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Influence of foliar spray boron and thiourea doses on biochemical and productive tillers of wheat cultivars in two sowing conditions

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Abstract

These experiments have been conducted in order to study the influence of foliar spray boron and thiourea doses on biochemical and productive tillers of four varieties in two sowing conditions at Experimental Research Farm, Nawabganj of Chandra Shekhar Azad University of Agriculture and Technology Kanpur, India. The experimental design was split-split plot design in which sowing conditions was in main plot (D₁- Timely sowing, D₂- Late sowing), four cultivars (V₁: K- 607, V₂: K-402, V₃: K-7903, V₄: K-9533) in subplot while five treatments in these two doses boron (T₁- 0.2%, T₂- 0.5%) and two doses thiourea (T₃- 500ppm, T₄-1000ppm) with control T₀- water spray in sub-sub plot with three replications. Results showed high significant effect of sowing condition, variety and treatment on specific leaf weight (D₁- 2.56, 4.19, V₂- 2.78, 4.10, T₃- 2.50, 3.96), starch content (D₁- 36.49, V₂- 35.91, T₂- 36.95), protein content (only in T₃- 12.46), productive tillers (D₁- 396.5, V₂- 383.2, T₃- 369.7) in first year 2013-14. Productive tillers were found significantly with sowing conditions, varieties treatments and their interaction in both years. Totally conclusion that timely sowing date (D₁), cultivar (V₂), and treatment (T₂- boron 0.2%, T₃- thiourea 500ppm) were superior to others

Keywords: specific leaf weight (SLW), starch content, protein content, productive tillers (m⁻²), sowing conditions, cultivars, boron and thiourea etc.

1. Introduction

Wheat [*Triticum aestivum* L.] is one of the most important cereal crops of the world. Bread wheat is an allohexaploid (2n = 42) and the major staple food source for a large part of global population. It is second most important cereal crop and plays an important role in national food security. It has originated from the Levant region of the New East and Ethiopian Highlands, but now cultivated worldwide. Nutrient analysis showed that N and B contents in grain were increased after addition of B to the soil indicating that B probably helped in protein synthesis (Hossain *et al.* 1994) [18]. Sharma *et al.* (1991) [21] also reported that boric acid which was sprayed with 5, 10, 20 or 40 ppm at anthesis and 1 week after anthesis and increased invertase and starch synthetase activities in developing wheat grain and decreased amylase activity compared with the controls (water). Ali Sajid *et al.* (2009) [18] revealed that the significant increase was recorded in number of spikes m⁻², grains spike⁻¹, thousand grain weight, biological yield and grain yield of wheat for foliar application of zinc and boron as compared to both control treatments. Moghadam *et al.* (2012) [14] also drew attention to the response of wheat to foliar application of Zinc, Boron and Copper micronutrients, were significant on the number of spikes per plant, Grain per spike, Harvest Index (H.I. %) and Grain yield (kg/ha) but had no effect on thousand grain weight. Boron and Zinc showed higher amounts in mentioned traits than Copper. Nishi *et al.* (2006) [15] results revealed that thiourea application showed favourable effects of on net photosynthesis and levels of leaf metabolites viz. total chlorophyll, starch, reducing sugars and soluble protein as well as nitrate reductase activity. Bavita *et al.* (2013) [4] also evaluated the potential of thiourea in improving the terminal heat resistance in bread wheat. Thiourea application also increased the total soluble proteins, amino acids and chlorophyll contents in all the tested genotypes. Godara *et al.* (2014) [6] revealed that thiourea @ 500 ppm improve the effective tillers/m², spike length, grains/spike, 1000-grain weight and grain and straw yield between water stress at tillering and jointing phases of wheat were statistically at par.

Materials and Methods

The present study was carried out at the Experimental Research Farm, Nawabganj of Chandra Shekhar Azad University of Agriculture and Technology Kanpur, India, during Rabi season 2013-1414 and 2014-15. The experiments was laid out in Randomized Complete

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Block Design with split-split plot arrangement and replicated three times. Sowing conditions (D₁- Timely sowing: 21 November and D₂- Late sowing: 23 December) were assigned to main plot and four cultivars (V₁: K-607, V₂: K402, V₃: K-7903 and V₄: K-9533) to subplot. The foliar spray boron (T₁- 0.2% and T₂- 0.5%) and thiourea (T₃-500ppm and T₄- 1000ppm) with control T₀- water spray were assigned to sub-sub plot in both years. According to each plot size 3.00m*1.38m a total dose of 150 kg/ha Nitrogen, 80 kg/ha Phosphorus and 60 kg/ha Potash, through urea, single super phosphate (SSP) and murate of potash (MOP) were used in the experiment. Half does of nitrogen, total Phosphorus and Potash were given as basal dose before sowing of seed; remaining half dose of nitrogen was given in two equal split doses, one at tillering and other at the time of spike initiation. Seed require for timely sown condition 100-110 kg ha⁻¹ and late sown condition 120-125 kg ha⁻¹. So, after calculation seed rate was 45 g plot⁻¹ (timely sown condition) and 55 g plot⁻¹.

