

Boosting Wheat Performance and Soil Fertility: Role of Advanced Planting System and Precision Nitrogen Management in Indo -Gangetic Plains

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ABSTRACT

A field experiment was conducted during Rabi 2024-25 and 2025-26 at the Agronomy Field Laboratory, F.S. University, Shikohabad, Uttar Pradesh, India, to evaluate the impact of advanced planting systems and precision nitrogen management on growth, physiological traits, and yield attributes of wheat (*Triticum aestivum* L.). The study was laid out in a split-plot design with three replications. Five tillage and crop establishment methods (TCEM) – Zero Tillage Wheat (ZTW), Conventional Tillage Wheat (CTW), Reduced Tillage (RT), Reduced Tillage with residue retention (RTW), and Furrow Irrigated Raised Bed (FIRB) – were assigned to main plots. Five precision nitrogen management (PNM) practices – Control, Recommended Dose of Fertilizer (RDF), SPAD-based, Leaf Color Chart (LCC)-based, and Targeted Yield (TY) approach – were assigned to sub-plots. Wheat variety DBW-17 was used. Growth analysis revealed that planting method and N management significantly influenced dry matter accumulation (DMA), leaf area index (LAI), crop growth rate (CGR), and net assimilation rate (NAR) in both years. Among TCEM, FIRB recorded the highest DMA at harvest of 1173.7 and 1174.5 g m⁻², maximum LAI at 90 DAS of 4.63 and 4.66, highest CGR at 90 DAS of 21.77 and 21.80 g m⁻² day⁻¹, and superior yield attributes including spike length of 10.6 and 11.4 cm, spikelets spike⁻¹ of 21.3 and 22.1, grains spike⁻¹ of 54.2 and 55.0, and test weight of 42.8 and 43.6 g during 2024-25 and 2025-26, respectively. ZTW was statistically at par with FIRB for most parameters. RTW consistently recorded the lowest values for all growth and yield attributes. Among PNM treatments, the Targeted Yield approach produced the maximum DMA at harvest of 1167.6 and 1168.4 g m⁻², LAI at 90 DAS of 4.87 and 4.90, CGR at 90 DAS of 21.82 and 21.85 g m⁻² day⁻¹, spike length of 9.9 and 10.7 cm, spikelets spike⁻¹ of 19.6 and 20.4, grains spike⁻¹ of 47.8 and 48.6, and test weight of 42.1 and 42.9 g in the two years. SPAD-based N management was the next best, while the control treatment recorded the lowest values for all parameters. Interaction effects between TCEM and PNM were non-significant for LAI and CGR. The study concludes that integration of FIRB or ZTW with Targeted Yield-based precision nitrogen management

significantly enhances wheat growth, physiological efficiency, and yield attributes by improving dry matter accumulation, canopy development, and assimilation rates. Adoption of these resource-conserving practices offers a sustainable pathway for improving wheat productivity and nitrogen use efficiency in the Indo-Gangetic Plains.

Keywords: *Triticum aestivum*, Dry matter accumulation, Leaf area index, Crop growth rate, Furrow Irrigated Raised Bed, Zero tillage, Precision nitrogen, Targeted Yield, Indo-Gangetic Plains.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the world's most important staple food crops and a primary source of calories and protein for more than 35% of the global population. It belongs to the Poaceae family and is an annual, self-pollinated, hexaploid cereal cultivated on over 220 million hectares worldwide. Globally, China, India, Russia, the USA, and France are the leading wheat producers. India ranks second in both area and production, contributing about 13% of world wheat output. In India, wheat is primarily grown during the Rabi season under irrigated conditions, with the Indo-Gangetic Plains (IGP) covering Punjab, Haryana, Uttar Pradesh, Bihar, and West Bengal accounting for nearly 60% of national production. Uttar Pradesh is the largest wheat-producing state, and Shikohabad in Firozabad district lies within this intensive wheat-growing belt. Wheat grain is rich in carbohydrates (70-75%), protein (10-15%), minerals, and vitamins, forming the basis of staple foods like roti, bread, and chapati. The crop requires a cool, dry climate during growth and warm, dry weather during maturity, with optimal temperatures of 15-20°C for vegetative growth and 20-25°C for grain filling. It performs best in well-drained loamy to clay loam soils with pH 6.0-7.5. Improved varieties like DBW-17, combined with proper agronomic practices, are key to achieving high yields. Despite its importance, wheat productivity in the IGP has stagnated over the past decade due to sub-optimal agronomic practices, declining soil fertility, inefficient nutrient use, and rising input costs. Conventional tillage combined with blanket fertilizer application increases production costs and leads to poor resource use efficiency, environmental degradation, and reduced long-term soil health. Conventional tillage wheat (CTW) is energy-intensive and time-consuming, while causing deterioration of soil physical properties. In contrast, conservation agriculture-based practices such as zero tillage wheat (ZTW), reduced tillage (RT), and furrow irrigated raised bed (FIRB) offer advantages including timely sowing, improved soil structure, better moisture conservation, and reduced fuel consumption. FIRB facilitates efficient irrigation and reduces waterlogging, while ZTW allows early planting and minimizes soil disturbance. Nitrogen is the most limiting nutrient for wheat production in India, yet its use efficiency rarely exceeds 30-35% under conventional management. Excessive and imbalanced N application increases cultivation costs and causes environmental pollution through leaching, volatilization, and denitrification. Precision nitrogen management (PNM) approaches such as SPAD meter-based, Leaf Color Chart (LCC)-based, and Targeted Yield (TY) enable site-specific and need-based N application. SPAD and LCC provide real-time assessment of crop N status, allowing N application at critical growth stages. The TY approach estimates N requirement based on yield target, soil supply, and crop demand, leading to higher N use efficiency and yield. Integration of PNM with efficient planting systems can synergistically enhance crop performance by improving nutrient uptake, tiller production, canopy development, and dry matter accumulation. Despite proven benefits of conservation tillage and precision N management individually, information on their combined effect on wheat growth, physiological traits, and yield under IGP conditions remains limited. Therefore, the present study was undertaken during Rabi 2024-25 and 2025-26 at Shikohabad, Firozabad, Uttar Pradesh, to evaluate the impact of various efficient planting methods and precision nitrogen management practices on growth, yield attributes, and productivity of wheat variety DBW-17. The objective was to identify an optimal combination of planting system and N management that maximizes wheat yield while improving resource use efficiency and sustaining soil fertility.

