

Effect of Tillage practices and Fertility levels on Growth, yield Attributes and yield of wheat in the Rice-wheat Cropping system

Abstract

The present investigation, entitled “Effect of tillage practices and fertility levels and yield of wheat in rice-wheat cropping system”, was conducted at Agronomy Research Farm, CSAUAT, during *rabi* 2021-22 and 2022-23. The experiment was laid out using a split-plot design with replication. Two levels of tillage *viz.* (1) Conventional tillage (Two ploughing followed by sowing), (2) Reduce tillage (one ploughing followed by sowing) were randomly allotted to the main plot while ten fertility levels). The observed plant parameters were plant height (at 30, 60, 90 DAT and harvest), Number of leaves/ Plant (30, 60, 90 and at harvest), Leaf area index (at 30, 60, 90 DAT and harvest), Relative growth rate (mg g day^{-1}), Relative growth rate (mg g day^{-1}), Grain weight ear^{-1} , 1000 grain weight (g), and Grain yield (q ha^{-1}). Study results revealed the maximum plant height (cm), number of leaves/plants, leaf area index, relative growth rate (mg g day^{-1}), Ear length (cm), number of grain ear^{-1} , grain weight ear^{-1} , 1000 grain weight (g) and Grain yield (q/ha) were recorded with conventional tillage with 125% RDF + chloromequate chloride.

Keywords:

Introduction

Being a significant prehistoric crop, wheat (*Triticum aestivum* L.) forms the foundation of our country's food security system. The expression "Dal roti chalna" acknowledges its importance in our way of life. Its straw is one of the paramount feedstuffs for many cattle. As a result, wheat is the food grain with the highest protein content; pulses come in first. It's used for bread, cakes, biscuits, noodles, petri dishes, and chapattis. Starch (60–68%), protein (8–15%), fat (1.5–2.0%), cellulose (2.0–2.5%), and minerals (1.5–2.0%) are all present in wheat grains. (Kumar *et al.*, 2019). By providing more than 50% of the calories for those who primarily rely on it, the wheat crop significantly contributes to the country's food

people through production and constant supply, especially in recent years. According to the Directorate of Economics and Statistics, wheat is cultivated on 33.64 million hectares in India, producing 107.59 million tonnes and 3206.30 kg ha⁻¹ of productivity in 2019–20. Six main zones have been identified for the nation's wheat-growing region. The North-Western Plain Zone (NEPZ) has the largest wheat cultivation area. All states in India save Kerala cultivate wheat. India's leading wheat-growing state is Uttar Pradesh. 9.85 million hectares of wheat are grown in Uttar Pradesh, producing 35.50 million tonnes of wheat. Madhya Pradesh and Punjab, with respective areas of 6.39 million hectares and 17.17 million tonnes and 3.5 million hectares and 17.14 million tonnes and 17.17 million tonnes, are next in line. By 2050, the world's wheat consumption will reach 900 million tonnes. By 2050, it is predicted that India will require at least 140 million tonnes of wheat, compared to the current anticipated 109.24 million tonnes of production. 216.18 million hectares worldwide are planted to wheat, yielding 763.6 million metric tonnes at an average of 3530 kg ha⁻¹. With an average productivity of 3530 kg ha⁻¹, it covers 29.32 million hectares in India and produces 103.6 million metric tons, or one-third of the country's total food grain production (**Kar et al. 2021**). Accordingly, wheat is likely to continue to be vital in ensuring food security across the globe.

With 9.65 million hectares (36.6 %), 26.87 million tonnes (39.3 %), and a productivity of 2785 kg ha⁻¹, Uttar Pradesh is the largest wheat-growing state in India (Anonymous, 2019). Approximately 90 % of the world's rice is produced in Asia, where it is farmed on 142 million hectares of land and produces 622 million tonnes of rice (**Rashid et al., 2012**). Approximately 43 % of India's total food grain production is derived from rice, making it one of the most significant contributors to food grain production (**Mondal et al., 2020**). With a 104.31 million tonne yield, rice is grown on 44.38 million hectares of land in India. By 2025, the nation must produce over 130 million tonnes of rice to feed its expanding population. Roughly 2 billion people in Asia alone rely on rice, which provides 80% carbs, 7-8% protein, 3% fat, and 3% fibre, to meet their energy demands. The export destinations are Middle Eastern nations, Malaysia, Korea, Japan, Australia, the United States, Canada, the United Kingdom, Italy, and Sweden. A significant portion of rice is also exported to

effectively when it is grown in milder climates throughout flowering and maturity. The majority of India's basmati rice production is exported. The most popular aromatic fine-quality rice in global trade, basmati rice, commands a premium price in the export market. Basmati rice grows solely on the Indo-Gangetic plain and is a gift from "Mother - Nature" to the Indian subcontinent. As of 2015, 23 basmati rice varieties were recognised by the Seeds Act 1966. Globally, India is the leading manufacturer and exporter of basmati rice (Shoomro *et al.*, 1999). Over 70 % of the world's basmati rice is produced in India; Pakistan produces the remaining portion. In India, 8.7 million tonnes of basmati rice were produced in 2014–15 from 2.1 million hectares.