Specific Leaf Weight (mg/cm²)

Specific leaf weight (SLW) is ratio of leaf dry weight and leaf area (mg cm⁻²). It was calculated by the following formula given below: SLW= Leaf dry weight/ Leaf area. **Starch**

Content (mg g⁻¹ grain or dry weight)

Starch content in the plant material was estimated by using the method of McCready *et al.* (1950) [13].

Reagents

Ethanol (80%), Perchloric acid (PCA) – 52 %, Anthrone Sulphuric acid reagent

Procedure

One hundred mg grinded grain sample was homogenized in 10 ml of 80 % ethanol and centrifuged at 4000 rpm for 20 min. The supernatant was collected and the residues was re – extracted with 10 ml of 80 % ethanol and centrifuged at 4000 rpm for 20 min. To this residue left after extraction were added 5 ml of distilled water and 6.5 ml PCA (52 %). It was kept at 0°C for 10 minute and then centrifuged at 6000 rpm for 20 minute Supernatant was saved as Ist and to the residue again 5 ml distilled water and 6.5 ml PCA (52 %) was added. Kept for 20 minute at 0°C and centrifuged for 20 minute at 6000 rpm. The supernatant obtained was considered as IInd and residue was discarded. Both the supernatants Ist and IInd were added and volume was made upto 100 ml with distilled water. From this, 0.5 ml aliquot was taken with 0.5 ml of distilled water to which 4 ml of anthrone sulphuric acid reagent was added. It was then heated for 8 minute at 100 °C on boiling water bath and cooled rapidly at room temperature. Absorbance was measured at 630 nm against reagent blank.

Protein content

For estimation of protein firstly estimate of nitrogen content multiply to 5.83 (factor). Nitrogen content in the plant material was estimated by using instrument Semi – automatic nitrogen analyzer of model Kel Plus.

Reagent

A. Potassium sulphate, B. Copper sulphate, C. Conc. Sulphuric acid, D. Boric acid (4 %), E. Sodium hydroxide (NaOH) 40%, F. Indicators (Methyl red and Bromo cresol green), G. Hydrochloric acid (0.1 N HCl).

Procedure

Digestion

Two hundred mg grinded plant sample was added in test tube along with 3g of catalyst mixture (potassium sulphate : copper sulphate :5:1), then add 10 ml conc. sulphuric acid (H₂SO₄). Its digest for 90 min or 1:30 hours in Kel 12L (VA) digester and fumes was sucked in 15% NaOH and distilled water by a Kel VAC sucker.

Distillation

Take digested tube in distillation chamber and collect the ammonia gas in boric acid solution in a conical flask. Then add 4-5 drops of indicator (methyl red and bromo- cresol green) in ammonia collected conical flask.

Titration

Fill Hydrochloric acid (0.1 N HCl) in automatic burette and get start for titration when the colour of ammonia collected boric acid change to green titration will complete record the reading.

Calculation

Final reading = Treatment reading - Blank reading

Nitrogen content (%) = $14.01 \times \text{normality} \times \text{final reading} \times 100 / \text{sample} \times 1000$, Protein content = Nitrogen content (%) * 5.83

Productive Tillers (m⁻²)

The number of tillers was counted in each plot in one square meter area in each replication.

Results and discussion

Specific Leaf Weight (mg cm⁻²) at 45 and 85 DAS:

The data stated for specific leaf weight at 45 DAS & 85 DAS as affected due to sowing dates, varieties and treatments of foliar spray boron, thio-urea and their interaction effect are predicated in Table No. 1(A) & (B).

Effect of sowing dates

The statistically maximum value of sowing dates to SLW at both stages *i.e.*, 45 DAS and 85 DAS found in timely sowing dates (D₁) *i.e.*, 2.56 and 2.43 at 45 DAS, 4.19 and 3.90 mg cm⁻² at 85 DAS over late sowing date (D₂) *i.e.*, 2.18 and 2.10 at 45 DAS, 3.52 and 3.34 at 85 DAS for 2013-14 and 2014-15 experimental years, respectively.

Effect of varieties

The mean value of varieties recorded significantly higher to SLW for both stage with variety V₂ with 2.78 and 2.59 (45 DAS), 4.10 and 3.93 (85 DAS) followed by V₁ with 2.56 and 2.45 mg cm⁻² (45 DAS), 3.90 and 3.78 mg cm⁻² (85 DAS) and IIIrd rank V₄ with 2.11 and 2.05 mg cm⁻² (45 DAS), 3.73 and 3.44 (85 DAS) but lowest in variety V₃ with 2.02 and 1.96 (45 DAS), 3.69 and 3.32 mg cm⁻² (85 DAS) during both years of experimentation.

