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Performance of wheat varieties under different nutrient management on growth, yield attributes and yields under late sown condition

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Abstract
A field experiment was carried out during *rabi* season of 2021-22 and 2022-23 in the Instructional Farm, Krishi Vigyan Kendra, Indira Gandhi Krishi Vishwavidyalaya, Raigarh (C.G.), Performance of wheat varieties under different nutrient management on growth, yield attributes and yields under late sown condition. The experiment was laid out in split plot design with three replications with keeping three varieties *i.e.* V_1 – Chhattisgarh Genhu-4, V_2 – Chhattisgarh Amber Wheat, V_3 – GW-366 as main plot and six nitrogen management *i.e.* N_1 – 50% RDN basal + 50% top dressing, N_2 – 50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1}, N_3 –50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1} + Azotobacter + PSB culture, N_4 – 50% RDN basal + 50% top dressing + vermi compost @ 01 t ha^{-1}, N_5 – 50% RDN basal + need based application through leaf colour chart, N_6 – 50% RDN basal + foliar application of nano urea at 35, 50 & 65 DAS as sub plot treatments. The result revealed that the all growth parameters (plant height, number of tillers and dry matter accumulation), yield attributes (effective tillers, number of grains $earhead^{-1}$ and 1000-grains weight), grain, straw yield and harvest index were significantly the highest under V_1 – Chhattisgarh Genhu-4. The shortest value of these above characters was recorded with GW-366 of wheat variety. As regards to nitrogen management in wheat, treatment N_4 – 50% RDN basal + 50% top dressing + vermi compost @ 01 t ha^{-1} registered significantly the highest all growth parameters (plant height, number of tillers and dry matter accumulation), yield attributes (effective tillers, number of grains $earhead^{-1}$ and 1000-grains weight), grain and straw yield and harvest index. The lowest value was recorded under N_1 – 50% RDN basal + 50% top dressing.

Keywords: Wheat variety, nutrient management, growth and yield

Introduction
Wheat (*Triticum aestivum* L.), a member of the Poaceae family, is one of the second main grain crop in the world. It is a significant global staple food that satisfies the majority of peoples protein needs. For the majority of Asian countries, the main challenges are providing food security for a growing population, reducing poverty, and maintaining agricultural systems in the face of finite natural resources, unpredictable weather, rising input costs, and unstable food prices. Among the cereals, wheat is one of the most significant and extensively grown staple food crops, making up around 30% of the nations food supply. It is agronomically and nutritionally most important cereal essential for the food security, poverty alleviation and improved livelihoods. In India, wheat output reached 108.75 million tons with an average national productivity of 3424 kg ha^{-1} during *Rabi* 2020–21, covering 31.76 million hectares of land (All India Coordinated Research Project on Wheat and Barley Progress Report 20-21). Varieties differ in their potential yield because they react differently to nitrogen fertilizer that has been administered. In a similar vein, cultivars range greatly in terms of yielding grains and straw, number of grains $spike^{-1}$, length of spike, and fertile tillers (Naeem, 2001; Ali *et al*., 2010) [15, 13]. Variety plays an important role in producing high yield of wheat because different varieties responded differently for the genotypic characters, input requirement, growth process and the prevailing environment during growing season.

One of the most crucial and costly inputs in agricultural productivity is nitrogen. It is a significant component of the hormones, proteins, enzymes, vitamins, and chlorophyll that are necessary for plant life. The sustainability of wheat production is seriously questioned due to the deteriorating soil health, decreasing soil organic matter, and rising nutritional shortages. Due to the mis-match between the supply and demand of key nutrients throughout Asia, the ratio will continue to widen. Crops and cropping systems are expected to have an impact on the NPK ratio. The use of organics in agriculture appears to be inevitable given the supply and demand for nutrients, especially when it comes to balancing out imbalances in potassium and nitrogen. From the perspective of plant nutrition, the idea of balanced nutrient utilization is crucial because it allows for the adjustment of fertilizer application amounts while accounting for soil nutrients that are available and crop requirements for desired production levels under certain soil-water-crop management techniques (Gupta and Jat, 2010) [8].

