

Original Research Article

<https://doi.org/10.20546/ijcmas.2021.1001.321>

Influence of Fertility Levels and Plant Growth Retardants on Growth and Productivity of Wheat (*Triticum aestivum* L.) in Jharkhand

Naiyar Ali^{1*}, P. Alam¹, Akhilesh Sah², Tajwar Izhar³ and Sanjay Kumar¹

¹Department of Agronomy, ²Akhilesh Sah, ZRS (BAU), Chianki, Palamu, India
³Department of Forage Breeding (LPM), RVC, Birsa Agricultural University, Kanke, Ranchi, Jharkhand, India

*Corresponding author

ABSTRACT

Keywords

CCC,
Tebuconazole, Net
Return, B:C Ratio,
Plant Growth
retardants, Wheat,
Grain yield

Article Info

Accepted:
18 December 2020
Available Online:
10 January 2021

The study was conducted during *rabi* 2017-18 and 2018-19 at Crop Research Farm, Eastern Section of Birsa Agricultural University, Ranchi-834006 (Jharkhand) to evaluate the Fertility levels and application of growth regulators on growth of wheat (*Triticum aestivum* L.) with objective to achieve yield maximization. The experiment was laid out in split plot design with three replications. The treatments consisted of four fertility levels absolute Control; 100% (Recommended Dose of Fertilizer); 150% RDF and 150% RDF+15tFYM/ha in main plot and four growth regulators (Two sprays each of water, CCC (0.2%), Tebuconazole (0.1%); CCC (0.2%)+ Tebuconazole (0.1%). The soil of the experimental field was clay loam in texture, acidic in reaction, low in available nitrogen, phosphorus and medium available potassium. Results revealed that application of 150% RDF+15tFYM led to higher plant height, dry matter accumulation and lodging score of wheat at harvest in both the years. The combined application of (CCC)+Tebuconazole reduced the plant height of wheat by 22.0% and 20.3% over water spray during 2016-17 and 2017-18 respectively. The minimum mean lodging score mean 1.0 and 1.5 were recorded with application of CCC and Tebuconazole during 2016-17 and 2017-18 respectively. The significantly higher number of spike (368 & 388 m⁻²), spike length (11.6 & 12.40 cm), number of spikelets/spike (21.40 & 22.50) and test weight (39.13 & 40g) were registered with application of 150% RDF+15tFYM during 2016-17 and 2017-18 respectively as compared to 100% RDF. The combined spray of CCC+Tebuconazole enhanced the test weight by 5.6% & 3.7% over water spray during both the years 2016-17 and 2017-18, respectively. The significantly maximum grain, straw and biomass yield of wheat were recorded with 150% RDF+15tFYM which were 5.8 & 17.03%, 16.3 & 32.2%, and 10.82 & 24.7% higher over 100% RDF during both the years 2016-17 and 2017-18, respectively. The grain yield of wheat due to combine application CCC and Tebuconazole was found significantly higher (10.84 and 11.15%) during both the years. There were no differences in straw and biomass yields of wheat due to different growth regulators.

Introduction

Worldwide, wheat (*Triticum aestivum* L.) is grown in a majority of the countries and finds

a significant share in consumption basket. Globally, wheat is the largest cultivated with an estimated area of 220.19 million hectares (mha). In India, during 2018-19 *Rabi* season,

Wheat was cultivated in 29.55mha, constituting 24.35 per cent of the total crop acreage, production 101.20 M tones and an average productivity of 3424 kg ha⁻¹ (Anonymous 2019). Jharkhand has an area of just 2.21 lakh ha, an productivity of 18.49qha⁻¹ (Anonymous 2019).The productivity of wheat in Jharkhand is very low as compared to national level. One of the main reasons of this low productivity in addition to restricted irrigation is imbalance use of chemical fertilizers which results in lower yield and also adversely affects the soil health. By use of sufficient quantity of organic manure in addition to chemical fertilizers, soil health can be improved. Fertilizers responsive varieties have important role in increasing yield. Hence it is urgent need to fine tune the fertilizers and manurial requirement of high yielding varieties of wheat. So one of the popular variety HD2967 has been taken in above experiment.