Effect of treatment

The significant effect of treatments was noted on SLW in mg cm⁻² for both corresponding years. The statistically higher mean value of SLW (mg cm⁻²) observed in treatment T₃ *i.e.*, 2.50, 2.39 and 3.96, 3.74 followed by T₂ *i.e.*, 2.42, 2.31 and 3.90, 3.65; occupy IIIrd and IVth rank to T₄ *i.e.*, 2.38, 2.27 and 3.85, 3.61 and T₁ *i.e.*, 2.23, 2.21 and 3.83, 3.58 lower in T₀ *i.e.*, 2.21, 2.13 and 3.73, 350 mg cm⁻² with 45 and 85 days after sowing, respectively.

Interaction effect of sowing dates and varieties

It is revealed that interaction effect of sowing dates with varieties that statistically maximum value of SLW in mg cm⁻² was in combination D₁V₂ (2.98, 2.79 and 4.69, 4.44) over in D₁V₁ (2.83, 2.68 and 4.43, 4.32) as compare to other combinations at 45 and 85 DAS for concerning years (2013-14 & 2014-15), respectively. On the other hands, significantly minimum interaction value was in combination D₂V₃ and D₂V₄ (1.85, 1.84 and 1.99, 1.95) at 45 DAS but, at 85 DAS in combination D₂V₁ (3.36 and 3.24 mg cm⁻²) during both experimental years.

Interaction effect of sowing dates and treatments

Although, data on interaction effect of sowing dates with treatments to SLW in mg cm⁻² did not significant at 45 DAS

and also 85 DAS for both years. But, this data was significant in experimental year 2014-15 at 45 DAS only for SLW. However, numerically maximum interaction value in combination D₁T₃ i.e., 2.67, 2.53 and 4.29, 4.03 followed by D₁T₂ i.e., 2.61, 2.48 and 4.25, 3.93 while minimum in D₂T₀ i.e., 2.01, 1.96 and 3.40, 3.22 over D₂T₁ i.e., 2.15, 2.04 and 3.49, 3.30 at 45 DAS and 85 DAS with both experimental seasons, respectively.

Interaction effect of varieties and treatments

Though, value of interaction effect on varieties and treatments for SLW (mg cm⁻²) was not significant at 45 and 85 DAS during both year, but in year 2013-14 significant value also found at 85

Table 1 (A): Effect of foliar applied boron and thio-urea on Specific Leaf Weight (mg cm⁻²) at 45 DAS of wheat cultivars under timely and late sown condition:

Treat.	2013-14						2014-15							
	V ₁	V ₂	V ₃		V ₄	Mean	V ₁	V ₂	V ₃		V ₄	Mean		
D ₁	2.83	2.98	2.18		2.23	2.56	2.68	2.79	2.09		2.14	2.43		
D ₂	2.30	2.59	1.85		1.99	2.18	2.21	2.39	1.84		1.95	2.10		
Mean	2.56	2.78	2.02		2.11		2.45	2.59	1.96			2.05		
Treat.	T ₀	T ₁	T ₂	T ₃	T ₄	Mean	T ₀	T ₁	T ₂	T ₃	T ₄	Mean		
D ₁	2.41	2.52	2.61	2.67	2.57	2.56	2.30	2.39	2.48	2.53	2.43	2.43		
D ₂	2.01	2.15	2.24	2.33	2.19	2.18	1.96	2.04	2.14	2.24	2.10	2.10		
Mean	2.21	2.33	2.42	2.50	2.38		2.13	2.21	2.31	2.39	2.27			
V ₁	2.45	2.52	2.59	2.69	2.56	2.57	2.32	2.39	2.49	2.59	2.45	2.45		
V ₂	2.63	2.74	2.84	2.91	2.80	2.79	2.45	2.54	2.64	2.72	2.60	2.59		
V ₃	1.79	2.00	2.09	2.15	2.05	2.00	1.84	1.92	2.01	2.07	1.97	1.96		
V ₄	1.97	2.07	2.17	2.24	2.12	2.12	1.92	2.00	2.09	2.17	2.05	2.05		
Mean	2.21	2.33	2.42	2.50	2.36		2.13	2.21	2.31	2.39	2.27			
Treat.	T ₀	T ₁	T ₂		T ₃	T ₄	T ₀	T ₁	T ₂		T ₃	T ₄		
D ₁	V ₁	2.70	2.81	2.85		2.95	2.84	2.54	2.65	2.74		2.80	2.70	
	V ₂	2.81	2.94	3.05		3.08	3.01	2.65	2.75	2.85		2.89	2.80	
	V ₃	2.04	2.14	2.24		2.29	2.20	1.98	2.05	2.13		2.20	2.09	
	V ₄	2.09	2.20	2.29		2.34	2.25	2.05	2.10	2.19		2.24	2.15	
D ₂	V ₁	2.10	2.24	2.34		2.44	2.29	2.09	2.14	2.24		2.38	2.20	
	V ₂	2.44	2.54	2.64		2.74	2.59	2.25	2.34	2.45		2.55	2.40	
	V ₃	1.54	1.86	1.94		2.01	1.91	1.69	1.79	1.90		1.95	1.85	
	V ₄	1.85	1.95	2.04		2.14	1.98	1.80	1.90	2.00		2.11	1.95	
Factors	D	V	D*V	T	D*T	V*T	D*V*T	D	V	D*V	T	D*T	V*T	D*V*T
SE(d)	0.01	0.02	0.02	0.02	0.02	0.03	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C.D. at 5%	0.06	0.04	0.05	0.03	NS	NS	NS	0.01	0.01	0.01	0.01	0.01	NS	0.03