Materials and Methods

The Raigarh experimental site was conducted during *rabi* season of 2021-22 and 2022-23 in the eastern part of Chhattisgarh the location of the experimental site is Instructional Farm, Krishi Vigyan Kendra, Indira Gandhi Krishi Vishwavidyalaya, Raigarh (C.G.), it is located at 21.899ºN latitude and 83.418ºE longitude with an altitude of 237 m above the mean sea level with sub-humid climate. The soil of experimental site was sandy loam in texture and neutral in reaction, medium in organic carbon content, low in available nitrogen and medium in available phosphorus and available potash. The total rainfall received during the cropping season of *rabi* 2021-22 and 2022-23 was 109.2 mm and 63.0 mm, respectively. The experiment was laid out in split plot design with three replications with keeping three varieties *i.e.* V_1 – Chhattisgarh Genhu-4, V_2 – Chhattisgarh Amber Wheat, V_3 – GW-366 as main plot and six nitrogen management *i.e.* N_1 – 50% RDN basal + 50% top dressing, N_2 – 50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1}, N_3 –50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1} + Azotobacter + PSB culture, N_4 – 50% RDN basal + 50% top dressing + vermi compost @ 01 t ha^{-1}, N5 – 50% RDN basal + need based application through leaf colour chart, N_6 – 50% RDN basal + foliar application of nano urea at 35, 50 & 65 DAS as sub plot treatments. The nutrient doses were 100, 60, 40 kg N, P_2O_5, K_2O ha^{-1} for the experiment. The nitrogen, phosphorus and potassium were given to crop through urea, single super phosphate and muriate of potash, respectively. The half of N and full dose of P_2O_5 and K_2O were applied as basal and remaining half of N was top dressed in two equal splits at 30 and 60 DAS. Sowing was done manually keeping 20 cm row to row at 4-5 cm depth on December, 10/11/2021 & December, 11/12/2022. The data obtained on growth and yield was statistically analyzed for computing the critical difference (CD) at 5% significant level as per the technique commonly used for split plot design (Gomez and Gomez, 1984) [7].

Results and Discussion

Performance of wheat varieties under different nutrient management on growth parameters

Plant height (cm)

The plant height was recorded at 30, 60, 90 DAS and at harvest under different varieties and nitrogen management are presented in Table 1.

Among varieties, the significantly maximum plant height was recorded in varieties of Chhattisgarh genhu-4 as compared to other varieties but, it was at par with variety of Chhattisgarh amber wheat during both the years and on mean basis. The minimum significantly plant height was recorded under varieties GW-366 at 30, 60, 90 DAS and at harvest stages in both the years and on mean analysis. Variation in plant height among the wheat varieties might be due to genetic makeup of the genotype and somewhat environmental condition. Similar results have also been reported by Tomar *et al*. (2002) [29] and Singh *et al.* (2003) [28].

The nitrogen management had a significant influence on plant height at all growth stages treatment N_4 (50% RDN basal + 50% top dressing + vermi compost @1.0 t ha^{-1}) produced significantly tallest plant than the other treatments. However, it was at par with other treatments except treatment N_1 (50% RDN basal + 50% top dressing) and N_6 (50% RDN basal + foliar application of nano urea at 35, 50 & 65 DAS) during both the year and mean basis. The shortest plant height was noted under N_1 (50% RDN basal + 50% top dressing) during both the years and on mean basis. It might role of nitrogen in the synthesis of growth promoting *i.e*. cytokinin and auxins which have role in increasing the plant height. Similar results have also been reported by Basita and Rout (2001) [4] and Pandey *et al.* (2004) [18].

Total number of tillers m^{-2}

The total number of tillers m^{-2} were recorded at 30, 60, 90 DAS and at harvest which were found to be influenced by different varieties and nitrogen management are presented in Table 2.

It is apparent from the data that the total number of tillers was found significantly the maximum in variety Chhattisgarh genhu-4 as compared to other varieties at all the crop growth stages during both the years and on mean basis. However, it was at par with variety Chhattisgarh amber wheat; whereas, the maximum number of tillers were found at 60 DAS of all varieties in both the years and on mean basis. These results are in conformity with Naik *et al.*, (1995) [16] and Parihar and Singh (1995) [19].

In various nitrogen management practices, the highest total number of tillers were found under treatment N_4 (50% RDN Basal + 50% top dressing + vermi compost @ 1.0 t ha^{-1}) over the other treatments, which remained at par with rest of the treatments except N_1 (50% RDN basal + 50% top dressing) and N_6 (50% RDN basal + foliar application of nano urea at 35, 50 & 65 DAS) during the both the year of study and also mean basis. The minimum total number of tillers was noted under N_1 (50% RDN basal + 50% top dressing) at 30, 60, 90 DAS and at harvest during both the years and on mean basis. The maximum total number of tillers was found at 60 DAS in all treatment in both the years and mean basis. The tiller emergence phase is followed, immediately or after some delay, by a phase of senescence during which a proportion of tillers die while others complete their cycle and produce an ear (Abichoua *et al*., 2018) [1]. The results are in agreement with Singh *et al.* (2003) [28] and Pandey *et al*. (2004) [18].