2. MATERIALS AND METHODS

The field experiment was conducted during the Rabi seasons of 2024-25 and 2025-26 at the Agronomy Field Laboratory, Department of Agronomy, F.S. University, Shikohabad, Firozabad, Uttar Pradesh, India. The experimental site lies at 27°07'N latitude, 78°35'E longitude, and 163 m above mean sea level in the Central Alluvial Plain Zone of Uttar Pradesh. The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction, low in available nitrogen, medium in phosphorus, and high in potassium. The experiment was laid out in a split-plot design with three replications. Five tillage and crop establishment methods (TCM) viz., Zero Tillage Wheat (ZTW), Conventional Tillage Wheat (CTW), Reduced Tillage

(RT), Reduced Tillage with residue retention (RTW), and Furrow Irrigated Raised Bed (FIRB) were assigned to main plots. Five precision nitrogen management (PNM) practices viz., Control (no N), Recommended Dose of Fertilizer (RDF: 120:60:40 kg N:P₂O₅:K₂O ha⁻¹), SPAD meter-based N application, Leaf Color Chart (LCC)-based N application, and Targeted Yield (TY) approach were assigned to sub-plots. Wheat variety DBW-17 was sown using 100 kg seed ha⁻¹ at 20 cm row spacing. Sowing was done in the second week of November in both years. In FIRB, beds of 67.5 cm width with 30 cm furrows were prepared. In ZTW and RT, seeds were drilled using zero-till and reduced-till drills, respectively. In CTW, two passes of disc harrow followed by two passes of cultivator and planking were done before sowing. For RTW, crop residue @ 5 t ha⁻¹ was retained on the soil surface after reduced tillage. Full dose of P and K and half dose of N were applied basally at sowing. Remaining N as per treatments was applied at critical growth stages. For SPAD-based management, N was applied when SPAD readings fell below 42 at 30, 45, and 60 DAS. For LCC-based management, N was applied when leaf color score fell below 4. For TY approach, N dose was calculated based on yield target of 55 q ha⁻¹, soil N supply, and crop N requirement. Observations on plant height and number of tillers m⁻² were recorded at 30, 60, 90 DAS and at harvest from randomly selected plants. Dry matter accumulation, leaf area index, crop growth rate, and net assimilation rate were recorded at corresponding growth stages. Yield attributes including spike length, spikelets spike⁻¹, grains spike⁻¹, and test weight were recorded at harvest. Grain yield, straw yield, biological yield, and harvest index were recorded after threshing and drying. Data were statistically analyzed using standard procedures for split-plot design.

3. RESULT & DISCUSSION

3.1. DRY MATTER ACCUMULATION (g m⁻²)

Dry matter accumulation (DMA) in wheat increased progressively with crop age and was significantly influenced by tillage and crop establishment methods and precision nitrogen management during both Rabi 2024-25 and 2025-26. At harvest, Furrow Irrigated Raised Bed (FIRB) recorded the highest DMA of 1173.7 and 1174.5 g m⁻² in 2024-25 and 2025-26, respectively, and was statistically at par with Zero Tillage Wheat (ZTW). Conventional Tillage Wheat and Reduced Tillage showed intermediate values. Reduced Tillage with residue retention (RTW) recorded the lowest DMA of 951.3 and 952.1 g m⁻² at harvest in both years. Among precision nitrogen management practices, the Targeted Yield approach produced the maximum DMA at all stages, with harvest values of 1167.6 and 1168.4 g m⁻² in 2024-25 and 2025-26, respectively, followed by SPAD-based N management. The control treatment recorded the lowest DMA of 889.0 and 889.8 g m⁻² at harvest. Differences among treatments were statistically significant at P=0.05 at all growth stages. The highest rate of dry matter accumulation was observed between 60 DAS and 90 DAS across all treatments.