Table 1 B: Effect of foliar applied boron and thio-urea on Specific Leaf Weight (mg cm⁻²) at 85 DAS of wheat cultivars under timely and late sown condition:

Treat.	2013-14						2014-15							
	V ₁	V ₂	V ₃		V ₄	Mean	V ₁	V ₂	V ₃		V ₄	Mean		
D ₁	4.43	4.69	3.79		3.86	4.19	4.32	4.44	3.35		3.50	3.90		
D ₂	3.36	3.51	3.60		3.61	3.52	3.24	3.42	3.30		3.38	3.34		
Mean	3.90	4.10	3.69		3.73		3.78	3.93	3.32		3.44			
Treat.	T ₀	T ₁	T ₂	T ₃	T ₄	Mean	T ₀	T ₁	T ₂	T ₃	T ₄	Mean		
D ₁	4.07	4.16	4.25	4.29	4.18	4.19	3.78	3.86	3.93	4.03	3.90	3.90		
D ₂	3.40	3.49	3.56	3.63	3.52	3.52	3.22	3.30	3.37	3.45	3.33	3.34		
Mean	3.73	3.83	3.90	3.96	3.85		3.50	3.58	3.65	3.74	3.61			
V ₁	3.74	3.85	3.95	4.03	3.90	3.90	3.62	3.73	3.83	3.91	3.80	3.78		
V ₂	3.97	4.05	4.15	4.22	4.09	4.10	3.81	3.90	3.96	4.05	3.93	3.93		
V ₃	3.55	3.69	3.75	3.76	3.70	3.69	3.23	3.30	3.35	3.43	3.31	3.32		
V ₄	3.66	3.72	3.75	3.83	3.72	3.73	3.35	3.41	3.47	3.57	3.41	3.44		
Mean	3.73	3.83	3.90	3.96	3.85		3.50	3.58	3.65	3.74	3.61			
Treat.	T ₀	T ₁	T ₂		T ₃	T ₄	T ₀	T ₁	T ₂		T ₃	T ₄		
D ₁	V ₁	4.25	4.38	4.52		4.60	4.42	4.15	4.25	4.36		4.50	4.35	
	V ₂	4.55	4.65	4.75		4.80	4.70	4.33	4.41	4.46		4.50	4.43	
	V ₃	3.68	3.78	3.86		3.83	3.78	3.26	3.33	3.38		3.43	3.33	
	V ₄	3.80	3.85	3.87		3.93	3.85	3.40	3.46	3.53		3.65	3.48	
D ₂	V ₁	3.23	3.33	3.40		3.46	3.40	3.10	3.21	3.30		3.33	3.26	
	V ₂	3.40	3.45	3.56		3.65	3.48	3.30	3.38	3.46		3.55	3.43	
	V ₃	3.43	3.60	3.65		3.70	3.63	3.20	3.26	3.33		3.43	3.30	
	V ₄	3.53	3.59	3.63		3.73	3.60	3.30	3.36	3.41		3.50	3.35	
Factors	D	V	D*V	T	D*T	V*T	D*V*T	D	V	D*V	T	D*T	V*T	D*V*T
SE(d)	0.02	0.03	0.04	0.01	0.02	0.03	0.04	0.01	0.02	0.04	0.01	0.02	0.03	0.04
C.D. at 5%	0.10	0.10	0.10	0.03	NS	0.10	NS	0.06	0.05	0.08	0.03	NS	NS	NS

DAS. Numerically highest interaction value was noted in combination V_2T_3 i.e., 2.91, 2.72 and 4.22, 4.05 followed by V_2T_2 i.e., 2.84, 2.64 and 4.15 (statistically at par), 3.96. On the other hands, minimum was in combination V_3T_0 i.e., 1.79, 1.84 and 3.55, 3.23 at 45 and 85 DAS, respectively for both years of experimentation.