Dry matter accumulation (g m^{-2})

Dry matter accumulation was recorded at 30, 60, 90 DAS and at harvest, data regarding the dry matter accumulation of wheat as influenced by varieties and nitrogen management are presented in Table 3.

A perusal of data reveals that significantly higher dry matter was recorded in variety Chhattisgarh genhu-4 as compared to other varieties during both the years and mean analysis, which was statistically at par with Chhattisgarh amber wheat at all growth stages during both the year and mean data. The minimum dry matter accumulation was recorded under variety GW-366 at 30, 60, 90 DAS and at harvest during both the years and on mean basis. Dry matter production increased as growth progressed and maximum value was observed at harvest. Similar results were also found by Mali and Kumar *et al*. (2013) [11] and Tripathi *et al*. (2013) [30].

Nitrogen management had a marked influence on dry matter production at 30, 60, 90 DAS and at harvest treatment N_4 (50% RDN Basal + 50% top dressing + vermi compost @ 1.0 t ha^{-1}) recorded significantly the higher during both the year and on mean data as compared to other treatments. However, it was statistically at par with the treatments N_2 (50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1}), N_3 50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1} + azotobacter + PSB culture) and N_5 (50% RDN basal + need based application through leaf color chart) during both the year and mean basis. The least dry matter accumulation was noted under N_1 (50% RDN Basal + 50% Top dressing) at 30, 60, 90 DAS and harvest during both the years and on mean basis. Dry matter accumulation, which is a function of various growth characteristics such plant density, plant height, number of tillers, leaf area, etc., is a crucial indicator of plant growth. The two key physiological processes that influence the development of leaf area and the accumulation of dry matter are cell division and expansion. Nitrogen management techniques have also been shown to significantly improve these processes. It is common knowledge that optimal N availability promotes better plant growth. The most important nutrient is nitrogen. It is the basic component of all biological things, including proteins and nucleic acids. These results are in conformity with those reported by Kumar *et al*. (2016) [12] and Reena *et al*. (2017) [24].

Performance of wheat varieties under different nutrient management on yield attributes and yields

The data pertaining to yield attributes *viz.*, number of effective tillers m^{-2}, number of grains spike^{-1}, 1000- grains weight (g), grain & straw yield and harvest index as influenced by different treatments are presented in Table 4 & 5.

Number of effective tillers m^{-2}

Data pertaining to number of effective tillers m^{-2}, as influenced by varieties and nitrogen management are presented in Table 4.

The wheat variety Chhattisgarh genhu-4 was significantly the highest number of effective tillers as compared to Chhattisgarh amber wheat and GW-366 during both the year and mean basis. Whereas, it was statistically at par with variety Chhattisgarh amber wheat and minimum effective tillers was recorded under variety GW-366 in both years and mean analysis. The Chhattisgarh genhu-4 variety appears to be distinguished by its ability to yield a greater quantity of tillers, which are subsequently thought to be converted into productive shoots that bear spikes when sufficient growth inputs are provided. This could be as a result of higher PAR interception, increased photosynthetic synthesis and enough moisture and nutrient availability during the early stages of crop growth, which led to a higher number of efficient tillers (m^{-2}). The results confirmed the findings of Jat and Dhakar (2002) [10] and Singh and Uma (2015) [27].

Number of effective tillers was significantly affected due to nitrogen management during both the years of experimentation. The treatment N_4 (50% RDN basal + 50% top dressing + vermi compost @ 1.0 t ha^{-1}) was recorded significantly the higher over other varieties during both years and on mean basis. While, it was at par with the treatment N_2 (50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1}), N_3 50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1} + azotobacter + PSB culture) and N_5 (50% RDN basal + need based application through leaf colour chart) in both the years and on mean basis. The minimum number of effective tillers recorded under N_1 (50% RDN basal + 50% top dressing) during both the years and on mean basis. The highest value of this parameter, which was seen when RDN and vermi compost were applied together, was caused by a steady delivery of nutrients in sufficient amounts throughout the crop growth season. The results are in line of Ram and Mir (2006) [22].