Conventional tillage often seeks to break up lumps and level the ground while also reversing and agitating a deep layer of soil, integrating and eliminating plant detritus, and exposing soil pests to sunlight for control. During the winter and summer production seasons, conventional tillage entails several mechanical operations, such as deep ploughing, deep disking, ripping, shallow tyne workings, and fine seedbed preparation after harvesting various grain crops. After that, a fallow season allows the crops to absorb moisture until the following crop is planted. After heavy rains, this method leaves the soil surface naked, vulnerable to erosion by wind and water, and highly compacted. This necessitates re-loosening the soil to help minimise weed growth and encourage moisture absorption from successive rainfalls. Full-width or reduced tillage involves disturbing the whole soil surface and leaving 15 % to 30 % of residue cover in place after planting. In the inland Pacific Northwest, other conservation tillage techniques include sweep tillage systems, chisel, discs, under-cutter fallow, and delayed minimum tillage. Over primary spring tillage, the under-cutter method of fallow management delivers nitrogen to the soil surface while slicing beneath it with broad V-blade sweeps. One or two non-inversion rod weeding operations are conducted over the summer to control weeds (**Pathania *et al.*, 2020**).

Undercutter V-sweep, minimal tillage and delayed minimum tillage are used as principal tillage techniques. After primary tillage, herbicides can be used to manage weeds; however,

management, and your objectives for lowering tillage. It is best to speak with your cooperative first.

Plants naturally take time to grow and develop. Plant growth promoters can speed up this process by providing nutrients to soil microorganisms, increasing the activity of microbes in the soil and helping to convert inaccessible plant nutrients into available forms. While organic plant growth promoters (PGPS), such as soil fertility and crop productivity, also aid in faster plant growth promotion and prevent grain disease, natural plant growth promoters (Phytohormones) are engaged in pushing and stimulating root and shoot growth. Improved chemistry allows plant growth promoters to work on several sites within treated plants rather than just the leaf surface. They are absorbed by the leaves as well as other plant components.

Material and Method

The field experiment was conducted during *Rabi* of 2021-22 and 2022-23 at Agronomy Research Farm, CSAUAT, Kanpur. The experiment was laid out in a split-plot design with three replications. Two levels of tillage viz. (1) Conventional tillage Two ploughing followed by sowing), (2) Reduce tillage (one ploughing followed by sowing were randomly allotted to the main plot while ten fertility levels viz. (1) Absolute Control. (2) RDF (150.60.40 NPK kg/ha), 3) 75 % RDF (112.5; 15 30 NPK kg/ha + 10 t FYM/ha) (4) 125 % RDF (187.5; 75; 50 NPK kg/ha) (5) RDF (150; 60; 40 NPK kg/ha) + Two spray of chloromequate chloride (Lihocine 0.2 % at first node (45 Days) and flag leaf stage (80 DAS). (6) RDF (150; 60; 40 NPK kg/ha) + Two Spray of tebuconazole (Folicur 430 SC @ 0.1 %) at first node and flag leaf stage (80 DAS). (7) 75 % RDF (112.5:45:30 NPK kg/ha + 10t FYM/ha + Two Spray of Chloromequate chloride (Lihocine 0.2 % at the first node (45 DAS) and flag leaf stage (80 DAS) (8) 75 % RDF (112.5:45:30 NPK kg/ha + 10 t FYM/ha + Two Spray to tebuconazole (Folicur 430SC @0.1 % at the first node and flag leaf stage (80 DAS) (9) 125 % RDF (187.5:75:50 NPK kg/ha+ Two Spray of Chloromequate chloride (Lihocine 0.2 % at the first node (45 DAS) and flag leaf stage (80 DAS) (10) 125 % RDF (187.5:75:50 NPK kg/ha + Two Spray of tebuconazole Folicur 430 SC @ 0.1 % (Folicur 430 SC @ 0.1 % at the first node and flag leaf stage (80 DAS) and flag leaf stage (80 DAS)