Interaction effect of sowing dates, varieties and treatments

The value of interaction effect among sowing dates, varieties and treatments on SLW in mg cm^{-2} was not significant during year 2013-14 at 45 and 85 DAS and year 2014-15 significant at 85 DAS. But in 2014-15, SLW at 45 DAS was significant effect on these interactions. The numerically more in $D_1V_2T_3$ followed by $D_1V_2T_2$ at 45 DAS i.e., 3.08, 2.89 and 3.05, 2.85 and also at 85 DAS with 4.80, 4.50 and 4.75, 4.46 but minimum in combination $D_2V_3T_0$ at 45 DAS 1.54, 1.69 and at

85 DAS was $D_2V_1T_0$ with 3.23, 3.10 mg cm^{-2} respectively for both corresponding years.

Starch content (mg g^{-1} grain)

The data with respect to the effect of sowing dates, varieties, foliar spray of boron and thio-urea treatment and their interaction on starch content in mg g^{-1} grain have been presented in Table 2.

Effect of sowing dates

It is visualized from the mean value of both experimental years that the sowing dates significantly influence the starch content accumulation in mg g^{-1} grain. The statistically maximum starch content (36.49 and 35.31) was recorded with D_1 and minimum (35.46 and 34.23 mg g^{-1} grain) with D_2 during both years of experimentation.

Table 2: Effect of foliar applied boron and thio-urea on Starch Content (mg g^{-1} grain) after harvesting of wheat cultivars under timely and late sown condition:

Treat.	2013-14					2014-15								
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean				
D ₁	36.90	36.39	36.28	36.39	36.49	35.79	35.29	35.11	35.08	35.31				
D ₂	35.87	35.42	35.32	35.22	35.46	34.64	34.27	33.99	34.01	34.23				
Mean	36.38	35.91	35.80	35.81		35.21	34.78	34.55	34.54					
Treat.	T ₀	T ₁	T ₂	T ₃	T ₄	Mean	T ₀	T ₁	T ₂	T ₃	T ₄	Mean		
D ₁	34.99	36.75	37.42	37.18	36.11	36.49	33.86	35.56	36.25	35.99	34.91	35.31		
D ₂	34.01	35.68	36.47	35.99	35.14	35.46	32.77	34.43	35.27	34.82	33.85	34.23		
Mean	34.50	36.21	36.95	36.59	35.63		33.31	35.00	35.76	35.40	34.38			
V ₁	34.85	36.32	37.42	37.30	36.03	36.38	33.68	35.16	36.18	36.17	34.88	35.21		
V ₂	34.58	35.93	36.62	36.64	35.76	35.91	33.52	34.66	35.57	35.59	34.56	34.78		
V ₃	34.22	36.32	36.99	36.14	35.36	35.80	32.95	35.06	35.71	34.93	34.09	34.55		
V ₄	34.35	36.29	36.76	36.27	35.36	35.81	33.12	35.12	35.58	34.91	33.99	34.54		
Mean	34.50	36.21	36.95	36.59	35.63		33.31	35.00	35.76	35.40	34.38			
Treat.	T ₀	T ₁	T ₂	T ₃	T ₄		T ₀	T ₁	T ₂	T ₃	T ₄			
D ₁	V ₁	35.31	36.82	37.93	37.85	36.58	34.28	35.72	36.77	36.74	35.42			
	V ₂	35.05	36.44	37.09	37.19	36.18	34.03	35.24	36.03	36.11	35.04			
	V ₃	34.79	36.86	37.21	36.77	35.80	33.56	35.75	36.07	35.54	34.61			
	V ₄	34.83	36.87	37.47	36.92	35.88	33.59	35.54	36.12	35.57	34.56			
D ₂	V ₁	34.39	35.82	36.91	36.75	35.47	33.08	34.60	35.59	35.62	34.34			
	V ₂	34.12	35.41	36.15	36.10	35.34	33.01	34.07	35.12	35.07	34.09			
	V ₃	33.64	35.79	36.77	35.50	34.93	32.34	34.36	35.35	34.33	33.57			
	V ₄	33.88	35.70	36.05		35.62	34.84	32.65	34.70	35.05	34.25	33.42		
Factors	D	V	D*V	T	D*T	V*T	D*V*T	D	V	D*V	T	D*T	V*T	D*V*T
SE(d)	0.19	0.14	0.19	0.14	0.20	0.29	0.40	0.06	0.10	0.14	0.20	0.28	0.40	0.57
C.D. at 5%	0.85	0.30	NS	0.29	NS	NS	NS	0.26	0.21	NS	0.40	NS	NS	NS

Effect of varieties

Significant effect of varieties was found for the accumulation of starch content. Among the varieties, V_1 was recorded significantly superior (36.38 & 35.21 mg g^{-1} grain) followed by V_2 (35.91 & 34.78), V_4 (35.81 & 34.54) and V_3 (35.80 & 34.55 mg g^{-1} grain) for both corresponding years.