3.2. CROP GROWTH RATE (CGR, g m⁻² day⁻¹)

Crop Growth Rate (CGR) in wheat increased with crop age and was significantly affected by planting methods and precision nitrogen management in both 2024-25 and 2025-26. CGR was highest at 90 DAS under all treatments, indicating maximum biomass accumulation during the reproductive phase. Among planting methods, Furrow Irrigated Raised Bed (FIRB, T₄) recorded the highest CGR at all stages. At 90 DAS, FIRB recorded 21.77 and 21.80 g m⁻² day⁻¹ in 2024-25 and 2025-26, respectively, and was statistically at par with Zero Tillage Wheat (ZTW, T₁). Reduced Tillage with residue (RTW, T₃) recorded the lowest CGR of 18.64 and 18.67 g m⁻² day⁻¹ at 90 DAS. Differences among planting methods were significant at P=0.05. Precision nitrogen management also significantly influenced CGR. The Targeted Yield approach (F₃) produced the maximum CGR at all stages, with 21.82 and 21.85 g m⁻² day⁻¹ at 90 DAS in 2024-25 and 2025-26, respectively, followed by SPAD-based management (F₂). The control (F₀) recorded the lowest CGR of 17.92 and 17.95 g m⁻² day⁻¹ at 90 DAS. CD values at 5% confirmed significant differences among N management treatments

3.3. LEAF AREA INDEX (LAI)

Leaf Area Index increased with crop age and was significantly affected by planting methods and precision nitrogen management in both 2024-25 and 2025-26. Maximum LAI was recorded at 90 DAS under all treatments. Among planting methods, Furrow Irrigated Raised Bed (FIRB) recorded the highest LAI of 4.63 and 4.66 at 90 DAS in 2024-25 and 2025-26, respectively, and was at par with Zero Tillage Wheat (ZTW). Reduced Tillage with residue (RTW) recorded the lowest LAI of 4.48 and 4.51 at 90 DAS. Differences among planting methods were significant at P=0.05. Among nitrogen management practices, the Targeted Yield approach produced the maximum LAI of 4.87 and 4.90 at 90 DAS, followed by SPAD-based

management. The control treatment recorded the lowest LAI of 3.66 and 3.69 at 90 DAS. Differences among N management treatments were statistically significant at all stages. Interaction effects between planting methods and nitrogen management were non-significant.

3.4. YIELD AND HARVEST INDEX

Grain yield, straw yield, biological yield, and harvest index of wheat were significantly influenced by planting methods and precision nitrogen management during 2024-25 and 2025-26.

3.4.1. EFFECT OF PLANTING METHODS:

Furrow Irrigated Raised Bed (FIRB) recorded the highest grain yield of 53.1 and 53.9 q/ha, straw yield of 64.3 and 65.7 q/ha, and biological yield of 116.9 and 117.7 q/ha in 2024-25 and 2025-26, respectively, and was statistically at par with Zero Tillage Wheat (ZTW). Reduced Tillage with residue (RTW) recorded the lowest grain yield of 37.9 and 38.7 q/ha and biological yield of 82.7 and 83.5 q/ha. Harvest index was highest under ZTW (46.3% and 47.1%). Differences among planting methods were significant at 5%.

3.4.2. EFFECT OF PRECISION NITROGEN MANAGEMENT:

The Targeted Yield approach produced the highest grain yield of 52.3 and 53.0 q/ha, straw yield of 59.9 and 60.7 q/ha, biological yield of 111.6 and 112.4 q/ha, and harvest index of 47.0% and 47.8% in 2024-25 and 2025-26, respectively, followed by SPAD-based management. The control treatment recorded the lowest yields. Differences among N management treatments were statistically significant at 5%.

Table I: Performance of various tillage and crop establishment methods and Precision nitrogen management on dry matter accumulation (g m^{-2}) of wheat during experimental season 2024-25 & 2025-26

Treatments	DRY MATTER ACCUMULATION (GM ⁻²)							
	30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	At Harvest
	CROP SEASON 2024-25				CROP SEASON 2025-26			
➤ Tillage and Crop Establishment Methods (TCEM- Main Plot)								
T ₁ (ZTW)	28.0	161.4	932.6	1119.0	28.8	162.2	933.4	1119.8
T ₂ (RT)	27.1	129.6	823.0	1040.0	27.6	130.4	823.8	1040.8
T ₃ (RTW)	24.2	125.6	803.1	951.3	24.7	126.4	803.9	952.1
T ₄ (FIRB)	33.0	199.9	979.0	1173.7	33.8	200.7	979.8	1174.5
T ₅ (CTW)	27.5	141.0	836.7	1079.4	28.3	141.8	837.5	1080.2
<i>SEm±</i>	<i>0.74</i>	<i>1.76</i>	<i>8.37</i>	<i>9.07</i>	<i>1.54</i>	<i>2.56</i>	<i>9.17</i>	<i>9.87</i>
<i>C.D. at 5%</i>	<i>2.41</i>	<i>5.74</i>	<i>27.29</i>	<i>29.57</i>	<i>5.02</i>	<i>8.35</i>	<i>29.89</i>	<i>32.18</i>
➤ Precision Nitrogen Management (PNM-Sub Plot)								
F0 (Control)	24.6	120.0	684.4	889.0	25.4	120.8	685.2	889.8
F1 (RDF)	28.0	152.7	895.5	1060.9	28.8	153.5	896.3	1061.7
F2 (SPAD)	29.0	160.6	930.6	1138.7	29.8	161.4	931.4	1139.5
F3 (TY)	29.5	165.6	947.8	1167.6	30.3	166.4	948.6	1168.4
F4 (LCC)	28.5	157.5	916.0	1097.6	29.3	158.3	916.8	1098.4
<i>SEm±</i>	<i>0.96</i>	<i>3.06</i>	<i>15.14</i>	<i>19.00</i>	<i>0.46</i>	<i>3.86</i>	<i>15.94</i>	<i>19.80</i>
<i>C.D. at 5%</i>	<i>2.75</i>	<i>8.75</i>	<i>43.30</i>	<i>54.34</i>	<i>1.32</i>	<i>11.04</i>	<i>45.59</i>	<i>56.63</i>