Early stages of 30 DAS of growth revealed non-significant differences in tillage techniques throughout the investigational years 2021–22 and 2022–23. Tillage techniques positively impacted the plant height at the 60 DAS, 90 DAS, and harvest stages in subsequent crop growth phases. The maximum plant height was recorded with conventional tillage (45.62, 88.30, 93.27 cm and 46.89, 86.22, 91.20 cm) overall growth stages followed by reduced tillage (43.45, 86.38, 91.70 cm and 44.54, 84.62, 90.04 cm). Among various fertility levels, the early growth stage (30 DAS) showed non-significant fertility levels during the 2021-22 and 2022-23 studies. At 60 and 90 DAS and harvest, the plant height was significantly increased by fertility levels. The maximum height of the plant was recorded with 125 % RDF + tebuconazole (48.12, 96.08, 101.94 and 49.34, 94.15, 100.08 cm) at 60, 90 DAS and harvest of wheat, which were parred with 125 % RDF + chloromequate chloride (47.36, 93.88, 99.55 and 48.54, 91.95, 97.69 cm) and also superior to 75 % RDF + 10 t FYM/ha + tebunconzole (46.22, 91.88, 96.89 & 47.40, 89.95, 95.03 cm) at 60, 90 DAS and harvest. The minimum height of the wheat plant was recorded with absolute control (40.09, 78.33, 82.29 & 41.27, 76.40, 80.42 cm), and it was at par with RDF (41.96, 81.28, 85.21 & 43.14, 79.35, 83.35 cm) during the study of both year 2021-22 and 2022-23. (Table 1). Similar findings were reported by **Timalsina *et al.*, 2021 and Ram *et al.*, 2018.**

2. Number of leaves/plant

The number of leaves grows as the wheat plant grows. When crop growth reached later stages, tillage practices at 60 DAS, 90 DAS, and harvest stages significantly impacted plant height. At the stage of 30 DAS, several leaves revealed non-significant differences in tillage practices between 2021-22 and 2022-23 of the study. Several leaves were recorded in conventional tillage (16.53, 19.86, 19.88 and 16.50, 14.98, 20.48) at all growth stages, followed by reduced tillage (12.05, 15.95, 18.66 and 12.76, 14.98, 19.07). Among various fertility levels, several leaves' early growth stages (30 DAS) showed non-significant fertility levels during the 2021-22 and 2022-23 studies. The number of leaves significantly increased due to fertility levels at 60 and 90 DAS and harvest stages. (Table 2). The consequences of the current investigation are additionally in concurrence with the inquiry of **Husnain *et al.* (2011) and Singh *et al.* (2020),**

3.68, 5.03, 5.37 and 0.59, 3.44, 4.78, 5.33) had the highest LAI, followed by the 125 % RDF + chlormequat chloride (0.551, 3.67, 4.90, 5.55 and 5.58, 3.37, 4.66, 5.21) and was on par with 75 % RDF + 10 t FYM/ha + tebuconazole (0.544, 3.51, 4.79, 5.44 and 0.576, 3.27, 4.55, 5.10), 75 % RDF + 10 t FYM/ha + Chloromequat chloride (0.531, 3.38, 4.68, 5.34 and 0.562, 3.14, 4.45, 5.00) during 2021-22 and 2022-23, respectively. The minimum leaf area index was recorded in control (0.44, 2.46, 3.74, 4.38 and 0.48, 2.22, 3.49, 4.04) followed by RDF (0.47, 2.69, 3.95, 4.59 and 0.50, 2.45, 3.70, 4.25) and 75 % RDF + 10t FYM/ha (0.48, 2.80, 4.08, 4.72 and 0.52, 2.56, 3.83, 4.38) respectively during 2021-22 and 2022-23 of study. During both years of the experiment, there was no discernible relationship between tillage practices and fertility levels. (Table 3). These results also confirm the findings of **Singh *et al.* (2001)**, **Kakraliya *et al.* (2018)**,