A chronic worldwide constraint to sustainable wheat production is lodging that often decreases photosynthetic ability and biomass production, deteriorates seed quality, and creates difficulties to harvest operations(Zhang *et al.*,2017) Wheat and rice are highly prone to lodging during late vegetative growth and at reproductive stages (Shah *et al.*, 2019) exaggerating the need for additional research efforts Lodging in cereals can be defined as the permanent displacement of stems from the vertical position, which could result from either plastic failure of the stem base (stem lodging) or failure of the belowground anchorage system (Berry *et al.*, 2004). The key reasons responsible for wheat lodging are increase in weight of mature ears due to water accumulation, occurrence of high speed winds at grain filling stage, wide use of flat planting and flood irrigation and the lack of acceptable cultivars of wheat that are lodging tolerant at higher nitrogen (N) rates etc. (Taiz and Zeiger 2004, Stachecki *et al.*,

2004). The lodging in wheat can be controlled by using short lodging tolerant cultivars and by applying growth retardant chemicals etc. (Rodrigues *et al.*, 2003).The semi-dwarf wheat cultivars can limit lodging under moderate levels of inputs, especially fertilizer and irrigation. Lodging resistance of these improved semi dwarf cultivars, resulting from shorter and stiffer straw, is markedly expressed at moderate levels of N fertility (Pinthus, 1974). Under certain agronomic conditions, however, even semi dwarf wheat cultivars have been observed to lodge under Indian condition (Tripathi *et al.*, 2003). This form of lodging which is most common with well-managed wheat crop occurs near or after flowering and is primarily the result of wind during or soon after irrigation or rainstorms (Hobbs, 2007). The reduction in grain yield caused by lodging ranged from 7 to 35% with greatest effect when lodging occurred within the month after anthesis, is most commonly reported under Indian condition. The yield potential of high yielding genotypes of wheat under irrigated and high input rates could be achieved consistently and efficiently by finding suitable solutions of lodging problem. In this context, the use of growth retardants found to be most effective for managing the problem of lodging (Zhang *et al.*, 2017). Growth retardants are chemical substances that have the potential to alter structural or vital processes inside the plant by modifying hormone balance to increase yield, improve quality or facilitate harvesting through checking lodging especially in cereals (Zhang *et al.*, 2017). Lodging preventers (plant height retardants) are generally antagonistic to gibberellin and act by altering their metabolism (Peake *et al.*, 2014) and for aforesaid reason they are frequently called anti-gibberellin. The nature and extent of lodging are closely related to height of the stem, which can be modified by application of growth inhibitors (Peng *et al.*, 2014). Application of growth inhibitors, like

ethephon (2-chloro ethyl phosphonic acid) or CCC (Chlormequat Chloride), was reported to be useful in decreasing plant height and subsequently reducing lodging (Niu *et al.*, 2012). Therefore, the objective of present study was to determine the effects of different fertility levels and lodging preventers on growth behavior, productivity in sub humid conditions.

Materials and Methods

The study was conducted during two consecutive *rabi* season of 2017-18 and 2018-19 at Crop Research Farm, Eastern Section of Birsa Agricultural University, Ranchi-834006 (Jharkhand) to evaluate the effect of nutrient management and application of growth regulators on growth of wheat (*Triticum aestivum* L.) with objective to achieve yield maximization under All India Coordinated Wheat and Barley Improvement Project. The experimental site situated in North Eastern Plain Zones of Jharkhand having average annual rainfall of zone is 1440.0mm of which about 85% is received during June to September with erratic distribution over time and space.

The soil of the experimental field was clay loam in texture, acidic in reaction (pH; 5.8), low in organic carbon and nitrogen, phosphorus and medium exchangeable potassium. The experiment was laid out in split plot design and consist of four fertility levels, viz. Control (No fertilization), 100% RDF (Recommended dose of fertilizer: 150:60:40 kg/ha), 150% RDF (225:90:60 kg/ha) and 150% RDF (225:90:60 kg/ha)+15t FYM/ha in main plots and four plant growth regulators, viz. control (water spray), 0.2% spray of Chlormequat Chloride(CCC) 0.1% spray of Tebuconazole and a combined spray of Chlormequat Chloride +Tebuconazole in sub plots, replicated thrice. Growth regulators were used twice i.e. at first node and flag leaf

stages. Field preparation included one deep ploughing by mould board plough followed by 2 cross harrowing and planking. The wheat variety HD-2967 was sown during second week of November with a recommended seed rate of 100 kg/ha. A well rotten 15 tonn/ha of FYM was applied before 15 days the sowing of crops as per treatment and well mixed in the soil. During both the seasons 1/3rd quantity of total N and whole amount of P₂O₅ and K₂O were applied as basal at sowing, while remaining 2/3rd quantity of N were applied in two split of equal quantity, i.e. 1/3rd at first irrigation and 1/3rd at second irrigation. Crop was raised under irrigated condition and a total of five irrigations were applied at critical growth stages. Crop protection measures were followed as and when required.

