

Journal of Cereal Research

12(2): 129-136

Homepage: http://epubs.icar.org.in/ejournal/index.php/JWR

Research Article

Performance of wheat variety Shalimar Wheat-2 under rainfed conditions of temperate Kashmir as influenced by sowing dates and nitrogen levels

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Article history

Received: 16 Apr., 2020 Revised: 07 July., 2020 Accepted: 05 Aug., 2020

Citation

Dar SB, RH Kanth, W Raja, SA Bangroo, Z Rashid, ZA Dar and SH Wani 2020. Performance of wheat variety Shalimar Wheat-2 under rainfed conditions of temperate Kashmir as influenced by sowing dates and nitrogen levels. *Journal of Cereal Research* 12(2):129-136. http://doi.org/10.25174/2582-2675/2020/100138

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Abstract

A field experiment was carried out during Rabi 2015 and 2016 at experimental farm of RRS&FoA, SKUAST-K, Wadura, to study the effect of sowing dates and nitrogen levels on wheat variety Shalimar wheat-2 under rainfed conditions of Kashmir. Experiment was conducted in split plot design and treatments included three sowing dates (D1-15th October, D2-30th October and D3-15th November) in main plots and four nitrogen levels (N0-0 kg N ha-1, N1-50 N ha-1, N2-100 Kg N ha⁻¹ and N3-150 Kg N ha⁻¹) in sub-plots and was replicated four times. The pooled results of two years revealed that grain yield decreased by 10.30 % from D1 to D2, 7.84 % from D2 to D3 and 17.30 % from D1 to D3. Recorded wheat growth attributes like plant height (95.11 cm), dry matter accumulation (113.3 q ha⁻¹), tillers m⁻² (416.5), leaf area index (3.60) and yield attributes like effective tillers (280.30), grains spike (40.39) and spike weight (2.58 g) were significantly higher with 15th October sowing than 30th October and D3-15th November of sowing. Increasing N levels results in increase in growth, yield attributes and yield, and highest valves were recorded with application of 150 kg N ha⁻¹ (N3) however, remained statistically at par with 100 kg N ha-1 (N2). The study finally concluded that delay in sowing reduces the grain yield, while as irrespective of sowing dates, application of 100 Kg N ha-1 to crop resulted in higher growth, yield attributes and yield of wheat as compared to other nitrogen levels, further increase in N application beyond 100 Kg N ha⁻¹ showed non-significant increase.

Keywords: Nitrogen, sowing dates, wheat, rainfed, yield

1. Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop for the food security of South Asia and is the 2nd major staple food crop after rice (Kumar *et al.*, 2018, Wani *et al.*, 2019). It accounts for nearly 30 per cent of global cereal production covering an area of 220 million hectare (m ha) registering production of 781 million tonnes (Wheat initiative, 2019: USDA 2019). At present, about 65 per

cent of the wheat production is used for food, 17 per cent for feed, and 12 per cent in industrial applications, including bio-fuels (FAO statistics, 2018). India cultivates wheat on 29.55 m ha area that accounts 13.43% of global area with overall production of 101.20 million tones i.e., 12.98% of wheat production (MoA & FW-2019). The three important wheat growing states (Uttar Pradesh, Punjab and Haryana) contribute about 80 % of the total wheat

production in the country (Khan et al., 2017). In Jammu and Kashmir wheat growing areas remained confined to sub tropical area of Jammu division, and in valley besides having lot of potential area under wheat cultivation and favorable climatic conditions it is relatively very low (Kour et al., 2012, Wani et al., 2017). In union territory of Jammu and Kashmir, the total production of wheat remained at 51.98 lakh quintals covering an area of approximately 2.53 lakh hectares with productivity of 22.23 q ha-1. Almost entire cultivation of wheat is concentrated in Jammu Division (2.47 lakh ha) with production of 50.50 lakh quintals, whereas in Kashmir Division, the cultivation of crop is confined to isolated places with an area of 0.06 lakh hectares with production of 1.48 lakh quintals and productivity of 24.06 q ha-1 (ESJK, 2017-18). Since the area under agriculture is stagnating/declining with wheat not being an exception the scope of horizontal expansion of crop is negligible. Therefore, region specific standardization of agronomic practices is pre-requisite to increase the wheat production and productivity.