Effect of treatments

Statistically significant mean value of T_2 was observed maximum starch content (36.95 and 35.76 mg g^{-1} grain) followed by T_3 i.e., 36.59 and 35.40, next to this were, T_1 (36.21 and 35.00) and T_4 was 35.63 and 34.38 mg g^{-1} grain as compare to T_0 i.e., 34.50 and 33.31 for both experimental years.

Interaction effect of sowing dates and varieties

The interaction effect of sowing dates with varieties had shown non-significant. Numerically highest mean value of starch content estimated in combination D_1V_1 (36.90 & 35.79

mg g^{-1} grain) during both years of experimentation, while lowest in D_2V_4 i.e., 35.22 mg g^{-1} grain (year 2013-14) and D_2V_3 i.e., 33.99 mg g^{-1} grain (year 2014-15).

Interaction effect of sowing dates with treatments

The interaction effect between sowing dates and treatments were showed non-significant. While, numerically interaction value was observed maximum starch content in combination D_1T_2 (37.42 & 36.25 mg g^{-1} grain) but lowest in D_2T_0 (34.01 & 32.77 mg g^{-1} grain) during same years.

Interaction effect of varieties and treatments

The interaction of varieties and treatments the mean value showed non-significant effect with respect to starch content. The combination V_1T_2 i.e., 37.42 and 36.18 mg g^{-1} grain estimated highest as compared to other combinations as well as lowest in V_3T_0 (34.22 & 32.95 mg g^{-1} grain) for both experimental years.

Interaction effect among sowing dates, varieties and treatments

The interaction effect among sowing dates, varieties, foliar applied boron and thio-urea treatments had showed non-significant. Numerically, mean value of starch content in mg g⁻¹ grain recorded higher in combination D₁V₁T₂ *i.e.*, 37.93 and 36.77 mg g⁻¹ grain, while lower with combination D₂V₃T₀ (33.64 & 32.34 mg g⁻¹ grain) in years *i.e.*, 2013-14 and 2014-15.

Protein content (%)

The data elucidated for protein content (%) as affected by

sowing dates, varieties, treatments of foliar applied boron and thio-urea and their interaction effects are presented in Table No. 3.

Effect of sowing dates

Though statistically mean value of sowing dates indicated non-significant effect but, numerically maximum protein content (11.87 %) accumulated in D₁ while, minimum (11.73%) in D₂ during first experimental years, but statistically significantly highest in D₁ *i.e.*, 11.29 to D₂ *i.e.*, 10.92% during second year.

Table 3: Effect of foliar applied boron and thio-urea on Protein Content (%) from grain after harvesting of wheat cultivars under timely and late sown condition:

Treat.	2013-14					2014-15								
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean				
D ₁	11.77	12.05	11.73	11.94	11.87	11.19	11.48	11.13	11.38	11.29				
D ₂	11.70	11.80	11.54	11.88	11.73	11.00	11.11	10.64	10.94	10.92				
Mean	11.78	11.93	11.63	11.91		11.10	11.29	10.89	11.16					
Treat.	T ₀	T ₁	T ₂	T ₃	T ₄	Mean	T ₀	T ₁	T ₂	T ₃	T ₄	Mean		
D ₁	10.15	12.10	12.25	12.50	12.35	11.87	9.87	11.30	11.58	12.01	11.72	11.29		
D ₂	10.27	11.77	12.15	12.42	12.03	11.73	9.65	10.90	11.20	11.56	11.30	10.92		
Mean	10.21	11.93	12.21	12.46	12.19		9.76	11.10	11.39	11.79	11.51			
V ₁	10.35	11.93	12.08	12.25	12.06	11.73	10.02	11.13	11.31	11.63	11.40	11.10		
V ₂	10.37	12.15	12.20	12.56	12.36	11.93	10.06	11.30	11.53	11.93	11.65	11.29		
V ₃	9.85	11.65	12.15	12.35	12.18	11.63	9.25	10.71	11.33	11.71	11.43	10.89		
V ₄	10.28	12.01	12.43	12.68	12.15	11.91	9.70	11.26	11.40	11.88	11.56	11.16		
Mean	10.21	11.93	12.21	12.46	12.19		9.70	11.10	11.39	11.79	11.51			
Treat.	T ₀	T ₁	T ₂	T ₃	T ₄	T ₀	T ₁	T ₂	T ₃	T ₄				
D ₁	V ₁	10.48	11.86	12.13	12.30	12.10	10.15	11.20	11.36	11.83	11.43			
	V ₂	10.18	12.30	12.50	12.73	12.56	10.03	11.43	11.83	12.20	11.90			
	V ₃	9.60	12.23	12.16	12.26	12.40	9.26	11.23	11.50	11.93	11.73			
	V ₄	10.36	12.00	12.30	12.70	12.33	10.03	11.33	11.63	12.10	11.83			
D ₂	V ₁	10.23	12.00	12.03	12.20	12.03	9.90	11.06	11.26	11.43	11.36			
	V ₂	10.56	12.00	11.90	12.40	12.16	10.10	11.16	11.23	11.66	11.40			
	V ₃	10.10	11.06	12.13	12.43	11.96	9.23	10.20	11.16	11.50	11.13			
	V ₄	10.20	12.03	12.56	12.66	11.96	9.36	11.20	11.16	11.66	11.30			
Factors	D	V	D*V	T	D*T	V*T	D*V*T	D	V	D*V	T	D*T	V*T	D*V*T
SE(d)	0.17	0.15	0.22	0.15	0.21	0.29	0.41	0.04	0.07	0.11	0.06	0.09	0.12	0.17
C.D. at 5%	N.S.	N.S.	N.S.	0.29	N.S.	N.S.	N.S.	0.16	0.16	N.S.	0.12	N.S.	N.S.	0.32