4. Relative growth rate (mg g day⁻¹)

The relative growth rate was typically at its maximum during the 30 to 60 DAS of the crop and began to decline from 60 DAS till harvest. Fertility levels and relative growth rates under tillage methods were not considerably impacted. The highest growth rate was observed in conventional tillage practice (24.56, 14.62, 2.82 and 24.11, 14.34, 2.80), followed by the reduced tillage practice (23.77, 14.10, 2.72 and 23.35, 13.91, 2.69) during the both year 2021-22 and 2022-23. Among fertility levels, the higher growth rate was noticed in 125 % RDF+ tebuconazole (25.13, 15.37, 3.05 and 24.70, 15.14, 3.02) which is at par on 125 % RDF + chlormequat chloride (24.93, 15.13, 2.97 and 24.50, 14.90, 2.96) and 75 % RDF + 10t FYM/ha + tebuconazole (24.73, 14.90, 2.96 and 24.29, 14.66, 2.89) respectively during both years 2021-22 and 2022-23. The control treatment's lowest relative growth rate was noticed, at par with the 75 % RDF + 10 t FYM/ha. The consequences of the current investigation are additionally in concurrence with the inquiry of **Saharawat *et al.* (2010)** and **Kumar *et al.* (2019)**.

5. Ear length (cm)

Spike length found remarkable variation in the tillage practice. The highest ear length was observed with conventional tillage (10.59 and 11.55 cm), which is at par with reduced tillage (9.95 and 10.54 cm) during the study's 2021-22 and 2022-23. The minimum ear length was observed in reduced tillage (9.95 and 10.54 cm). Among fertility levels, the highest ear

practice and fertility levels on ear length during both years of study. These results also confirm the findings of **Toyota *et al.* (2010)** and **Shri *et al.* (2021)**

6. Number of grain ear⁻¹

The number of grains per ear was found to vary significantly in the tillage practice. The maximum number of grain per ear were observed with conventional tillage (39.89 and 42.27), which is at par with reduced tillage during (38.81 and 40.80) 2021-22 and 2022-23 of the study. Among fertility levels, the maximum number of grain per ear were recorded in 125 % RDF+ tebuconazole (42.67 and 44.43), followed by 125 % RDF + chlormequat chloride (42.24 and 44.83) and 75 % RDF + 10 t FYM/ha + tebuconazole (41.16 and 43.33) respectively. The minimum grain per ear was counted in the control treatment (43.90 and 37.08), which was at par with RDF (37.05 and 39.23) and 75 % RDF + 10t FYM/ha (38.0 and 40.18). There was no significant interaction effect of tillage practice and fertility levels on ear length during both years of study. Similar findings were reported by **Mitra *et al.*, 2014** and **Gupta *et al.*, 2006**;

7. Grain weight ear⁻¹

Significant differences in the tillage practices were identified in the grain weight per ear. The maximum grain weight per ear was observed with conventional tillage (1.50 and 1.59 g), which is at par with reduced tillage (1.34 and 1.41 g) during the 2021-22 and 2022-23 studies. Among fertility levels, the maximum grain weight per ear was recorded in 125 % RDF+ tebuconazole (1.73 and 1.82 g) followed by 125 % RDF + chlormequat chloride (1.72 and 1.80 g) and 75 % RDF + 10 t FYM/ha + tebuconazole (1.61 and 1.69 g) respectively. The minimum grain weight per ear was weighted in the control treatment (1.02 and 1.09 g), which was at par with RDF (1.20 and 1.27 g) and 75 % RDF + 10 t FYM/ha (1.26 and 1.33 g). During the two years of the experiment, there was no discernible interaction impact between tillage practices and fertility levels on grain weight per ear. Similar findings were reported by **Ghazanfar *et al.* (2010)**, **Zang *et al.* (2017)**

8. 1000 grain weight (g)

There was an apparent variance in the tillage technique for 1000 grain weight. The

control treatment (28.19 and 29.35 g), which was at par with RDF (31.26 and 32.42 g) and 75 % RDF + 10 t FYM/ha (32.06 and 33.22 g). There was no significant interaction effect of tillage practice and fertility levels on 1000 grain weight during the 2021-22 and 2022-23 years of study. Similar findings were reported by **Woźniak & Rachoń (2020)**.