(Source: Field experiment conducted during rabi 2024-25 and 2025-26 at FSU, SKB., U.P.)

Dry matter accumulation at 2024-25

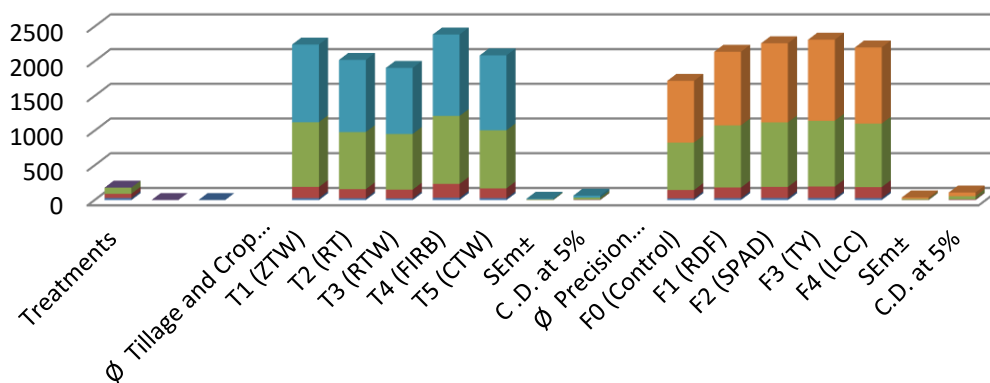


Figure – I a: Dry matter accumulation affected by various treatments TCEM and PNM

Dry matter accumulatio at 2025-26

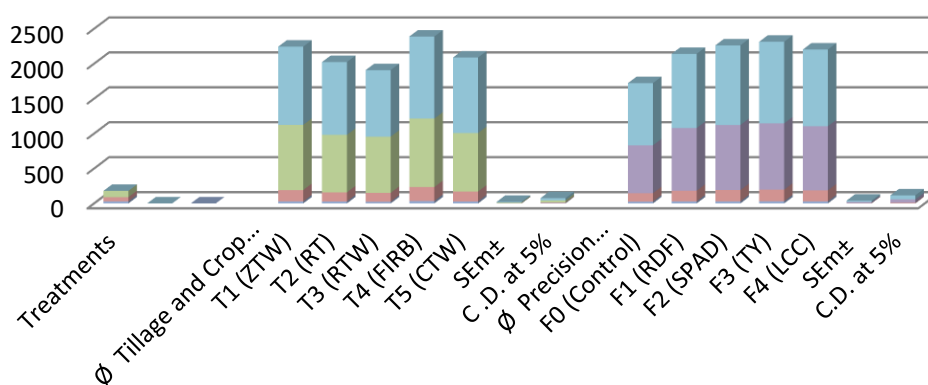


Figure – I b: Dry matter accumulation affected by various treatments TCEM and PNM

Table – II : Performance of various tillage and crop establishment methods (TCEM) and precision nitrogen management (PNM) on crop augmentation (CGR) rate at three crucial stages.

Treatments	CROP GROWTH RATE (CGR)					
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
	CROP SEASON 2024-25			CROP SEASON 2025-2026		
➤ Tillage and Crop Establishment Methods (TCEM- Main Plot)						
T ₁ (ZTW)	1.56	4.59	20.99	1.59	4.62	21.02
T ₂ (RT)	1.50	4.50	19.19	1.53	4.53	19.22
T ₃ (RTW)	1.48	4.42	18.64	1.51	4.45	18.67
T ₄ (FIRB)	1.58	4.67	21.77	1.61	4.70	21.80
T ₅ (CTW)	1.53	4.54	20.05	1.56	4.57	20.08
<i>SEM±</i>	<i><u>0.034</u></i>	<i><u>0.062</u></i>	<i><u>0.20</u></i>	<i><u>0.064</u></i>	<i><u>0.092</u></i>	<i><u>0.23</u></i>
<i>C.D. at 5%</i>	<i><u>0.111</u></i>	<i><u>0.202</u></i>	<i><u>0.652</u></i>	<i><u>0.209</u></i>	<i><u>0.300</u></i>	<i><u>0.750</u></i>
➤ Precision Nitrogen Management (PNM-Sub plot)						
F0 (Control)	1.38	3.46	17.92	1.41	3.49	17.95
F1 (RDF)	1.49	4.31	20.09	1.52	4.34	20.12
F2 (SPAD)	1.57	5.02	20.62	1.60	5.05	20.65
F3 (TY)	1.65	5.06	21.82	1.68	5.09	21.85
F4 (LCC)	1.54	4.87	20.19	1.57	4.90	20.22
<i>SEM±</i>	<i><u>0.045</u></i>	<i><u>0.097</u></i>	<i><u>0.36</u></i>	<i><u>0.075</u></i>	<i><u>0.127</u></i>	<i><u>0.39</u></i>
<i>C.D. at 5%</i>	<i><u>0.129</u></i>	<i><u>0.277</u></i>	<i><u>1.030</u></i>	<i><u>0.215</u></i>	<i><u>0.363</u></i>	<i><u>1.115</u></i>

(Source: Field experiment conducted during rabi 2024-25 and 2025-26 at FSU, SKB., U.P.)