Effect of varieties

The first year mean value of protein content did not examine significant effect on varieties. Although, minimum (11.63%) protein content numerically recorded in V₃ for year 2013-14, but statistically significant mean value of protein content was observed highest in V₂ (11.29%) as compare to varieties V₄ (11.16%), V₁ (11.10%) and lowest in V₃ (10.89%) for experimental year 2014-15. In this year, varieties V₂, V₄ and V₁ showed at par performance for protein content.

Effect of treatments

The treatment significantly influence on protein content during both years. Among the treatments, T₃ gave statistically superior (12.46 and 11.79) protein content (%) during both year of experimentation but first year treatment T₂ (12.21) and T₄ (12.19) and second year treatment T₄ (11.51) and T₁ (11.10) at par). Both years of experimentation untreated control T₀ *i.e.*, 10.21 and 9.70 showed significantly inferior performance than other treatments.

Interaction effect of sowing date and varieties

Though the interaction of sowing dates and varieties was non-significant with regards to protein content, but combination D₁V₂ had produced high (12.05 and 11.48%) for both year

and D₂V₃ numerically less (11.54 and 10.64%) with years *i.e.*, 2013-14 and 2014-15 experiment.

Interaction effect of sowing date and treatments

Interaction of sowing dates with treatments has shown non-significant effect on protein content. Numerically, the combination D₁T₃ *i.e.*, 12.50 and 12.01% accumulated highest protein content and lowest in D₁T₀ (10.15%) in the year 2013-14 and D₂T₀ (9.65%) in the year 2014-15.

Interaction effect of varieties and treatments

The interaction effect of varieties with treatments has indicated non-significant effect on protein content (%). The combination V₃T₀ showed lowest (9.85 & 9.25%) for both years and highest protein content accumulated in combination V₄T₃ (12.68) with year 2013-14 while, V₂T₃ produced highest *i.e.*, 11.93 in year 2014-15.

Interaction effect of sowing date, varieties and treatments:

The interaction effect of sowing dates, varieties and treatments have indicated non-significant effect in year 2013-14, but statistically significant in year 2014-15. The significantly maximum protein content *i.e.*, 12.20% which was exhibited by combination D₁V₂T₃ and it was statistically

at par $D_1V_4T_3$ (12.10), $D_1V_3T_3$ (11.93%) and $D_1V_2T_4$ (11.90%) as well as superior to all other combinations during year 2014-15.

Productive tillers (m^{-2})

The data pertaining to productive tillers affected due to foliar spray of boron and thio-urea with four varieties on two

sowing dates and their interaction are predicated in Table 4.

Effect of sowing dates

The statistically higher mean value of sowing dates to productive tillers (m^{-2}) noted in D_1 i.e., 396.5 and 388.7 and lower in D_2 i.e., 320.8 and 313.5 for both experimental years.

Table 4: Effect of foliar applied boron and thio-urea on Numbers of Productive Tillers (m^{-2}) of wheat cultivars after harvesting under timely and late sown condition:

Treat.	2013-14						2014-15							
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean				
D ₁	437.1	443.0	348.8	356.9	396.5	430.9	433.6	342.0	348.3	388.7				
D ₂	320.4	323.4	310.8	328.6	320.8	312.4	316.8	303.8	321.0	313.5				
Mean	378.8	383.2	329.8	342.7		371.6	375.2	322.9	334.6					
Treat.	T ₀	T ₁	T ₂	T ₃	T ₄	Mean	T ₀	T ₁	T ₂	T ₃	T ₄	Mean		
D ₁	380.1	393.9	402.7	407.8	397.8	396.5	373.1	385.4	394.7	399.8	390.5	388.7		
D ₂	307.5	316.7	326.5	331.6	321.8	320.8	299.4	309.0	319.6	323.7	315.5	313.5		
Mean	343.8	355.3	364.6	369.7	359.8		336.2	347.2	357.2	361.7	353.0			
V ₁	361.8	375.6	385.1	390.6	380.6	378.8	354.6	365.6	379.3	383.6	375.0	371.6		
V ₂	366.8	379.6	389.6	394.6	385.5	383.2	359.1	371.3	381.5	387.5	376.5	375.2		
V ₃	316.5	326.1	335.6	341.1	329.8	329.8	308.5	318.6	328.6	333.5	325.3	322.9		
V ₄	330.1	339.8	348.0	352.5	343.3	342.7	322.8	333.3	339.3	342.5	335.3	334.6		
Mean	343.8	355.3	364.6	369.7	359.8		336.2	347.2	357.2	361.7	353.0			
Treat.	T ₀	T ₁	T ₂	T ₃	T ₄	T ₀	T ₁	T ₂	T ₃	T ₄				
D ₁	V ₁	416.7	435.0	444.0	450.7	439.3	411.0	425.0	440.0	444.0	434.6			
	V ₂	424.0	440.0	451.0	454.3	446.0	416.7	431.0	439.0	446.3	435.0			
	V ₃	334.6	345.0	355.0	361.0	348.6	327.0	337.3	348.0	354.0	344.0			
	V ₄	345.3	355.6	361.0	365.3	357.3	338.0	348.3	352.0	355.0	348.3			
D ₂	V ₁	307.0	316.3	326.3	330.6	322.0	298.3	306.3	318.7	323.3	315.3			
	V ₂	309.6	319.3	328.3	335.0	325.0	301.7	311.6	324.0	328.6	318.0			
	V ₃	298.3	307.3	316.3	321.3	311.0	290.0	300.0	309.3	313.0	306.7			
	V ₄	315.0	324.0	335.0	339.6	329.3	307.6	318.3	326.7	330.0	322.3			
Factors	D	V	D*V	T	D*T	V*T	D*V*T	D	V	D*V	T	D*T	V*T	D*V*T
SE(d)	0.2	0.6	0.9	0.3	0.5	0.6	1.1	0.7	0.7	1.0	0.4	0.5	0.8	1.1
C.D. at 5%	1.0	1.2	2.0	0.6	0.9	1.3	1.8	3.1	1.5	2.2	1.0	1.1	1.5	2.2

Effect of varieties

For both years of experimentation, the significantly maximum mean value of varieties to number of productive tillers (m^{-2}) counted in variety V_2 over V_1 and V_4 with 383.2 and 375.2; 378.8 and 371.6; 342.7 and 334.6 while, V_3 was minimum with 329.8 and 322.9, respectively.

Effect of treatments

The effect of treatments on numbers of productive tillers in m^{-2} observed significant effect during both years. Among the treatments, T_3 gave better performance (369.7 and 361.7 productive tillers) followed by T_2 (364.6 and 357.2) and T_4 (359.8 and 353.0) than T_1 (355.3 and 347.2). During first and second year treatment T_0 did not give better performance (343.8 and 336.2) as compare to all other treatments, respectively.

Interaction effect of sowing dates with varieties

The interaction effect of sowing dates with varieties for number of productive tillers (m^{-2}) was counted significantly more in combination D_1V_2 i.e., 443.0 and 433.6 followed by D_1V_1 i.e., 437.1 and 430.9 while less in combination D_2V_3 i.e., 310.8 and 303.8 in the first and second years of experimentation.

Interaction effect between sowing dates and treatments

The data on the sowing dates and treatments for productive tillers (m^{-2}) recorded significant effect during both years of experimentation. The statistically maximum numbers of

productive tillers was in D_1T_3 followed by D_1T_2 with 407.8; 399.8 and 402.7; 394.7 as well as minimum in combination D_2T_0 with 307.5; 299.4, respectively.

Interaction effect of varieties and treatments

It is revealed from interaction effect of varieties and treatments that number of productive tillers in m^{-2} showed significant effect during years 2013-14 and 2014-15. The higher productive tillers m^{-2} counted in combination V_2T_3 followed by V_1T_3 i.e., 394.6 and 387.5; 390.6 and 383.6 meanwhile, lower in combination V_3T_0 i.e., 316.5 and 308.5, respectively.

Interaction effect of sowing dates, varieties and treatments

The interaction effect of sowing dates, varieties and treatments on productive tillers (m^{-2}) was statistically significant for both experimental seasons. The maximum value observed from combination $D_1V_2T_3$ (454.3 and 446.3) followed by $D_1V_2T_2$ (451.0) in year 2013-14 and $D_1V_1T_3$ (444.0) in 2014-15 while, minimum from combination $D_2V_3T_0$ (298.3 and 290.0).

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