Wheat being a cold loving crop can not only be successfully grown in Kashmir but also there is an ample scope for increasing the production and productivity of crop through suitable technological interventions and innovations. There are many factors responsible but appropriate dates of sowing and proper nitrogen (N) fertilization are important factors for sustainable production of wheat under temperate conditions of Kashmir. Wheat production in rainfed areas is greatly influenced by precipitation. Precipitation pattern and amounts determine the overall crop production and productivity. Date of sowing has a noteworthy impact on yield of wheat as the crop is sensitive to environmental variations for optimum emergence, growth and development. (Dabre et al, 1993) and is highly vulnerable to high temperature, exposure during reproductive stages (Kalra et al., 2008) as temperature cannot be manipulated but seeding time can be adjusted to meet the specific requirements. Thus, sowing date is an important management practice that can be manipulated to counter the adverse effects of environmental stress during the later stages of wheat crop in order to improve both the quantity and quality of crop yield (Gul et al., 2008). Numerous studies (Bassu et al., 2009; Bannayan et al., 2013) have revealed the higher production with early sowing and reduction

in production with delayed sowing beyond ideal time (Qasim et al., 2008). Adjusting the planting date can avoid the exposure of wheat crop to adverse environmental conditions. Nitrogen constitutes an integral part of improved crop production technology. Nitrogen content is also widely considered as the main factor that affects grain quality in wheat (Blandino et al., 2015). Supply of adequate amounts of nitrogen and its management is one of the most important factors influencing the yield of not only wheat but other crops as well. However, at the same time nitrogen are most vulnerable to losses (Imdad et al., 2018). Optimizing nitrogen application timings and rate can improve nutrient uptake and nutrient efficiencies in wheat particularly under rainfed conditions. Application rates of nitrogen vary spatially as a result of various soil characteristics and temporally because of environmental interactions. (Mamo et al., 2003; Subedi and Ma, 2007). Under water limited/ deficit conditions wheat grain yield and N use efficiency (NUE) usually decreases particularly during later stages of crop growth (Albrizio et al., 2010; Liu et al., 2018). Yu et al., 2018 stated that approximately 40% to 90% of grain nitrogen in wheat originates from the remobilization of N stored in vegetative tissues before anthesis, so that N remobilization depends on these nutrient sources. Further, the requirement of N fertilizer for wheat can vary greatly from irrigated to rainfed conditions. So, it is essential to apply N fertilizers on adequate time and rate. There is a sufficient scope to carry out what minimum amount of nitrogen should be applied to have maximum yield per unit nitrogen applied (Shahid and Ram, 2016). Nitrogen fertilizer is an expensive input, farmers usually apply N in large amounts to maximize the production. Under rainfed conditions the lower nitrogen absorption by crop roots is mainly because of lack of moisture in root zone as the applied nitrogen remains highly vulnerable to leaching and runoff losses. So, demand based N application to wheat crop as per the prevailing climatic and soil characteristics is of great importance for economically optimum application of N fertilizer. In view of this, an experiment was carried out to study the effect of sowing dates and nitrogen levels under rainfed conditions of Kashmir.

2. Materials and methods

The field experiments were carried out during the *Rabi* season of 2015-16 and 2016-17 with different sowing dates