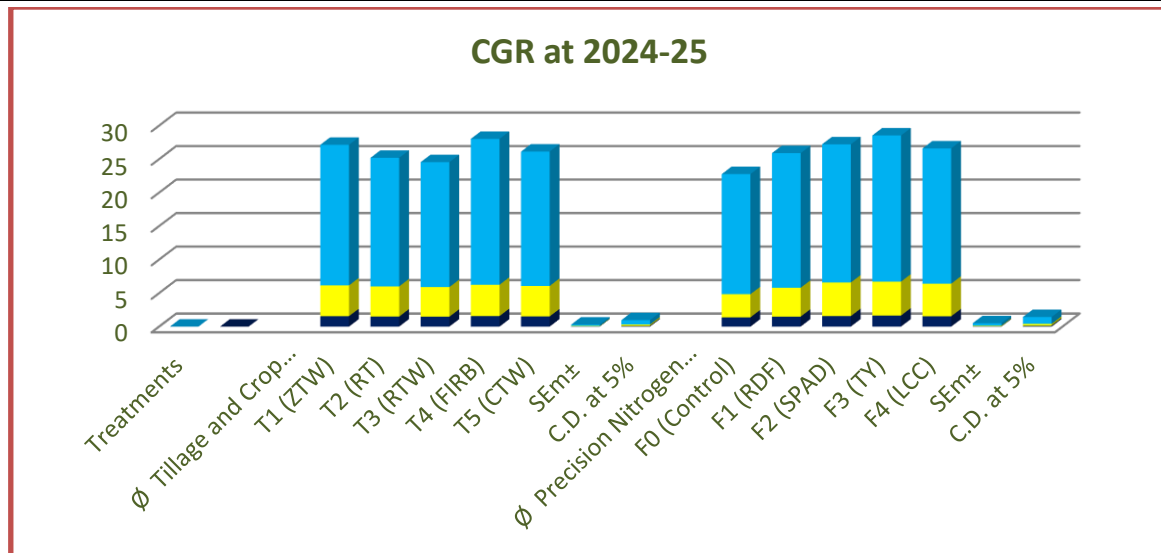


Figure – II a : Crop Growth rate affected by different treatments combinations of wheat

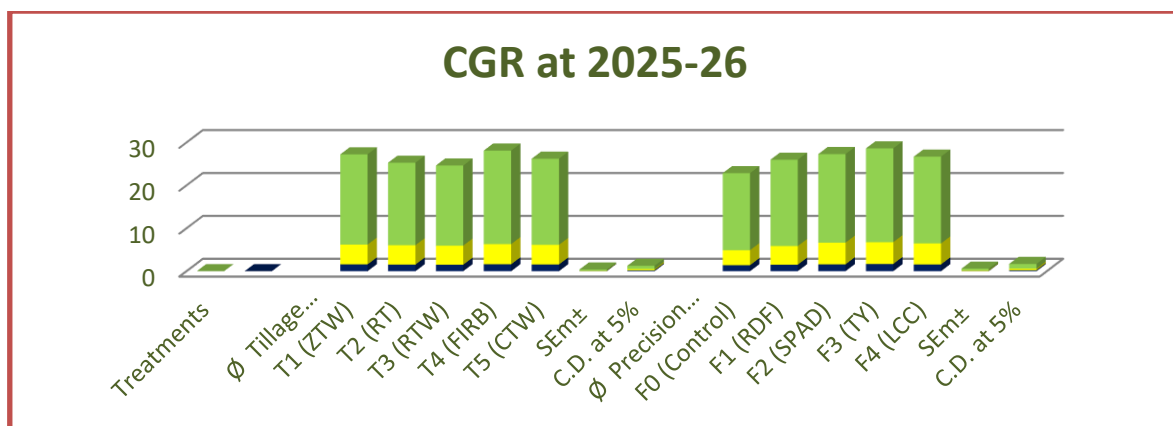


Figure – II b : Crop Growth rate affected by different treatments combinations of wheat

Table - III : Performance of various tillage and crop establishment methods and precision nitrogen management on Leaf area index (LAI) at various crop growth stages of wheat, with the experimental session of 2024-25 and 2025-26