Number of grains earhead^{-1}

The Number of grains earhead^{-1} of wheat as influenced by varieties and nitrogen management are presented in Table 4.

As regards to the variety Chhattisgarh genhu-4 was produced significantly the higher number of grains ear head^{-1} as compared to variety Chhattisgarh amber wheat and GW-366, however it was at par with variety Chhattisgarh amber wheat during both the years and on mean basis. The lowest number of grains earhead^{-1} was recorded under variety GW-366 in both the years and on mean analysis. It seems that the Chhattisgarh genhu-4 variety stands out due to its higher grains spike^{-1}. The varieties differed among themselves due to genetic characteristics of the varieties and the results are in agreements with the findings of Tripathi *et al*. (2004) [30] and Singh and Uma (2015) [27].

According to the results obtained, significantly the highest number of grains earhead^{-1} was found under the treatment N_4 (50% RDN basal + 50% top dressing + vermi compost @ 1.0 t ha^{-1}) over the other treatments, however it was statistically at par rest of the treatments except N_1 (50% RDN basal + 50% top dressing) and N_6 (50% RDN basal + foliar application of nano urea at 35, 50 & 65 DAS) during both years and on mean basis. The minimum number of grains earhead^{-1} was recorded under N_1 (50% RDN basal + 50% top dressing) during both the years and on mean basis. The increase in no. of grains earhead^{-1} is the result of no. of fertilized ear head which is determined primarily by amount of nitrogen absorption and amount of carbohydrates produced at the time of spiklets differentiation. The increase in no. of grains earhead^{-1} with application of vermi compost @ 1.0 t ha^{-1} might be the result of better assimilation of carbohydrate in the ear. These results are in agreements to Pandey *et al.* (2004) [18] and Ram and Mir (2006) [22].

1000-grains weight (g)

The data pertaining 1000-grains weight as influenced by different varieties and nitrogen management during both the years as well as their mean are presented in Table 4.

Perusal of data reveals that 1000-grains weight differed significantly with different varieties. However, statistically the highest 1000-grains weight was recorded under Chhattisgarh genhu-4 variety as compared to other varieties during both the year and on mean basis. While, it was mutually at par with variety Chhattisgarh amber wheat and the lowest 1000-grains weight was observed in GW-366 during both the years and on mean analysis. Similar results were also obtained by Jat and Dhakar (2002) [10] and Oak *et al*. (2004) [17].

The data revealed that the 1000– grains weight of wheat was significantly influenced by nitrogen management. Amongst the treatments N_4 (50% RDN basal + 50% top dressing + vermi compost @ 1.0 t ha^{-1}) significantly the higher 1000– grains weight than other treatments during both the years and on mean basis. However, it was found statistically at par with treatments N_2 (50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1}), N_3 (50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1} + Azotobacter +PSB culture) and N_5 (50% RDN basal + need based application through leaf colour chart) during both the years and on mean analysis. The lowest 1000– grains weight was recorded under N_1 (50% RDN basal + 50% top dressing) during both the years and on mean basis. Lower 1000-grain weight was thus the result of inadequate nutrient delivery throughout the crop growth period, especially during the stages of grain formation and filling. The similar result finding was obtained by Shahi *et al*. (2016) [25] and Patel *et al*. (2017) [20].

Grain yield (t ha^{-1})

The data pertaining to grain yield of wheat as influenced by different treatments are presented in Table 5.

The data pertaining to grain yield of wheat was influenced significantly due to different varieties. Among the varieties, Chhattisgarh genhu-4 was produced significantly more grain yield as compared to rest of the varieties during both the years and mean basis. The differences among grain yield of varieties were calculated statistically significant, but it was at par with variety Chhattisgarh amber wheat during both the years and mean basis. The minimum straw yield was recorded under variety GW-366 during both the years and on mean basis. Because of its genetic makeup, the Chhattisgarh genhu-4 variety took a substantially longer time than the other kinds to reach the anthesis stage. The production and transfer of photo assimilates to growing grain during the milking stage were controlled by environmental variables, so this stage is important for determining the wheat crop grain size and grain weight. It may have been caused by the favourable temperature that prevailed and extended the crop's life. The most important stage of the wheat crop, anthesis, determines how many grains will set in the spike. Chakrabarti *et al.* (2011) [5] reported that the favourable temperature for anthesis was 18-24 ºC. Because pollen grains are extremely sensitive to temperature and other environmental factors, fertilization is extremely dependent on those factors. The results were in close conformity with the findings of Tripathi *et al*. (2004) [30] and Yadav and Dhanai (2017) [31].

