Environment and Ecology 42 (3B) : 1407—1411, July—September 2024
Article DOI: https://doi.org/10.60151/envec/QDMX8028
ISSN 0970-0420

Relative Weed Composition, Weed Dry Matter and Wheat Yield as Influenced by Different Tillage Practices and Nitrogen Management

Sudarshan S., Kapila Shekhawat, Gunturi Alekhya, Niveditha M. P., Chethan Babu, Shashank Patel

Received 15 December 2023, Accepted 25 August 2024, Published on 4 September 2024

ABSTRACT

In the *rabi* (winter) season of 2020-21, a field experiment conducted at the Indian Agricultural Research Institute in New Delhi. The experimental employed a split-plot design, encompassing four distinct tillage practice in the main plots and four nitrogen management approaches in the sub-plots, all replicated thrice. The results show that, residue retention in zero tillage recorded significantly lower weed density and weed dry matter and higher grain yield (4.99 t/ha) over other treatments. Similar results also recorded under different nitrogen management practices, where LCC-guided N application has significantly lower weed density and weed dry matter and higher grain yield (5.39t/ha) over remaining treatments. The LCC-guided nitrogen application practice in residue retained zero tillage can be recommended for wheat farmers under rice-wheat system. This combined approach not only enhances weed control but also elevates overall productivity, signifying its potential as an effective and sustainable practice for optimizing wheat yields.

Keywords Zero tillage, Weed density, Weed dry matter, LCC, Nitrogen management.

INTRODUCTION

Wheat (*Triticum aestivum* L.) stands as a pivotal cereal crop globally and holds the second-highest position in India, following rice. The rice-wheat cropping system, critical for global food security, sustains a significant portion of the world's population. To meet escalating food demands, enhancing the productivity of the rice-wheat system is imperative, and conservation agriculture (CA) has gained favor among farmers, particularly in the North-western plains of the Indian Gangetic Plain (IGP). Traditional tillage methods, such as conventional tillage (CT), not only consume time but also have adverse effects on soil structure and quality, prompting a shift towards new,

Sudarshan S[1], Kapila Shekhawat[2], Gunturi Alekhya[3], Shashank Patel[6]

[1,3,6]PhD Scholar, [2]Principal Scientist
Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi 110012, India

Niveditha M P[4]
[4]PhD Scholar (Agronomy), College of Agriculture, UAHS, Shivamogga, Karnataka 577201, India

Chethan Babu[5]
[5]Ph.D Scholar (Agronomy),
ICAR- National Dairy Research Institute, Karnal 132001, India

Email: sudarshan.ss83@gmail.com
*Corresponding author

time-efficient tillage practices. Zero tillage (ZT) has proven to be a viable alternative in addressing issues like late sowing, rising cultivation costs, and weed infestation in wheat, gaining widespread adoption in the western IGP due to its efficiency, profitability, environmental sustainability, and heat stress resistance (CSISA 2015, Keil *et al.* 2015). However, the increased reliance on chemical fertilizers, particularly nitrogen (N), in response to wheat's rapid and substantial nutrient uptake, has led to imbalanced nutrient use. No-tillage (NT) systems pose challenges in N fertilizer management, necessitating further studies to optimize its effectiveness. The need for adjustments in N fertilization timing and rates for wheat receiving residues calls for a closer look at N management practices. Real-time monitoring of N status in wheat emerges as a solution, allowing for the incorporation of N supply over time. The leaf-color chart (LCC) tool proves valuable in need-based N management for rice and wheat. By estimating crop N status in the field, considering soil N supply variations, and determining the optimal time for N application, the LCC facilitates farmers in aligning N application with crop demand. This not only enhances N efficiency but also provides flexibility to adjust N recommendations based on real-time crop conditions. Keeping the above fact in view, the present investigation was carried to assess the impact of real time nitrogen management under different tillage practices.