and nitrogen levels at experimental farm of Regional Research Station and Faculty of Agriculture, SKUAST-K, Wadura, Sopore on wheat variety Shalimar wheat -2 under rainfed conditions of Kashmir situated at 340 20 N and 740 24 E at an altitude of 1588 m above mean sea level. Experiment consisted of twelve treatments and was conducted in split plot design; keeping three sowing dates (D1-15th October, D2-30th October and D3-15th November) in main plots and four nitrogen levels (N0-0 kg N ha¹, N1-50 N ha¹, N2-100 N ha¹ and N3-150 N ha¹) and was replicated four times. The experimental soil was well drained silty clay loam in texture with pH 7.6 (Jackson, 1973), high in inorganic C 0.86% (Walkley and Black, 1934), medium in available N 315.4 kg ha⁻¹ (Subbiah and Asija, 1954), available P 21.5 kg ha-1 (Olsen et al., 1954) and available K 248.7 kg ha⁻¹ (Jackson, 1953). The climate of the experimental site is temperate characterized by moderately hot summers and very cold winters. Under average climatic conditions, the area receives 690 mm of mean annual rainfall most of which occurs from December to April. Rainfall received during the growing season (October to June) was 620.6 mm and 1115 mm during 2015-16 and 2016-17, respectively. Wettest months during crop growth period were March (199.24 mm) and February (626.2 mm) during 2015-16 and 2016-17, respectively. However, driest month during 2015-16 was December (23.03 mm) and November (0.00 mm) during 2016-17. The mean maximum and minimum temperature for entire crop growth period of wheat crop for 2015-16 was 17.50 and 3.74 °C, respectively and corresponding values for 2016-17 were 16.49 and 3.01 °C. The sowing of the crop and nitrogen was applied as per treatments. Wheat (SW-2) was sown by hand drill method @ 100 Kg/ ha at 23×10 cm spacing. Sources of fertilizers were Urea for nitrogen, Muriate of potash for potassium and Single Super Phosphate for phosphorus. Full dose of phosphorus and potassium @ 60 kg P₂O₅ and 30 kg K₂O respectively, were applied as basal dose. Nitrogen was applied as per the treatments in two splits (1/2 at sowing, 1/2 at active tillering). Weed control was done manually. All other agronomic practices were followed as per standard recommendations. Crop was harvested when at fully ripened stage. The grain and straw yield of wheat were recorded and observation on growth and yield attributers were recorded from five randomly selected tagged plants from each plot during both the years using the standard procedures. Data on yield attributes and yield were collected at harvesting. The data were analyzed as per the standard procedure for Analysis of Variance by SAS, version 9.4. The significance of treatments was tested by 'F' test (Variance ratio). The difference in the treatment mean was tested by using critical difference (CD) at 5% level of probability.

3. Results & discussions

3.1 Growth and yield Attributes

The results obtained from the experiment concluded that the various growth attributes (Table-1) were significantly influenced by dates of sowing and different nitrogen levels. Early sowing date (15th October) recorded significantly taller plants (95.11 cm), dry matter accumulation (113.3 q ha-1), total tillers (416.5) and leaf area index (3.6) while as the minimum plant height (88.88 cm), dry matter accumulation (94.3 q ha-1), total tillers (377.9) and leaf area index (3.4) were recorded with 15th November date of sowing. Growth attributes decreased with deferral in sowing time because of less favorable weather conditions and shorter crop growing period that resulted in net photosynthesis as compared to optimum sowing dates. Several authors have reported reduction in growth attributes with delay in sowing time from the optimum (Jat et al., 2013; and Mumtaz et al., 2015). During early growth the crop was subjected to lower temperature, longer vegetative phase led to production of growth characters under late sown conditions. The results are in conformity with the findings of Deshmukh et al., (2015). DMA decreased with deferral in sowing time because of less favorable weather conditions and shorter crop growing period, reduced plant height and LAI. Suleiman et al., 2014; Alam et al., 2013 and Deshmukh et al., 2015 also reported that DMA was higher in early sown crop because of favorable cool climate accessible for longer period as compared to late sown crop. Further, the reduction in production of tillers and lower leaf senescence as this period coincide with conducive period of crop growth, thus accumulating more dry matter.