The data indicate that the seed yield of wheat was influenced significantly due to Nitrogen management. Significantly the highest grain yield was recorded in the treatment N_4 (50% RDN basal + 50% top dressing + vermi compost @ 1.0 t ha^{-1}) as compared to other treatments, but was found statistically at par with treatment N_2 (50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1}), N_3 50% RDN basal + 50% top dressing + FYM @ 5 t ha^{-1} + Azotobacter + PSB culture) and N_5 (50% RDN basal + need based application through leaf colour chart) during both the years and on mean basis. However, among all treatments significantly the lowest grain yield was recorded in N_1 (50% RDN basal + 50% top dressing) during both the years and on mean analysis. The number of grains per unit area determines the strength of the physiological sink and can be increased by either increasing the plant density or the number of grains $spike^{-1}$. These crucial stages are crucial for wheat grain output, and only under ideal agronomic and meteorological circumstances does a large number of fertile spikelets form. This leads to a high requirement for carbohydrates during the grain loading phase, which is only met when there is an adequate supply of N. Wheat grain yield is determined by a number of yield components, including test weight, effective tillers, ear length, and the number of grains $spike^{-1}$. Wheat grain size can only increase grain yield to a certain extent because the physiological sink becomes the limiting factor for wheat yield rather than the rate of photosynthesis that controlled growth (Yoshida, 1972) [32]. The results were in close conformity with the findings of Gurjar (2011) [9] and Banerjee *et al*. (2014) [3].

Straw yield (t ha^{-1})

The data pertaining to straw yield of wheat as influenced by varieties and nitrogen management are presented in Table 5.

A perusal of data reveals that varieties brought about significant differences in straw yield. Among the varieties, Chhattisgarh genhu-4 was produced significantly the higher straw yield over other varieties, but was statistically at par with variety Chhattisgarh amber wheat during both the year and mean basis. However, lowest straw yield was recorded in variety GW-366 during both the years and mean data. It may have been caused by the favourable temperature that prevailed and extended the crops life. Hossian *et al.* (2015) provide support for the finding. Because of its genetic composition, variety Chhattisgarh genhu-4 took a lot longer than the other kinds to reach the anthesis stage. The Environment conditions prevailing at heading stage significantly influenced the yield and yield attributes of wheat. The similar results were finding by Thripathi *et al.* (2004), Yadav and Dhanai (2017) [31].

Critical appraisal of data showed that N_4 (50% RDN Basal + 50% top dressing + vermi compost @ 1.0 t ha^{-1}) was recorded significantly the highest straw yield as compared to other treatments during both the years and on mean basis. However, it was mutually at par with rest of the treatments except N_1 (50% RDN basal + 50% top dressing) and N_6 (50% RDN basal + foliar application of nano urea at 35, 50 & 65 DAS) in both the years and on mean analysis. Significantly the lowest straw yield was recorded with N_1 (50% RDN basal + 50% top dressing) during both the years and on mean basis. Shahi *et al.* (2016) [25] have also reported similar results, demonstrating increased straw yields with administration of larger doses of nutrients. These results are in conformity with those reported by Ram and Mir (2006) [22], Chesti *et al*. (2013) [6] and Banerjee *et al*. (2014) [3].

Harvest index (%)

The data pertaining to harvest index as influenced by different variety and nitrogen management are presented in Table 5.

A perusal data revealed that the harvest index was found significant effect among the varieties. The wheat variety

Chhattisgarh genhu-4 was recorded the maximum harvest index as compared to Chhattisgarh amber wheat and GW-366 during both the years of mean basis. However, it was mutually at par with variety Chhattisgarh amber wheat and the minimum harvest index was recorded under variety GW-366 during both the years and on mean basis. Similar trend was also reported by Yadav and Dhanai (2017) [31].

An examination of data further reveals that the harvest index was significantly affected with nitrogen management. The maximum harvest index was recorded under the treatment N_4 (50% RDN basal + 50% top dressing + vermi compost @ 1.0 t ha^{-1}) compared to other treatment during both the years and on mean basis. While, it was statistically at par with rest of the treatments except N_1 (50% RDN basal + 50% top dressing) and N_6 (50% RDN basal + foliar application of nano urea at 35, 50 & 65 DAS) in both the years and on mean analysis. Significantly the least harvest index was recorded under N_1 (50% RDN basal + 50% top dressing) during both the years and on mean basis. The harvest index shows the distribution of biomass between grain and straw production both directly and indirectly. Harvest index indicates directly the allocation of biomass to grain and indirectly the partitioning between grain and straw production. Rani *et al*. (2000) [23] and Maqsood *et al*. (2002) [13] also observed the significant increase in harvest index up to 150 kg N ha^{-1} than lower rate of nitrogen application.