MATERIALS AND METHODS

In the *rabi* (winter) season of 2020-21, a field experiment conducted at the Indian Agricultural Research Institute in New Delhi. India, at 28°38'23"N, 77°09'27"E, and 228.61 meters above mean sea level. The experimental employed a split-plot design, encompassing four distinct tillage practice in the main plots [conventional tillage (CT) and stale seed bed-conventional tillage (SSB-CT), zero tillage without residue application (ZT-R), zero tillage with residue application at 3t/ha (ZT+R)] and four nitrogen management approaches in the sub-plots [No nitrogen application (0 kg N: 60 kg P_2O_5: 60 K_2O / ha respectively), Recommended nitrogen application (120 kg N: 60 kg P_2O_5: 60 K_2O /ha respectively, 100% P and 100% K as basal, N scheduled as 33% N basal, 33% N at 20-25 DAS and remaining 33% at 45-50 DAS), Modified nitrogen scheduling (120 kg N: 60 kg P_2O_5: 60 K_2O /ha respectively, 100% P and 100% K as basal, No basal N application, three split N applications at 20-25 DAS, 40-45 DAS and 60-65 DAS), LCC- guided nitrogen application (120-60-60 N: P_2O_5: K_2O kg/ha, all P and K as basal, No basal N and split N use at LCC (≤ 4.0) @40 kg N application from 20 to 65 DAS)] with 3 replications. The gross plot area was 5.4 × 4 m (21.6 m^2) and the net plot area 16.32 m^2. Planted the seeds on November 25, 2020, using a method where the seeds were placed in rows with 20 cm spacing. HD-2967 variety of wheat was used as a test crop.

RESULTS AND DISCUSSION

Weed composition and density

Weed composition and density were significantly influenced by tillage practices and nitrogen management practices (Table 1). Under tillage practices, ZT recorded highest number of broad-leaved weeds (BLW) (9.5 No./m^2) and narrow leaved weeds (NLW) (12.4 No./m^2) at 30 DAS also recorded highest number of BLW (34.1 No./m^2) and NLW (65.2/m^2) at 60 DAS but ZT+R recorded least number of BLW (4.3 No./m^2) (17.5 No./m^2) and NLW (3.5 No./m^2) (23.9 No./m^2) at 30 DAS and 60 DAS respectively. When

Table 1. Effect of crop establishment methods and nitrogen management on weed density (No./m^2) of wheat.

Treatments	30 DAS		60 DAS	
	BLW (No./m^2)	NLW (No./m^2)	BLW (No./m^2)	NLW (No./m^2)
Tillage practices				
CT	7.3	9.6	32.5	49.2
SSB-CT	5.4	4.4	20.8	36.0
ZT	9.5	12.4	34.1	65.2
ZT+R	4.3	3.5	17.5	23.9
SEm ±	0.144	0.142	0.42	0.35
CD (p=0.05)	0.509	0.502	1.49	1.25
Nitrogen management practices				
No N	9.3	9.0	32.8	52.7
RDN	5.8	7.2	26.8	45.3
Mod DN	5.8	6.9	24.8	42.9
LCC	5.6	6.8	20.4	36.7
SEM	0.148	0.219	0.4	0.36
CD (p=0.05)	0.435	0.644	1.17	1.05

compared to CT, ZT+ R results in reduction of 41.1% and 63.5% of BLW and NLW at 30 DAS respectively and at 60 DAS ZT+R results in reduction of 46.1% BLW and 51.4 % NLW when compared to CT. Zero tillage with residue retention results in reduction of weed density of both NLW and BLW when compared to zero tillage without residue retention. This is mainly due to residue act as barrier for germination and seedling emergence. When compared to conventional tillage, stale seedbed method has better weed control than the traditional seedbed method and permitted better crop growth than the conventional seedbed method. When compared to zero tillage without residue conventional tillage recorded low weed density both at 30 DAS and 60 DAS. Bisen and Singh (2008) also recorded that weed density was significantly lower in conventional tillage compared to reduced tillage and zero tillage. Baghel *et al.* (2018) also reported that the weed population in wheat under zero tillage plots was 30% lower than conventional weed plots in rice-wheat rotation. Kende *et al*. (2017) reported that weed infestation had decreased due to the adoption of zero tillage in wheat due to less soil disturbances.