9. Grain yield (q ha⁻¹)

The tillage practices caused a striking variance in grain yield. The maximum grain yield (51.68 and 50.86 q ha⁻¹), straw yield (67.85 and 66.51 q ha⁻¹), biological yield (119.53 and 117.38 q ha⁻¹) and harvest index (43.22 and 43.22 %) were recorded with conventional tillage which is at par with reduce tillage during 2021- 22 and 2022-23 of study. Among fertility levels, the maximum grain yield (55.02 and 54.32 q ha⁻¹), straw yield (71.68 and 70.47 q ha⁻¹), biological yield (126.67 and 124.66 q ha⁻¹) and harvest index (43.40 and 43.39 %) were recorded in 125 % RDF + tebunconazole followed by 125 % RDF + chloromequat chloride and 75 % RDF + 10 t FYM/ha + tebunconazole respectively. The minimum grain yield (45.44 and 44.69 q ha⁻¹), straw yield (62.79 and 61.48 q ha⁻¹), biological yield (108.11 and 106.05 q ha⁻¹) and harvest index (42.08 and 42.19 %) were observed in the control treatment. There was a significant interaction effect of tillage practice and fertility levels on grain yield during the 2021-22 and 2022-23 years of study. The consequences of the current investigation are additionally in concurrence with the inquiry of **Gholami *et al.* (2014)** and **Kumar *et al.* 2019**.

Table-1: Effect of tillage practices and fertility levels on plant height of wheat

Treatment	Plant height (cm)											
	30 DAS			60 DAS			90 DAS			At harvest		
Tillage Practices	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Conventional tillage	25.63	26.87	26.25	45.62	46.89	46.29	88.30	86.22	87.43	93.27	91.20	92.38
Reduce tillage	24.54	25.65	25.05	43.45	44.54	43.91	86.38	84.62	85.40	91.70	90.04	90.79
SE(m)	0.048	0.59	0.092	0.069	0.068	0.155	0.123	0.111	0.339	0.112	0.121	0.220
C.D.	NS	NS	NS	0.455	0.446	1.015	0.804	0.725	1.728	0.733	0.789	1.441
Fertility Level												
F ₁ (Control)	24.05	25.32	24.62	40.09	41.27	40.55	78.33	76.40	77.24	82.29	80.42	81.23
F ₂ - RDF (150.60.40 NPK kg/ha)	24.40	25.64	24.97	41.96	43.14	42.40	81.28	79.35	80.17	85.21	83.35	84.13
F ₃ -75% RDF + 10t FYM/ha	25.55	25.68	25.12	42.53	43.71	43.17	82.18	80.25	81.27	87.33	85.46	86.44
F ₄ -125% RDF	24.80	26.01	25.37	43.68	44.86	44.20	84.39	82.46	83.6	89.85	87.98	88.84
F ₅ - RDF + chloromequate chloride	25.05	26.05	25.62	44.25	45.43	44.98	86.39	84.46	85.56	91.73	89.86	90.93
F ₆ - RDF + tebunconzole	25.20	26.33	25.77	45.23	46.41	45.83	88.46	86.53	87.51	94.15	91.28	93.22
F ₇ - 75% RDF + 10t FYM/ha + Chloromequate chloride	25.40	26.57	25.97	45.90	47.08	46.46	90.52	88.59	89.53	95.95	94.09	94.99
F ₈ -75% RDF + 10t FYM/ha + tebunconzole	25.60	26.79	26.17	46.22	47.40	46.89	91.88	89.95	91.65	96.89	95.03	96.57
F ₉ -125% RDF + chloromequate chloride	25.80	26.96	26.37	47.36	48.54	47.92	93.88	91.95	92.89	99.55	97.69	98.59
F ₁₀ -125% RDF+ tebunconzole	26.00	27.27	26.57	48.12	49.34	48.62	96.08	94.15	94.98	101.94	100.08	100.88
SE(m)	0.237	0.85	0.288	0.089	0.088	0.370	0.162	0.153	0.906	0.136	0.134	1.018
C.D.	NS	NS	NS	0.256	0.254	1.066	0.459	0.439	2.610	0.392	0.388	2.931

Table-2: Effect of tillage practices and fertility levels on Number of leaves per plant of wheat

