5348	8970	9266
Raj-3777	89.7	91.4	36.4	37.3	3491	3639	4969	5139	8459	8778
Raj-4037	115.8	117.9	38.3	38.6	4406	4510	5608	5742	10014	10253
SEm +	1.6	2	0.8	0.8	55	54	104	112	187	197
CD (P = 0.05)	5.2	6.3	NS	NS	174	171	326	351	588	620
Nitrogen levels (kg/ha)										
0	84.4	87.5	29.4	29.7	2786	2931	4240	4432	7026	7363
40	101.4	103.3	36.6	37.1	3858	3966	5136	5244	8994	9210
80	113.6	114.2	41.3	41.8	4422	4547	5739	5910	10161	10457
120	115.2	116.5	42.3	43.3	4516	4645	5893	6054	10409	10699
SEm +	1.5	1.7	0.7	0.7	53	54	84	83	127	140
CD (P = 0.05)	4.4	4.9	2	2.1	153	153	240	238	364	400

capabilities of variety Raj-4037 with enhanced vegetative growth with optimum duration available under prevailing climatic conditions might have helped the plants to efficiently utilize prevailing climatic conditions (Mali and Choudhary, 2010 and Singh *et al.*, 2017).

Nitrogen levels

Data pertaining to growth parameters presented in Table 1 revealed that as the nitrogen application rate was progressively increased, the growth of wheat increased significantly. Across the years, significant increase in plant height, total number of tillers/m row, dry matter accumulation/m row, LAI and LAD in wheat was recorded by nitrogen application from control to 120 kg N/ha but at par with 80 kg N/ha. The increase represented with application of 120 kg N/ha treatment was to the tune of 15.3 and 15.8% in plant height, 5.2 and 5.4% in total number of tiller/m row, 26.4 and 25.2% in dry matter accumulation/m row, 19.4 and 19.8% in LAI and 6.0 and 6.1 in LAD over control during 2015-16 and 2016-17, respectively. The positive effects of N fertilization on overall growth could be due to its role in modifying nutritional environment within rhizosphere and plant system as it governs the utilization of other nutrients (Jat *et al.*, 2014).

Yield attributes and yields

Sowing dates

Data revealed that dates of sowing recorded significant variation in yield attributes. Crop sown on 10 December decreased number of effective tillers/m row length and number of grains/spike (Table 2). The increase represented with 20 November sown crop was 24.4 and 19.9% in number of tillers/m row, 49.3 and 49.7% in number of grains/spike over 10 December sown crop during 205-16 and 2016-17, respectively. Early sown crop was exposed to favourable weather during the whole life cycle and thus the different phases of plant life were completed at appropriate timings, which result in production of more number of tillers and ultimately higher yield attributes like number of grains/spike (Shirpurkar *et al.*, 2008 and Mukherjee, 2012).

The significant difference in grain, straw and biological yield was recorded with different dates of sowing (Table 2). Grain yield is function of various yield attributing factors and maximum grain yield was obtained with 20 November sown crop which was significantly higher over 10 December sown crop. The increase represented with 20 November were 18.1 and 14.8% in grain yield, 20.4 and 18.9% in straw yield and 19.4 and 17.2% in biological yield during 2015-16 and 2016-17, respectively over 10 December sowing. Late sown crop has exposed to higher mean temperature during reproductive phase as against the mean temperature under 20 November sown crop. This shortened the crop period and caused forced maturity resulted in shriveled grain ultimately low grain yield as well as straw and biological yield under late sown crop (Amrawat *et al.*, 2014).

Varieties

Different varieties showed significant variation for different yield attributes (Table 2). Effective tillers/m row length was the highest with Raj-4037 and was significantly superior over Raj-4083 and Raj-3777 during both the years. The number of grains/spike was not differ significantly among the varieties. The differences in effective tillers of varieties might be attributed due to their genetic makeup (Mattas *et al.*, 2011).

Among the varieties, Raj-4037 was found to record significantly higher grain yield (4406 and 4510 kg/ha), straw yield (5608 and 5742 kg/ha) and biological yield (10014 and 10253 kg/ha) over Raj-4083 and Raj-3777 during 2015-16 and 2016-17 (Table 2). Whereas, variety Raj-3777 produced lowest grain, straw and biological yield than all other varieties. Variety Raj-4037 recorded 26.2 and 23.9% higher grain yield, 12.9 and 11.7% straw yield and 18.4 and 16.8 biological yield over Raj-3777 during 2015-16 and 2016-17, respectively. Higher yields under Raj-4037 may be attributed to its higher biomass accumulation due to higher number of tillers and superior yield attributes *i.e.* effective tillers/metre row length. Variety Raj-3777 recorded low yield due to lower biomass accumulation as a result of less number of tillers (Dhaka *et al.*, 2006 and Singh *et al.*, 2017).

Nitrogen levels

Among the different nitrogen levels, the application of 120 kg N/ha significantly increased the number of effective tillers/m row and number of grains/spike over control and 40 kg N/ha during both the years and it was found statistically at par with 80 kg N/ha (Table 2). Improvement in these characters due to N application can be ascribed mainly to the overall improvement in vigour and crop growth as discussed earlier. The improved growth followed by profuse tillering due to N fertilization coupled with increased photosynthates on one hand and greater mobilization of photosynthates towards reproductive structures on the other might have been responsible for improvement in yield attributes of wheat (Chaturvedi, 2006).

Significant increase in grain, straw and biological yield was recorded by raising the rate of nitrogen application. Application of 120 kg N/ha to wheat fetched significantly higher grain, straw and biological yield as compared to control and 40 kg N/ha during both the years while it remains at par with 80 kg N/ha. The corresponding increase with 120 kg N/ha was 62.1 and 58.5% in grain yield, 39.0 and 36.6% in straw yield and 48.2 and 45.3% in biological yield during 2015-16 and 2016-17, respectively over control. As grain yield is primarily a function of cumulative effect of yield attributing characters, the higher values of these attributes could be assigned as the most probable reason for significantly higher grain yield. Straw yield was also recorded higher with increasing rates of N application. Improved biomass per plant at successive growth stages and increase in various morphological parameters like plant height, number of tillers etc could be probable reason (Yadav *et al.*, 2007 and Singh *et al.*, 2017).

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