Increasing the nitrogen fertilization also results in the significant increase of growth attributes as compared to growth attributes recorded in control (N1). Application of 150 kg ha⁻¹ (N3) recorded highest plant height (96.31 cm), total tillers (413.45), leaf area index (3.9) and total dry matter accumulation (118.70 q ha⁻¹) but remained statistically at par with the treatment involving application of 100 kg N ha⁻¹ (N2) and were significantly superior over control (N1) and N2 (50 kg N ha⁻¹). Similar findings were also reported by Shahid and Ram (2016). More

Table 1: Growth and yield attributes of wheat as influenced by sowing dates and nitrogen levels (Pooled data over 2015-16 and 2016-17)

Treatments	Growth attributes				Yield at			
	Plant height (cm)	Dry matter accumulation (q ha ⁻¹)	Leaf area index	Tillers (m-2)	Total tillers at harvest (m-2)	Effective tillers (m-2)	Grains Spike ⁻¹	Spike weight (g)
Sowing date								
D1 D2 D3	95.11 90.33 88.88	113.3 101.3 94.3	3.6 3.5 3.4	416.5 392.4 377.9	315.5 300.5 287.3	280.3 267.9 257.4	40.39 39.35 38.04	2.58 2.56 2.52
CD (p=0.05)	3.69	3.44	0.05	11.3	11.89	9.61	1.15	0.06
Nitrogen leve	els							
N0 N1 N2 N3	83.40 90.61 95.45 96.31	80.4 99.9 113.7 118.7	2.7 3.5 3.9 3.9	368.4 392.9 407.6 413.4	281.0 298.3 309.8 315.5	229.5 272.8 284.8 287.8	36.93 38.50 40.85 40.86	2.43 2.52 2.61 2.61
CD (p=0.05)	3.19	3.73	0.04	8.6	8.53	7.04	0.85	0.04

and quick supply of N as a result of higher nitrogen application increased various physiological processes like photosynthetic activity, cell division, elongation and differentiation etc. resulted in higher growth attributes and growth. The increase in growth characters with increase in nitrogen levels has also been reported by Krupnik *et al.*, (2004) and Simonetta *et al.*, (2009). Further, increased level of nitrogen resulted in reduction of motality of tillers, leaf senescence. The results are quite in line with findings of Imdad *et al.*, (2018).

The results obtained (Table-1) revealed wheat yield attributes were significantly influenced by the date of sowing and nitrogen levels, significantly higher yield attributes viz. total tillers (315.18) at harvest, effective tillers (280.30), grains/spike (40.39) and spike weight (2.58 g) were recorded with 15th October sowing than 30th October and 15th November date of sowing. With each delay in sowing there was a significant reduction in the yield attributes. The minimum yield attributes viz. total tillers (287.30), effective tillers (257.39), grains spike⁻¹ (38.23) and spike weight (2.52 g) were recorded in 15th November sowing. The total and effective tillers were higher in earlier sowing due to higher number of total tillers at all the growth stages together with favorable weather conditions throughout the growing season. Mumtaz et al., (2015) also reported reduction in number of total and effective tillers with deferral in sowing time. Significantly higher grains/spike and spike weight with D1

as compared to all other sowing dates may be attributed to unfavorable effect of late sowing on yield attributing characters like grains spike⁻¹ and spike weight. Under late sown conditions of wheat, the crop is subjected to sharp rise in temperature accompanied by hot winds during later stages of growth. These unfavorable climatic conditions cause poor grain filling during the milk stage of growth. Early sowing of crop (15th October), however, was at advantage because after having completed its vegetative growth satisfactorily, it entered reproductive phase when grain development and maturity was subjected to steady rise in temperature. Similar findings were confirmed by Singh and Pal (2003) and Andarzian *et al.*, (2015).

With the imposition of different nitrogen levels, the highest grain yield of 45.36 q ha-1 straw yield (87.51 q ha-1) and biological yield (132.87 q ha-1) was obtained when nitrogen was applied at 150 kg N ha-1 (N3), which was significantly higher than N0 and N1 but remained statistically at par with N2 (100 kg N ha-1). The lowest grain yield, straw yield and biological yield were recorded in the nitrogen control treatment (N0). The lower grain yield in nitrogen deficit treatments may be due to lower soil nitrogen availability to the extent that could limit its extraction by roots and imposing severe physiological limitations like damage to photosynthetic machinery and shortening of growth cycle, damage reduced carbon fixation and assimilate translocation, accelerated leaf senescence resulted in reduced grain set and development (Shahid and Ram, 2016 and Yu et al., 2018). Moreover,