Treatment	Number of leaves per plant											
	30 DAS			60 DAS			90 DAS			At harvest		
Tillage Practices	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Conventional tillage	5.67	5.27	5.47	16.53	16.50	16.51	19.86	18.82	19.34	19.88	20.48	20.18
Reduce tillage	5.12	4.82	4.97	12.05	12.76	12.40	15.95	14.98	15.46	18.66	19.07	18.86
SE(m)	0.025	0.015	0.032	0.129	0.036	0.039	0.010	0.126	0.084	0.070	0.160	0.087
C.D.	NS	NS	NS	0.848	0.236	0.256	0.064	0.825	0.548	0.459	1.049	0.568
Fertility Level												
F ₁ (Control)	4.40	4.05	4.22	9.90	9.79	9.84	13.25	12.24	12.74	15.45	15.95	15.70
F ₂ - RDF (150.60.40 NPK kg/ha)	4.75	4.40	4.57	11.50	11.39	11.44	15.35	14.34	14.84	16.95	17.45	17.20
F ₃ -75% RDF + 10t FYM/ha	4.95	4.60	4.77	12.10	11.99	12.04	16.55	15.54	16.03	17.60	18.10	17.85
F ₄ -125% RDF	5.15	4.80	4.97	13.20	13.09	13.14	17.30	16.29	16.79	18.20	18.70	18.45
F ₅ - RDF + chloromequate chloride	5.30	4.95	5.12	13.90	13.79	13.84	18.15	17.14	17.64	19.05	19.55	19.30
F ₆ - RDF + tebunconzole	5.5	5.15	5.32	14.50	15.74	15.12	18.50	17.49	17.99	19.65	20.15	19.90
F ₇ - 75% RDF + 10t FYM/ha + Chloromequate chloride	5.70	5.35	5.52	15.90	16.58	16.24	19.15	18.14	18.62	20.5	21.0	20.75
F ₈ -75% RDF + 10t FYM/ha + tebunconzole	5.85	5.50	5.67	16.60	17.28	16.94	19.65	18.64	19.14	21.25	21.75	21.50
F ₉ -125% RDF + chloromequate chloride	6.05	5.70	5.87	17.40	18.08	17.74	20.30	19.29	19.78	21.7	22.20	21.95
F ₁₀ -125% RDF+ tebunconzole	6.30	5.95	6.25	17.90	18.57	18.23	20.85	19.84	20.34	22.35	22.85	22.60
SE(m)	0.057	0.054	0.053	0.157	0.153	0.156	0.196	0.158	0.174	0.189	0.208	0.167
C.D.	NS	NS	NS	0.451	0.440	0.450	0.565	0.454	0.501	0.545	0.600	0.480

Table-3: Effect of tillage practices and fertility levels on leaf area index of wheat

Treatment	Leaf Area Index (LAI)											
	30 DAS			60 DAS			90 DAS			At harvest		
Tillage Practices	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Conventional tillage	0.535	0.571	0.553	3.258	3.08	3.13	4.56	4.29	4.48	5.23	4.82	5.05
Reduce tillage	0.490	0.518	0.504	3.042	2.81	2.92	4.32	4.10	4.21	4.94	4.61	4.78
SE(m)	0.012	0.003	0.002	0.007	0.017	0.028	0.013	0.008	0.014	0.049	0.014	0.009
C.D.	0.038	0.018	0.016	0.047	0.111	0.186	0.083	0.050	0.091	0.152	0.089	0.061
Fertility Level												
F ₁ (Control)	0.449	0.481	0.465	2.46	2.22	2.34	3.74	3.49	3.61	4.38	4.04	4.21
F ₂ - RDF (150.60.40 NPK kg/ha)	0.473	0.505	0.489	2.69	2.45	2.57	3.95	3.70	3.82	4.59	4.25	4.42
F ₃ -75% RDF + 10t FYM/ha	0.488	0.520	0.504	2.80	2.56	2.68	4.08	3.83	3.95	4.72	4.38	4.55
F ₄ -125% RDF	0.499	0.531	0.515	2.98	2.74	2.65	4.26	4.02	4.14	4.91	4.57	4.74
F ₅ - RDF + chloromequate chloride	0.511	0.543	0.527	3.12	2.88	3.00	4.44	4.20	4.32	5.09	4.75	4.92
F ₆ - RDF + tebusconazole	0.522	0.554	0.538	3.25	3.01	3.13	4.53	4.29	4.41	5.18	4.84	5.01
F ₇ - 75% RDF + 10t FYM/ha + Chloromequate chloride	0.53	0.562	0.546	3.38	3.14	3.26	4.69	4.45	4.57	5.34	5.00	5.17
F ₈ -75% RDF + 10t FYM/ha + tebusconazole	0.544	0.576	0.560	3.51	3.27	3.39	4.79	4.55	4.67	5.44	5.10	5.27
F ₉ -125% RDF + chloromequate chloride	0.551	0.582	0.567	3.61	3.37	3.49	4.90	4.66	4.78	5.55	5.21	5.38
F ₁₀ -125% RDF+ tebusconazole	0.559	0.591	0.575	3.68	3.44	3.65	5.03	4.78	4.90	5.67	5.33	5.50
SE(m)	0.006	0.007	0.005	0.034	0.029	0.032	0.053	0.039	0.042	0.042	0.055	0.045
C.D.	0.016	0.017	0.015	0.099	0.083	0.091	0.151	0.113	0.091	0.122	0.158	0.129