Under different nitrogen management practices, LCC-guided nitrogen management practice recorded lowest number of BLW (5.6 No./m^2) and NLW (6.8 No./m^2) at 30 DAS and recorded lowest number of BLW (20.4 No./m^2) and NLW (36.7/m^2) at 60 DAS. When compared to RDN practice, LCC-guided nitrogen management practice results in reduction of 3.5% and 5.6% of BLW and NLW at 30 DAS respectively and at 60 DAS ZT+R results in reduction of 23.9% BLW and 19% NLW when compared to RDN practice. No-N application practice has recorded highest number of BLW (9.3) (9.0) and NLW (32.8) (52.7) at 30 DAS and 60 DAS respectively. The observed phenomenon could be attributed to the consistent application of nitrogen in both equal and liberal quantities through LCC. Additionally, a higher number of nitrogen splits at crucial growth stages ensured timely and adequate nitrogen availability tailored to the plant's requirements. These outcomes align with the discoveries reported by Sen *et al*. (2011).

Weed dry matter

Weed dry matter was significantly influenced by tillage practices and nitrogen management practices (Table 2). Under tillage practices, ZT+R practice recorded lowest weed dry weight at 30 DAS (7.4 g/m^2) also recorded lowest weed dry weight at 60 DAS (30.2 g/m^2). When compared to CT practice, ZT+ R practice results in reduction of 10.8% and 39.2% at 30 DAS and 60 DAS respectively. ZT practice recorded highest weed dry weight at 30 DAS (9.7 g/m^2) and 60 DAS (58 g/m^2).

Table 2. Effect of crop establishment methods and nitrogen management on weed dry matter (g/m^2) in wheat.

Treatments	30 DAS	60 DAS
	Dry weight (g/m^2)	
Tillage practices		
CT	8.3	49.7
SSB-CT	8.0	35.8
ZT	9.7	58.0
ZT+R	7.4	30.2
SEM	0.062	1.54
CD	0.22	5.42
Nitrogen management practices		
No N	8.9	48.5
RDN	8.2	44.1
Mod DN	8.2	43.0
LCC	8.1	38.5
SEM	0.048	1.26
CD	0.141	3.70

Under different nitrogen management practices, LCC-guided nitrogen management practice recorded lowest weed dry weight at 30 DAS (8.1 g/m^2) also recorded lowest weed dry weight at 60 DAS (38.5 g/m^2). When compared to RDN practice, LCC-guided nitrogen management practice results in reduction of 1.2% and 12.7% at 30 DAS and 60 DAS respectively. No-N practice recorded highest weed dry weight at 30 DAS (8.9 g/m^2) and 60 DAS (48.5 g/m^2). The RDN (120 kg/ha) registered higher weed biomass (Chaudhary *et al.* 2011). The increased dry weight of weeds in the RDN treatment, when nitrogen was applied partially at sowing can be linked to the robust weed growth stimulated by the early nitrogen supply. This, in turn, led to elevated weed dry weights at various growth stages. These observations parallel the outcomes documented by Sharma *et al.* (2007).

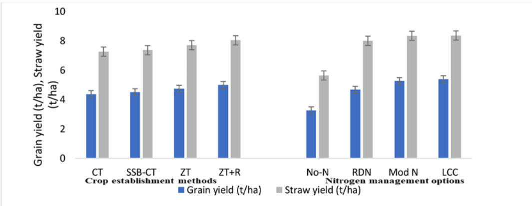

Fig. 1. Effect of crop establishment methods and nitrogen management on yield of wheat.