Table 1: Effect of varieties and nitrogen management on plant height of wheat at different time intervals.

Treatments	Plant height (cm)											
	30 DAS			60 DAS			90 DAS			At harvest		
	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Varieties												
V_1 – Chhattisgarh Genhu-4	21.1	24.3	22.7	43.8	47.4	45.6	81.5	84.2	82.8	83.88	86.66	85.3
V_2 – Chhattisgarh Amber Wheat	19.2	22.3	20.7	42.1	45.3	43.7	78.9	81.9	80.4	82.01	85.29	83.7
V_3 – GW-366	17.0	20.0	18.5	40.2	43.1	41.7	76.3	78.1	77.2	77.02	82.74	79.9
SEm ±	0.58	0.62	0.60	0.35	0.61	0.48	0.97	0.93	0.95	0.98	0.63	0.81
CD (P=0.05)	2.29	2.43	2.36	1.39	2.41	1.90	3.82	3.66	3.74	3.83	2.47	3.15
Nitrogen management												
N_1– 50% RDN Basal + 50% Top dressing	16.7	19.3	18.0	39.3	43.2	41.3	70.3	73.5	71.9	77.72	82.39	80.1
N_2– 50% RDN Basal + 50% Top dressing + FYM @ 5 t ha^{-1}	19.2	22.5	20.8	41.8	45.4	43.6	79.4	81.9	80.7	80.86	84.64	82.8
N_3–50% RDN Basal + 50% Top dressing + FYM @ 5 t ha^{-1} + Azotobacter +PSB culture	20.1	23.2	21.7	42.9	46.3	44.6	81.4	83.8	82.6	83.41	85.75	84.6
N_4 – 50% RDN Basal + 50% Top dressing + Vermi compost @1.0 t ha^{-1}	21.8	24.7	23.3	44.9	47.9	46.4	83.3	85.8	84.6	85.20	87.76	86.5
N_5 – 50% RDN Basal + Need based application through leaf colour chart	19.1	22.5	20.8	42.3	45.2	43.8	80.7	83.2	82.0	79.67	85.12	82.4
N_6 – 50% RDN Basal + Foliar application of nano urea at 35, 50 & 65 DAS	17.7	20.9	19.3	40.9	43.8	42.4	78.2	80.0	79.1	78.93	83.72	81.3
SEm ±	1.04	1.00	1.02	1.10	1.01	1.06	1.64	1.71	1.68	1.56	1.12	1.34
CD (P=0.05)	3.01	2.89	2.95	3.18	2.93	3.06	4.72	4.93	4.83	4.50	3.23	3.87

Treatments	Total number of tillers m^{-2}											
	30 DAS			60 DAS			90 DAS			At harvest		
	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Varieties												
V_1 – Chhattisgarh Genhu-4	197.9	209.9	203.9	233.1	237.2	235.1	223.6	231.8	227.7	221.3	228.5	224.9
V_2 – Chhattisgarh Amber Wheat	193.9	204.2	199.1	230.0	232.0	231.0	220.9	228.1	224.5	217.1	225.6	221.3
V_3 – GW-366	187.8	196.9	192.3	222.6	228.6	225.6	215.6	222.8	219.2	212.4	221.0	216.7
SEm ±	1.5	1.9	1.7	2.0	1.6	1.8	1.5	1.6	1.6	1.7	1.3	1.5
CD (P=0.05)	5.9	7.6	6.8	7.7	6.1	6.9	6.0	6.4	6.2	6.5	5.1	5.8
Nitrogen management												
N_1– 50% RDN Basal + 50% Top dressing	184.1	199.1	191.6	223.6	225.0	224.3	209.8	219.6	214.7	209.2	221.5	215.4
N_2– 50% RDN Basal + 50% Top dressing + FYM @ 5 t ha^{-1}	193.0	204.2	198.6	228.0	230.6	229.3	220.4	227.6	224.0	217.2	224.9	221.0
N_3–50% RDN Basal + 50% Top dressing + FYM @ 5 t ha^{-1} + Azotobacter +PSB culture	196.2	205.9	201.0	230.6	237.2	233.9	223.7	230.9	227.3	219.9	226.5	223.2
N_4 – 50% RDN Basal + 50% Top dressing + Vermi compost @1.0 t ha^{-1}	200.1	209.1	204.6	234.9	239.4	237.2	225.7	233.0	229.4	222.5	230.6	226.5
N_5 – 50% RDN Basal + Need based application through leaf colour chart	194.2	203.9	199.1	228.5	232.9	230.7	221.8	229.1	225.4	218.5	224.7	221.6
N_6 – 50% RDN Basal + Foliar application of nano urea at 35, 50 & 65 DAS	191.4	199.8	195.6	225.8	230.3	228.0	218.7	225.2	221.9	214.2	222.0	218.1
SEm ±	2.9	2.4	2.6	2.4	3.1	2.8	2.4	2.7	2.6	2.8	2.1	2.4
CD (P=0.05)	8.4	6.8	7.6	7.0	9.1	8.1	6.9	7.8	7.4	8.0	5.9	7.0