Treatments	LEAF AREA INDEX (LAI)					
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
	CROP SEASON 2024-2025			CROP SEASON 2025-2026		
➤ Tillage and Crop Establishment Methods (TCEM- Main Plot)						
T ₁ (ZTW)	1.16	2.76	4.59	1.19	2.79	4.62
T ₂ (RT)	1.03	2.67	4.52	1.06	2.70	4.55
T ₃ (RTW)	0.92	2.63	4.48	0.95	2.66	4.51
T ₄ (FIRB)	1.19	2.80	4.63	1.22	2.83	4.66
T ₅ (CTW)	1.15	2.71	4.55	1.18	2.71	4.58
<i>SEm±</i>	<i><u>0.04</u></i>	<i><u>0.05</u></i>	<i><u>0.06</u></i>	<i><u>0.07</u></i>	<i><u>0.08</u></i>	<i><u>0.09</u></i>
<i>C.D at 5%</i>	<i><u>0.13</u></i>	<i><u>0.16</u></i>	<i><u>0.20</u></i>	<i><u>0.23</u></i>	<i><u>0.26</u></i>	<i><u>0.29</u></i>
➤ Precision Nitrogen Management (PNM-Sub plot)						
F0 (Control)	0.89	2.61	3.66	0.92	2.64	3.69
F1 (RDF)	1.09	2.66	4.70	1.12	2.69	4.73
F2 (SPAD)	1.17	2.77	4.80	1.19	2.80	4.83
F3 (TY)	1.17	2.83	4.87	1.20	2.86	4.90
F4 (LCC)	1.11	2.69	4.76	1.14	2.72	4.79
<i>SEm±</i>	<i><u>0.05</u></i>	<i><u>0.07</u></i>	<i><u>0.10</u></i>	<i><u>0.08</u></i>	<i><u>0.10</u></i>	<i><u>0.13</u></i>
<i>C D (P=0.05)</i>	<i><u>0.14</u></i>	<i><u>0.20</u></i>	<i><u>0.29</u></i>	<i><u>0.23</u></i>	<i><u>0.29</u></i>	<i><u>0.37</u></i>

(Source: Field experiment conducted during rabi 2024-25 and 2025-26 at FSU, SKB., U.P.)

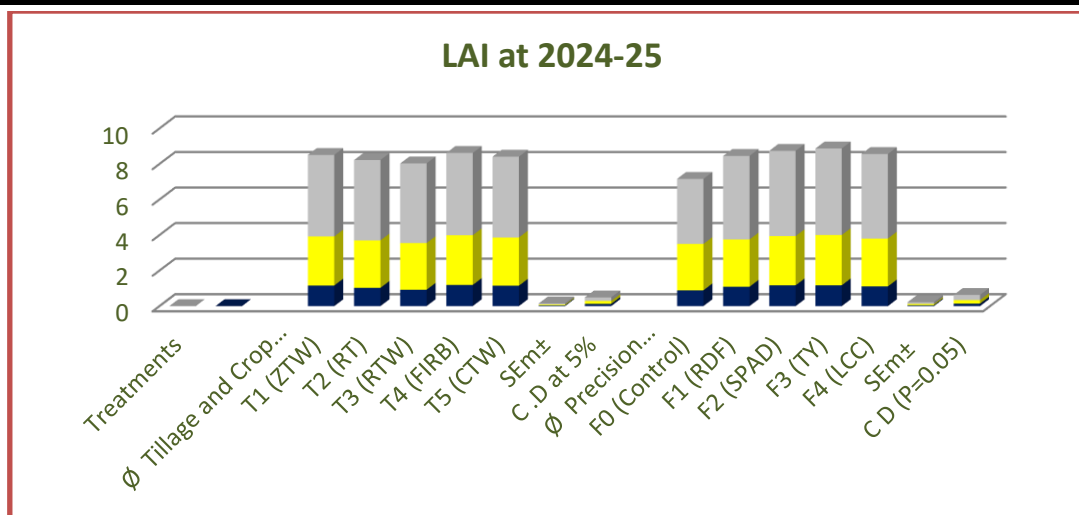


Figure – III a : Experimental wheat LAI affected by various treatments of TCEM and PNM

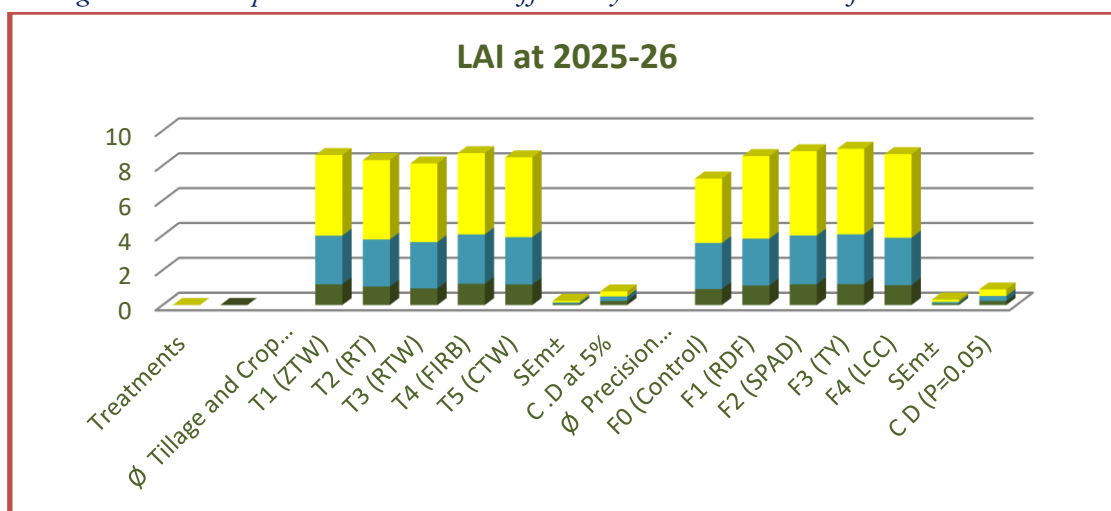


Figure – III b : Experimental wheat LAI affected by various treatments of TCEM and PNM