Wheat yield

The grain and straw yield of wheat were significantly influenced by tillage practices and nitrogen management practices (Fig. 1). Under different tillage practice, the highest grain yield was obtained under ZT+R practice (4.99 t/ha) which remains statistically at par with ZT practice, but was found significantly higher over SSB-CT and CT practice. ZT+R has 14.2%, 10.9%, and 5.5% higher grain yield than CT, SSB-CT and ZT practice respectively. The straw yield under different tillage practice ranged between 7.26-8.03 t/ha. The straw yield recorded highest under ZT+R practice which remains significantly higher over SSB-CT, CT and ZT practice. ZT+R practice has 10.6%, 9.1%, and 4.2% higher straw yield than CT, SSB-CT, and ZT practice. The mean grain, and straw yield were 4.65, and 7.59 t/ha respectively.

The complimentary interaction between vegetative and reproductive growth in crops like wheat is a crucial factor in determining yield. A positive correlation exists between several growth and yield qualities, contributing to an amplified wheat grain yield under ZT+R practices. Crop residue management steps in as a valuable player, enhancing nutrient cycling and ultimately bolstering crop yields (Cruse and Herndl 2009). Shaheb *et al.* (2021) argues that an excessive disturbance of soil through tillage operations is not a prerequisite for optimal crop yield. Zero-tillage drills, adept at ensuring precise seed placement at the right depth, respond favorably, culminating in superior crop yields. In the realm of soil dynamics, the exposure of soil organic matter to direct sunlight in conventional tillage accelerates mineralization rates. Contrastingly, zero-tillage acts as a shield, covering the soil organic matter. This protective layer slows down the breakdown of organic matter, facilitating a gradual release of nutrients crucial for plant growth. This amalgamation of practices, encompassing ZT+R, judicious seed placement, and organic matter protection, paints a holistic picture of sustainable agricultural methods fostering increased wheat yields.

Under different nitrogen management practice, the highest grain yield was obtained under LCC-guided N application practice (5.39 t/ha) which was significantly higher over RDN, No-N practice but remained statistically at par with Mod N application practice. LCC-guided N application practice has 19.8%, 15.4%, and 2.4% higher grain yield than No-N, RDN and Mod N application practice. The straw yield recorded highest under LCC-guided N application practice, which remained statistically at par with Mod N practice, but significantly higher over RDN and No-N practice. LCC-guided N application practice has 54.3%, 8.5%, and 1% higher straw yield than No-N, RDN, and Mod N practice. The mean grain and straw yield were 4.65 and 7.58 t/ha. The precision offered by LCC-guided nitrogen application introduces a dynamic element into the agricultural equation, capable of accommodating variations in N supply across fields and time. This approach, as highlighted by Singh *et al.* (2014), holds the promise of optimizing fertilizer N usage in rice, maize, and wheat crops, ultimately yielding higher grain output compared to uniform recommendations. The success of Site-Specific Nutrient Management (SSNM) in boosting yields is attributed to multiple factors, as noted by Neha and Chandrashekar (2018). The augmentation in grain yield is linked to enhanced photosynthate translocation from source to sink, improvements in growth parameters, and a judicious increase in inorganic fertilizer application. Further supporting the efficacy of tailored nutrient management, previous studies underscore the positive impact of decision support tools like Nutrient Expert® on wheat productivity. Majumdar *et al.* (2013a), Sapkota *et al.* (2014), and Mitra *et al.* (2019) collectively validate that a balanced nutritional approach, guided by such tools, surpasses the outcomes of conventional recommended practices. Results reported by Meena *et al.* (2014) revealed that application of SSNM treatment recorded significantly higher grain and straw yield. Similar results were also reported by Kumar *et al.* (2018).

REFERENCES

Baghel JK, Das TK, Raj R, Paul S, Mukherjee I, Bisht M (2018) Effect of conservation agriculture and weed management on weeds, soil microbial activity and wheat (*Triticum aestivum*) productivity under a rice (*Oryza sativa*) wheat cropping system. *Indian Journal Agricultural Science* 88: 1709-1716.