Table 3: Effect of varieties and nitrogen management on dry matter accumulation of wheat at different time intervals.

Treatments	Dry matter accumulation (g m^{-2})											
	30 DAS			60 DAS			90 DAS			At harvest		
	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Varieties												
V_1 – Chhattisgarh Genhu-4	26.1	27.7	26.9	136.8	141.6	139.2	733.2	751.9	742.5	928.3	948.1	938.2
V_2 – Chhattisgarh Amber Wheat	25.2	26.2	25.7	134.7	136.4	135.6	710.8	726.7	718.7	890.8	906.5	898.6
V_3 – GW-366	24.9	25.7	25.3	131.4	131.8	131.6	700.7	714.8	707.7	872.2	884.3	878.3
SEm ±	0.2	0.4	0.3	1.0	1.2	1.1	6.1	4.7	5.4	10.3	9.2	9.8
CD (P=0.05)	0.9	1.6	1.2	3.8	4.9	4.3	24.0	18.5	21.3	40.6	36.0	38.3
Nitrogen management												
N_1– 50% RDN Basal + 50% Top dressing	24.0	24.3	24.1	128.9	128.5	128.7	660.9	699.6	680.2	818.1	855.7	836.9
N_2– 50% RDN Basal + 50% Top dressing + FYM @ 5 t ha^{-1}	25.5	26.9	26.2	134.1	138.5	136.3	723.5	736.8	730.2	912.2	933.8	923.0
N_3–50% RDN Basal + 50% Top dressing + FYM @ 5 t ha^{-1} + Azotobacter +PSB culture	26.0	27.3	26.7	137.6	142.1	139.9	737.3	756.7	747.0	942.5	947.0	944.7
N_4 – 50% RDN Basal + 50% Top dressing + Vermi compost @1.0 t ha^{-1}	26.4	28.3	27.3	138.0	144.5	141.2	744.9	760.4	752.7	962.3	966.3	964.3
N_5 – 50% RDN Basal + Need based application through leaf colour chart	25.5	26.3	25.9	133.9	135.9	134.9	716.9	723.2	720.1	905.3	895.0	900.2
N_6 – 50% RDN Basal + Foliar application of nano urea at 35, 50 & 65 DAS	24.9	26.1	25.5	133.3	130.1	131.7	705.9	709.9	707.9	842.3	880.2	861.3
SEm ±	0.5	0.8	0.6	1.5	2.0	1.8	10.0	11.2	10.6	13.7	11.6	12.7
CD (P=0.05)	1.4	2.2	1.8	4.4	5.7	5.1	28.8	32.3	30.6	39.6	33.5	36.5

Table 4: Effect of varieties and nitrogen management on number of effective tillers, number of grains and 1000-grains weight of wheat.