	Relative Growth Rate (day g ⁻¹)						
	30 DAS			60 DAS			2021-22
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	
	24.56	24.11	24.33	14.62	14.34	14.48	2021-22
	23.77	23.35	23.56	14.10	13.91	14.01	2021-22
	0.124	0.168	0.123	0.072	0.051	0.050	0.072
	NS	NS	NS	NS	NS	NS	14.01
	23.13	22.70	22.91	13.33	13.09	13.21	2021-22
	23.44	23.00	23.22	13.63	13.39	13.52	2021-22
	23.63	23.20	23.41	13.79	13.55	13.67	2021-22
	23.85	23.41	23.63	14.02	13.78	13.90	2021-22
de	24.05	23.61	23.83	14.26	14.02	14.14	2021-22
	24.26	23.83	24.04	14.49	14.25	14.37	2021-22
+	24.49	24.06	24.27	14.71	14.48	14.59	2021-22
+	24.73	24.29	24.51	14.90	14.66	14.78	2021-22
e chloride	24.93	24.50	24.71	15.13	14.90	15.01	2021-22
	25.13	24.70	24.92	15.37	15.14	15.25	30 DAS
	0.261	0.293	0.227	0.165	0.146	0.137	0.165
	NS	NS	NS	NS	NS	NS	14.48

[illegible]

Table-5: Effect of tillage practices and fertility levels on yield attributes of wheat

Treatments	Ear length (cm)			No. of grain ear ⁻¹			Grain weight ear ⁻¹			1000 grain weight (g)		
Tillage Practices	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Conventional tillage	10.59	11.55	11.07	39.89	42.27	41.08	1.50	1.59	1.54	36.34	37.51	36.93
Reduce tillage	9.95	10.54	10.14	38.81	40.80	39.80	1.34	1.41	1.38	33.36	34.50	33.91
SE(m)	0.028	0.085	0.052	0.044	0.129	0.212	0.005	0.008	0.005	0.036	0.086	0.076
C.D.	0.183	0.557	0.344	0.288	0.848	0.986	0.032	0.053	0.035	0.233	0.566	0.501
Fertility Level												
F₁ (Control)	8.20	9.07	8.63	34.90	37.08	35.99	1.02	1.09	1.05	28.19	29.35	28.77
F₂- RDF (150.60.40 NPK kg/ha)	8.85	9.72	9.28	37.05	39.23	38.14	1.20	1.27	1.23	31.26	32.42	31.84
F₃-75% RDF + 10t FYM/ha	9.25	10.12	9.68	38.0	40.18	39.09	1.26	1.33	1.30	32.06	33.22	32.63
F₄-125% RDF	9.65	10.52	10.09	38.65	40.83	39.74	1.33	1.41	1.37	33.32	34.48	33.90
F₅- RDF + chloromequate chloride	10.0	10.87	10.43	39.01	41.18	40.09	1.39	1.47	1.43	34.50	35.65	35.07
F₆- RDF + tebunconzole	10.30	11.17	10.74	39.42	41.58	40.48	1.44	1.52	1.48	35.48	36.64	36.06
F₇- 75% RDF + 10t FYM/ha + Chloromequate chloride	10.65	11.52	11.07	40.45	42.63	41.54	1.53	1.61	1.57	36.65	37.80	37.22
F₈-75% RDF + 10t FYM/ha + tebunconzole	11.15	12.02	11.59	41.16	43.33	42.25	1.61	1.69	1.65	38.00	39.15	38.57
F₉-125% RDF + chloromequate chloride	11.65	12.52	12.08	42.24	44.83	43.73	1.72	1.80	1.76	39.21	40.36	39.77
F₁₀-125% RDF+ tebunconzole	12.00	12.87	12.42	42.67	44.42	43.34	1.73	1.82	1.78	39.87	41.03	40.45
SE(m)	0.028	0.111	0.112	0.458	0.399	0.047	0.012	0.017	0.017	0.413	0.323	0.360
C.D.	0.183	0.319	0.324	1.319	1.149	1.353	0.036	0.050	0.049	1.190	0.929	1.038