Table IV: Performance of Various efficient planting methods and Precision nitrogen management on Grain, Straw, Biological yield & Harvest index of experimental wheat of both years (2024-25 & 2025-26).

Treatments	YIELD AND HARVEST INDEX							
	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest Index (%)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest Index (%)
	CROP SEASON 2024-25				CROP SEASON 2025-26			
➤ Tillage and Crop Establishment Methods (TCEM-main plot)								
T ₁ (ZTW)	49.2	58.0	106.7	46.3	50.0	58.8	107.5	47.1
T ₂ (RT)	42.4	51.4	93.3	45.7	43.2	52.2	94.1	46.5
T ₃ (RTW)	37.9	45.3	82.7	45.5	38.7	46.1	83.5	46.3
T ₄ (FIRB)	53.1	64.3	116.9	45.7	53.9	65.7	117.7	46.5
T ₅ (CTW)	44.1	57.1	100.7	44.0	44.9	57.9	101.5	44.8
<i>SEm±</i>	<i><u>0.56</u></i>	<i><u>0.58</u></i>	<i><u>3.48</u></i>	<i><u>0.50</u></i>	<i><u>0.64</u></i>	<i><u>0.66</u></i>	<i><u>3.56</u></i>	<i><u>0.58</u></i>
<i>C.D at 5%</i>	<i><u>1.83</u></i>	<i><u>1.89</u></i>	<i><u>11.34</u></i>	<i><u>1.63</u></i>	<i><u>2.09</u></i>	<i><u>2.15</u></i>	<i><u>11.61</u></i>	<i><u>1.89</u></i>
➤ Precision Nitrogen Management (PNM-sub plot)								
F ₀ (control)	34.3	45.5	79.3	43.4	35.1	46.3	80.1	44.2
F ₁ (RDF)	45.9	55.8	101.2	45.6	46.7	56.6	102.0	46.4
F ₂ (SPAD)	47.6	58.7	105.8	45.2	48.4	59.5	106.6	46.0

F ₃ (TY)	52.3	59.9	111.6	47.0	53.0	60.7	112.4	47.8
F ₄ (LCC)	46.7	56.2	102.4	45.9	47.5	57.0	103.2	46.7
<i>SEm±</i>	<i>0.83</i>	<i>1.06</i>	<i>3.18</i>	<i>0.79</i>	<i>0.91</i>	<i>1.14</i>	<i>3.26</i>	<i>0.87</i>
<i>C.D. at 5%</i>	<i>2.37</i>	<i>3.03</i>	<i>9.09</i>	<i>2.26</i>	<i>2.60</i>	<i>3.26</i>	<i>9.32</i>	<i>2.49</i>

(Source: Field experiment conducted during rabi 2024-25 and 2025-26 at FSU, SKB., U.P.)

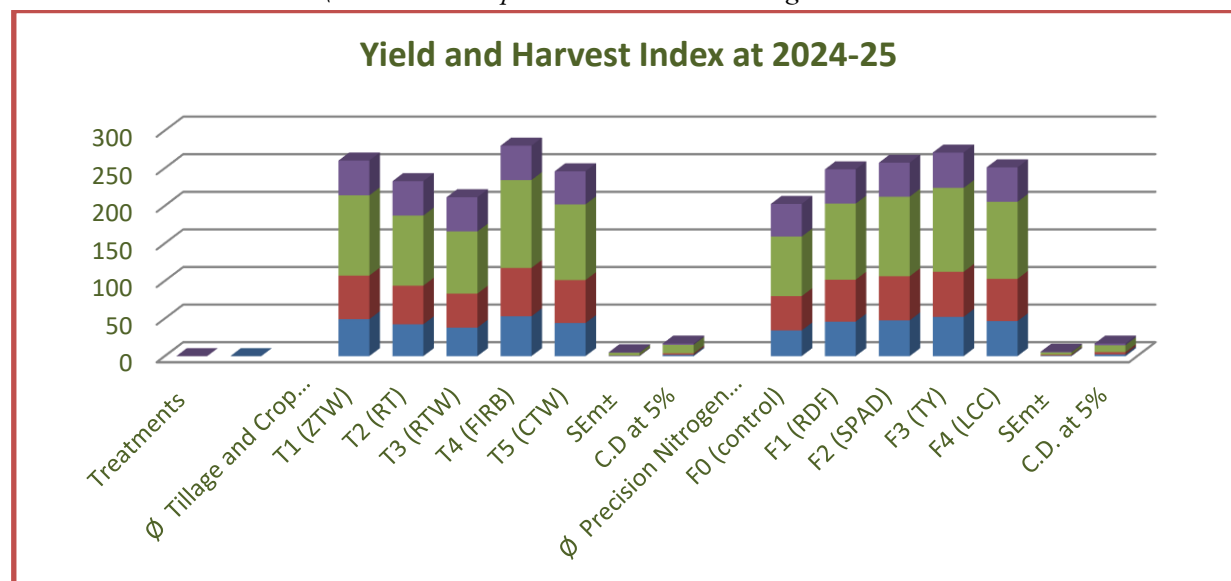


Figure –IV : Grain , Straw, Biological yield and Harvest Index affected by various treatments TCEM & PNM in wheat during the crop season 2024-25