Treatments	Number of effective tillers m^{-2}			Number of grains earhead^{-1}			1000- grains Weight (g)		
	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Varieties									
V_1 – Chhattisgarh Genhu-4	181.4	190.2	185.8	29.4	32.1	30.8	39.03	39.07	40.04
V_2 – Chhattisgarh Amber Wheat	177.2	183.0	180.1	27.7	29.9	28.8	38.43	38.49	38.22
V_3 – GW-366	157.2	167.2	162.2	24.8	26.4	25.6	36.99	37.08	36.23
SEm ±	3.6	3.7	3.6	0.7	1.0	0.9	0.28	0.27	0.58
CD (P=0.05)	14.0	14.5	14.2	2.6	4.1	3.3	1.11	1.06	2.28
Nitrogen management									
N_1– 50% RDN Basal + 50% Top dressing	158.1	167.1	162.6	25.7	26.9	26.3	37.11	37.42	36.50
N_2– 50% RDN Basal + 50% Top dressing +FYM @ 5 t ha^{-1}	170.3	184.0	177.2	27.1	29.3	28.2	38.26	38.72	38.29
N_3–50% RDN Basal + 50% Top dressing + FYM @ 5 t ha^{-1}+ Azotobacter +PSB culture	180.2	187.3	183.7	28.6	32.2	30.4	38.74	38.97	39.21
N_4 – 50% RDN Basal + 50% Top dressing + Vermi compost @ 1.0 t ha^{-1}	185.9	190.5	188.2	29.4	32.8	31.1	39.21	39.49	40.44
N_5 – 50% RDN Basal + Need based application through leaf colour chart	170.0	177.9	174.0	27.0	29.0	28.0	37.99	37.72	37.91
N_6 – 50% RDN Basal + Foliar application of nano urea at 35, 50 & 65 DAS	167.3	173.9	170.6	25.8	26.7	26.3	37.38	37.44	36.65
SEm ±	6.1	5.4	5.7	0.9	1.6	1.2	0.61	0.84	0.93
CD (P=0.05)	17.7	15.4	16.6	2.5	4.7	3.6	1.75	2.02	2.69

Table 5: Effect of varieties and nitrogen management on grain and straw yield as well as harvest index of wheat.

Treatments	Grain yield (t ha^{-1})			Straw yield (t ha^{-1})			Harvest index (%)		
	2021-22	2022-23	Mean	2021-22	2022-23	Mean	2021-22	2022-23	Mean
Varieties									
V_1 – Chhattisgarh Genhu-4	3.21	3.42	3.32	5.00	5.27	5.14	39.03	39.07	39.05
V_2 – Chhattisgarh Amber Wheat	3.08	3.30	3.19	4.88	5.10	4.99	38.43	38.49	38.46
V_3 – GW-366	2.81	2.99	2.90	4.67	4.89	4.78	36.99	37.08	37.04
SEm ±	0.05	0.06	0.06	0.06	0.04	0.05	0.28	0.27	0.28
CD (P=0.05)	0.18	0.25	0.22	0.23	0.17	0.20	1.11	1.06	1.09
Nitrogen management									
N_1– 50% RDN Basal + 50% Top dressing	2.87	3.06	2.97	4.78	4.89	4.84	37.11	37.42	37.27
N_2– 50% RDN Basal + 50% Top dressing +FYM @ 5 t ha^{-1}	3.04	3.23	3.14	4.86	5.05	4.96	38.26	38.72	38.49
N_3–50% RDN Basal + 50% Top dressing + FYM @ 5 t ha^{-1}+ Azotobacter +PSB culture	3.13	3.32	3.23	4.97	5.21	5.09	38.74	38.97	38.86
N_4 – 50% RDN Basal + 50% Top dressing + Vermi compost @ 1.0 t ha^{-1}	3.26	3.46	3.36	5.09	5.36	5.23	39.21	39.49	39.35
N_5 – 50% RDN Basal + Need based application through leafcolour chart	3.03	3.26	3.15	4.89	5.13	5.01	37.99	37.72	37.86
N_6 – 50% RDN Basal + Foliar application of nano urea at 35, 50 & 65 DAS	2.88	3.08	2.98	4.71	4.91	4.81	37.38	37.44	37.41
SEm ±	0.08	0.09	0.09	0.1	0.11	0.11	0.61	0.84	0.73
CD (P=0.05)	0.24	0.26	0.25	0.28	0.33	0.31	1.75	2.02	1.89
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS

Conclusion

Among the wheat varieties, Chhattisgarh genhu-4 resulted in significantly the higher growth parameters and yield attributes of wheat which consequently resulted in significantly the highest grain and straw yields, harvest index, biological yield, nutrient content and uptake, protein content, protein yield as well as gross, net returns and B:C ratio.

As regards to nitrogen management in wheat, significantly the highest growth parameters, yield attributes, grain and straw yields, harvest index, biological yield, nutrient content and uptake by grain and straw, protein content, protein yield, gross and net return were found under treatment N_4 (50% RDN basal + 50% top dressing + vermi compost @ 1.0 t ha^{-1}).

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