Table 6: Effect of tillage practices and fertility levels on the yield of wheat

Treatments	Grain yield (q ha ⁻¹)			Straw yield (q ha ⁻¹)			Biological yield (q ha ⁻¹)			Harvest Index		
Tillage Practices	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Conventional tillage	51.68	50.86	51.31	67.85	66.51	67.21	119.537	117.382	118.52	43.22	43.22	43.28
Reduce tillage	49.92	49.30	49.62	66.83	65.55	65.24	116.779	114.869	115.84	42.72	42.73	43.81
SE(m)	0.070	0.081	0.245	0.076	0.088	0.256	0.093	0.078	0.051	0.072	0.074	0.165
C.D.	0.457	0.528	1.607	0.497	0.573	0.169	0.607	0.572	0.334	0.472	0.478	1.008
Fertility Level												
F₁ (Control)	45.44	44.69	44.94	62.79	61.48	62.01	108.112	106.05	106.95	42.08	42.19	42.01
F₂- RDF (150.60.40 NPK kg/ha)	47.75	47.0	47.23	64.13	62.82	63.33	111.74	109.68	110.56	42.79	42.46	42.71
F₃-75% RDF + 10t FYM/ha	48.57	47.82	48.24	64.78	63.47	64.17	113.40	111.34	112.42	42.80	42.85	42.91
F₄-125% RDF	49.64	48.89	49.20	65.93	64.62	65.20	115.50	113.44	114.40	43.01	42.97	43.03
F₅- RDF + chloromequate chloride	50.43	49.68	50.19	66.86	65.55	66.34	117.43	115.73	116.53	42.88	43.06	43.07
F₆- RDF + tebunconzole	41.42	50.73	51.08	68.04	66.73	67.39	119.47	117.47	118.48	43.03	43.18	43.11
F₇- 75% RDF + 10t FYM/ha + Chloromequate chloride	52.22	51.52	52.35	68.56	67.25	68.38	121.26	119.25	120.73	42.81	43.23	43.35
F₈-75% RDF + 10t FYM/ha + tebunconzole	53.32	52.62	53.09	69.73	68.42	69.14	122.97	120.96	122.23	43.37	43.35	43.43
F₉-125% RDF + chloromequate chloride	54.20	53.51	53.83	70.82	69.51	70.14	125.00	122.99	123.97	43.40	43.39	43.44
F₁₀-125% RDF+ tebunconzole	55.02	54.32	54.53	71.78	70.47	70.99	126.67	124.66	125.53	43.51	43.47	43.47
SE(m)	0.172	0.179	0.520	0.171	0.168	0.634	0.178	0.173	12.7	0.170	0.164	0.435
C.D.	0.496	0.513	1.497	0.493	0.482	1.827	0.514	0.511	3.505	0.489	0.481	1.213

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Conclusion

Plant height, number of tillers and dry matter accumulation were significant due to rice residue management practices at all stages except the 30th day after sowing during both years. The highest Plant height, number of tillers and dry matter accumulation was recorded with treatment Bio-decomposer Treated Residue at all stages, which was at par with treatment Residue Burning and Urea Treated Residue (5% urea) during both years, minimum Plant height, number of tillers and dry matter accumulation were recorded with the treatment residue removal during both the years respectively. Growth parameters such as leaf area index CGR are influenced by rice residue management. The highest LAI and CGR were recorded with the treatment of Bio-decomposer Treated Residue, and the minimum was recorded with treatment residue removal at all stages during both years. RGR was statistically not influenced by rice residue management during both years.

All the Nutrient management options, 125% RDF+ Growth Regulator (Chlormequat chloride @ 0.2% + Tebuconazole @ 0.1%), were found to have significantly superior respect to growth attributes viz plant height (cm), tillers (m⁻⁴) dry matter accumulation (g/m²), LAI, CGR and RGR, yield attributes as effective tillers, length of the spike, spikelet's/spike number of grain per spike, test weight (g) and yields and nutrient content and uptake by the crop during both the years. However, 75% RDF +10 t FYM minimum was recorded with respect of growth attributes viz plant height (cm), tillers (m⁻²) dry matter accumulation (gm⁻²), LAI, CGR and RGR, yield attributes as effective tillers, length of spike, spikelet's/spike number of grain per spike, test weight (g) and yields and nutrient content and uptake by crop during both the years. Protein content in grain was not influenced significantly due to rice residue management practices and nutrient management during both years. The highest value of protein content was recorded with Bio-decomposer Treated Residue in residue management and 125% RDF+ Growth Regulator (Chlormequat chloride @ 0.2% + Tebuconazole @ 0.1%) in Nutrient management. However, Protein yield was significantly influenced by rice residue and nutrient management in the Bio-decomposer Treated Residue in residue management and 125% RDF+ Growth Regulator (Chlormequat chloride @ 0.2% + Tebuconazole @ 0.1%) in Nutrient management during both the years respectively.

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