Bisen PK, Singh R (2008) Effect of tillage and weed management practices on weed growth and yield of wheat (*Triticum aestivum*) rice (*Oryza sativa*) system. *Indian Journal Agricultural Science* 78(4): 347–350.

Chaudhary SK, Jha S, Sinha NK (2011) Influence of nitrogen and weed management practices on productivity and nutrient uptake of wet direct-seeded rice. *Oryza* 48(3): 222–225.

Cruse RM, Herndl CG (2009) Balancing corn stover harvest for biofuels with soil and water conservation. *Journal of Soil and Water Conservation* 64(4): 286-291.

CSISA (2015) Cereal Systems Initiative for South Asia (CSISA)-Phase-II Annual Report 2015. International Maize and Wheat Improvement Center (CIMMYT), New Delhi.

Keil A, D Souza A, MLS Donald A (2015) Zero-tillage as a pathway for sustainable wheat intensification in the Eastern Indo-Gangetic Plains: Does it work in farmers' fields? *Food Science* 7: 983–1001.

Kende Z, Sallai A, Kassai K, Mikó P, Percze A, Birkás M (2017) The effects of Tillage-Induced Soil Disturbance on Weed infestation of winter wheat. *Polish Journal of Environmental Studies* 26(3) : In press.

Kumar V, Jat Hanuman S, Sharma Parbodh C (2018) Can productivity and profitability be enhanced in intensively managed cereal systems while reducing the environmental footprint of production? *Science Direc*t 252 (2018): 132-147.

Majumdar K, Satyanarayana T, Mirasol Pampolino, Sudarshan Dutta, Jat ML Gavin Sulewski, Adrian M, Johnston (2013a) Nutrient Expert for Hybrid Maize: User Manual for South Asia. International Plant Nutrition Institute, pp 52.

Meena RR, Purohit HS, Khatik ML, Sumeriya HK (2014) Productivity of maize (*Zea mays* L.) as influenced by site specific nutrient management. *Annals of Agriculture Biological Research* 19(1): 38–44.

Mitra B, Kaushik M, Sudarshan Kr Dutta, Triptesh Mondal, Saikat Das, Hirak Banerjee, Krishnendu Ray, Satyanarayana T (2019) Nutrient management in wheat (*Triticum aestivum*) production system under conventional and zero tillage in eastern sub-Himalayan plains of India. *Indian Journal Agricultural Science* 89(5): 775–784.

Neha J, Chandrashekar CP (2018) Precision nutrient management in maize (*Zea mays* L.) under northern transition zone of Karnataka. *Journal of Farm Science* 30(3): 343-348.

Sapkota TB, Majumder K, Jat ML, Kumar A, Bishnoi DK, MLS Donald AJ, Pampolino M (2014) Precision nutrient management in conservation agriculture-based wheat production of Northwest India: Profitability, nutrient use efficiency and environmental footprint. *Field Crop Research* 155: 233–244.

Sen A, Srivastava VK, Singh MK, Singh RK, Suneel K (2011) Leaf color chart vis-a- vis nitrogen management in different rice genotypes. *American Journal Plant Science* 2 : 223-236.

Shaheb MR, Venkatesh R, Shearer SA (2021) A review on the effect of soil compaction and its management for sustainable crop production. *Journal of Biosystems Engineering,* pp 1-23.

Sharma RP, Pathak SK, Singh RC (2007) Effect of nitrogen and weed management in direct-seeded rice (*Oryza sativa*) under upland conditions. *Indian Journal of Agronomy* 52(2): 114-119.

Singh Ajit, Phogat VK, Dahiya Rita, Batra DD (2014) Impact of long-term zero till wheat on soil physical properties and wheat productivity under rice–wheat cropping system. *Soil Tillage Research* 140: 98-105.