Table 2: Grain yield (q ha ·¹), Straw yield (q ha ·¹), Biological yield (q ha ·¹) and harvest index (%), of wheat as influenced by different sowing dates and nitrogen levels (Pooled data over 2015-16 and 2016-17)

Treatments	Grain yield (q ha -1)	Straw yield (q ha -1)	Biological yield (q ha -1)	Grain N(%)	Straw N(%)
Sowing date					
D1 D2 D3	44.64 40.04 36.90	83.06 77.02 72.61	127.71 117.06 109.51	1.550 1.655 1.677	0.466 0.419 0.383
CD (P=0.05	2.16	3.65	4.74	0.089	0.031
Nitrogen levels					
N0 N1 N2 N3	31.51 40.58 44.65 45.36	63.18 74.27 85.31 87.51	94.70 114.85 129.97 132.87	1.536 1.631 1.678 1.679	0.358 0.393 0.465 0.487
CD (p=0.05)	2.05	3.11	3.89	0.043	0.028

Table 3: Grain yield (q ha⁻¹) as influenced by interaction between sowing dates and nitrogen levels (Pooled data over 2015-16 and 2016-17)

Sowing		Nitrogen levels 50			
Sowing date	0	50	100	150	Mean
D1	33.31	44.42	50.06	50.78	44.64
D2	31.97	39.80	43.87	44.51	40.04
D3	29.26	37.52	40.03	40.78	36.90
Mean	31.51	40.58	44.65	45.36	
CD (p=0.05)	0.05)		Nitrogen levels=206	Interaction=NS	

Table 4: Biological yield (q ha⁻¹) as influenced by interaction between sowing dates and nitrogen levels (Pooled data over 2015-16 and 2016-17)

Sowing	Nitrogen levels (kg N ha-1)					
date	0	50	100	150	Mean	
D1 D2 D3	102.13 94.02 87.93	124.05 113.05 107.46	141.238 127.97 120.71	143.438 133.22 121.96	127.716 117.06 109.51	
Mean	94.70	114.85	129.97	132.87		
CD (p=0.05)		Sowing date=4.74	Nitrogen levels=3.89	Interaction=NS		

reduced effective tillers, grains ear¹ and test weight were recorded, which significantly contribute to lower grain yields. On the other hand, increasing nitrogen rate gave more yield because large amount of DMA, more assimilates were produced and transported to fill the seeds as a results of higher nitrogen. Ghobadi *et al.*, (2010) and Imdad *et al.*, (2018) reported similar results. Nonsignificant interaction (Table 3 & 4) was found between the sowing dates and nitrogen levels with respect to grain and biological yield.

3.2 Nutrient content of grain at harvest

Nitrogen content in grain showed an increase with delaying sowing from 15th October to 15th November, whereas nitrogen content in straw reduced significantly by delaying sowing. Higher yield at earlier sowing might have resulted in dilution effect. These results are in conformity with the findings of Yu *et al.*, (2018) and Shahid and Ram (2016). Nitrogen levels produced a pronounced effect on grain and straw N content. Grain and straw N content decreased significantly with decrease in the amount of nitrogen application from N3 to N0. N3 recorded significantly higher grain and straw N content

during both years than N0 and N1 but was statistically at par with the grain and straw N content recorded with the application of 100 kg N ha⁻¹ (N2). Variation in nitrogen content between different nitrogen levels have been also reported by Imdad *et al.*, (2018).

4. Conclusion

On the basis of generalization of the results obtained, it was found that 15th October sowing of wheat is most suitable in terms of yield under rainfed conditions of temperate Kashmir. Irrespective of sowing dates, application of 100 Kg N ha⁻¹ to crop resulted in higher growth, yield attributes and yield of wheat as compared to other nitrogen levels, further increase in N application beyond 100 Kg N ha⁻¹ showed non-significant increase. Late sowing and no application of nitrogen recorded lowest yield of wheat crop.

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