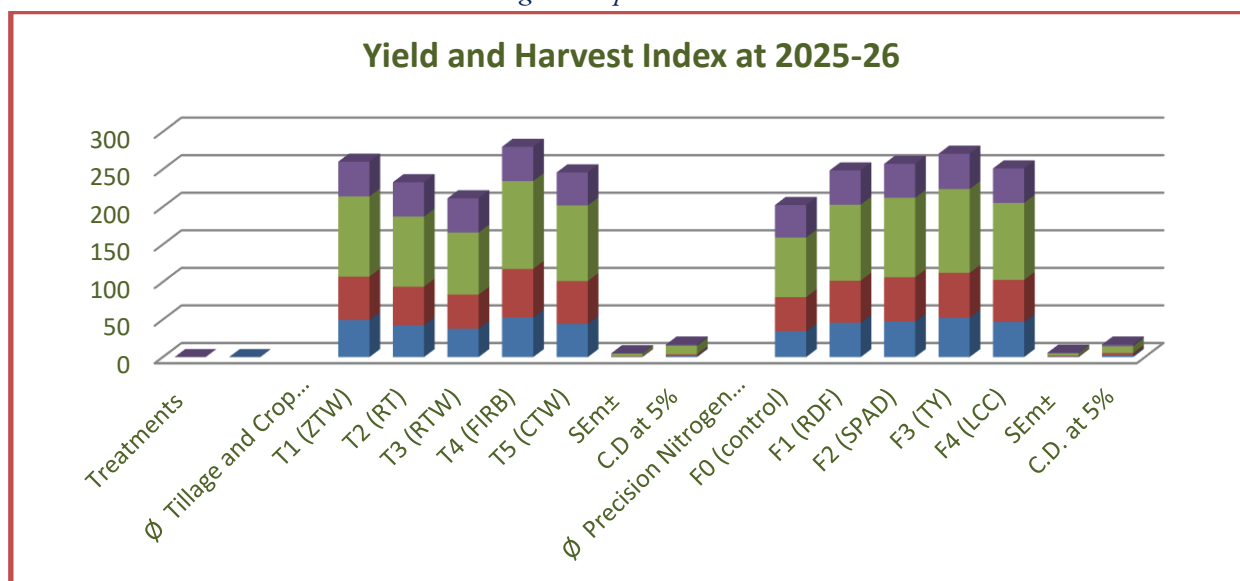


Figure –IV : Grain , Straw, Biological yield and Harvest Index affected by various treatments TCEM & PNM in wheat during the crop season 2025-26

3. DISCUSSION

The superior dry matter accumulation, leaf area index, crop growth rate, and yield under Furrow Irrigated Raised Bed (FIRB) can be attributed to improved soil aeration, better root development, efficient water and nutrient use, and reduced crop lodging compared to conventional and reduced tillage systems. FIRB being at par with Zero Tillage Wheat (ZTW) suggests that conservation tillage practices maintain soil structure and moisture, promoting biomass production. Lower values under Reduced Tillage with residue (RTW) may be due to slower mineralization and temporary N immobilization in the early growth stages. Among precision nitrogen management practices, the Targeted Yield (TY) approach resulted in maximum growth and yield attributes because it synchronizes N supply with crop demand based on yield goals, avoiding both deficiency and excess. SPAD-based management also performed well, indicating the utility of real-time N monitoring. The poor performance of the control treatment confirms the critical role of adequate N in enhancing canopy development and

photosynthetic efficiency. The significant increase in LAI and CGR at 90 DAS across treatments reflects peak vegetative growth during the reproductive phase. Consistent trends over two years validate the robustness of FIRB and TY for enhancing wheat productivity. These findings align with earlier reports highlighting the benefits of conservation agriculture and site-specific nutrient management in improving resource use efficiency and sustaining yield.

4. CONCLUSION:

The study revealed that Furrow Irrigated Raised Bed (FIRB) planting method and Targeted Yield-based precision nitrogen management (TY) consistently produced the highest dry matter accumulation, leaf area index, crop growth rate, and grain, straw, and biological yields in wheat during 2024-25 and 2025-26. FIRB was statistically at par with Zero Tillage Wheat for most growth parameters and yields, while Reduced Tillage with residue recorded the lowest values. Among nitrogen management, TY approach outperformed SPAD, LCC, RDF, and control treatments at all growth stages. Differences among planting methods and nitrogen management practices were significant at $P=0.05$. Interaction effects were non-significant. Results indicate that adopting FIRB planting with TY-based nitrogen management can enhance wheat productivity, growth efficiency, and resource use under the studied conditions.

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