The growth and yield attributes were recorded as per the standard procedure by sampling from three places in each plot. The net plots, leaving the one border rows on the rows direction and half meter on opposite direction of the plots of wheat were harvested manually with sickle. The produce was kept for sun drying for some days in field and after drying; the biological yield was recorded and expressed in q/ha. After threshing the bundles from each plot, the grains were cleaned, dried and weighed. The grain yield was expressed in q/ha. Straw yield was obtained by subtracting the grain yield from the weight of total biological yield for individual plots and was expressed in tonnes/ha. Lodging was scored with the formula $\{(\% \text{ plot area lodged} \times \text{angle of lodging from vertical position})/90\}$ described by Fischer and Stapper (1987). All data recorded were analyzed with the help of analysis of variance (ANOVA) technique (Gomez and Gomez 1984). The least significant test was used to decipher the main and interaction effects of treatments at 5% level of significance (P<0.05).

Results and Discussion

Effect of fertility levels and growth regulators on growth parameters and lodging of wheat

The nutrient management had significant effect on plant height of wheat at harvest. At harvest the crop fertilized with 150% RDF+FYM attained significantly maximum plant height (91.50 & 91.0cm) over control (61.75&65.08cm) during both years respectively. However, the crop supplied with 150% RDF produced statistically similar plant height compared to 150% RDF+ FYM during both the years. The nutrient management levels also realized significant effect on dry matter accumulation of wheat (Table 1) at harvest during both the years. At harvest stage, crop fertilized with 150% RDF+FYM

recorded significantly highest dry matter accumulation over control and 100% RDF. However, the crop fertilized with 150%RDF produced statistically similar dry matter compared to 150% RDF+ FYM during both the years. The application of 150% RDF+FYM enhanced the dry matter of crop with the magnitude of 13.20 and 11.30% at harvest) over 100% RDF during 2016-17 and 2017-18. The maximum lodging score was found due to application of 150% RDF+FYM during both the years. The major nutrients (NPK) are important constituents for cell division and cell elongation and their optimum availability with integrated use of organic and inorganic nutrient sources led to higher plant growth. Higher availability of these nutrients might improve photosynthetic area of plants that cumulatively contribute to higher dry matter accumulation.

Table.1 Effect of fertility levels and plant growth regulators on growth and lodging on wheat

Treatments	Plant height at maturity(cm)		Dry matter accumulation at maturity (gm ⁻²)		Lodging scores	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Nitrogen levels						
1. Absolute control	61.75	65.08	850.50	880.40	0.0	0.0
2. RDF (150:60:40)	87.17	88.92	1450.22	1510.20	0.0	0.0
3. 150% RDF	90.60	90.75	1560.12	1590.40	12.8	15.8
4.150% RDF+15 t FYM	91.50	91.0	1580.14	1630.80	14.8	16.8
S.Em±	0.98	0.76	22.24	24.82	-	-
CD (P=0.05)	3.41	2.62	54.91	58.82	-	-
Plant growth regulators						
1. water sprays	98.50	97.50	1382.91	1412.12	8.0	9.8
2. CCC	79.17	81.08	1405.04	1420.14	4.4	5.8
3. Tubaconazole	78.33	79.50	1420.50	1480.24	7.8	8.4
2. CCC+Tubaconazole	76.83	77.67	1450.20	1510.20	1.0	1.5
S.Em±	1.74	2.28	21.40	23.60	-	-
CD (P=0.05)	5.08	6.65	45.02	48.20	-	-

Table.2 Effect of fertility levels and plant growth regulators on yield attributes of wheat

Treatments	Spike m ⁻²		Length of spike (cm)		No. of grains spike ⁻¹		No. of spikelets spike ⁻¹		Test weight (g)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Nitrogen levels										
1. Absolute control	169	166	6.50	7.20	16.9	11.94	13.30	14.60	35.12	34.53
2. RDF (150:60:40)	339	335	10.10	9.98	33.90	32.76	18.60	17.90	38.54	38.13
3. 150% RDF	354	360	11.2	11.30	35.40	33.87	20.50	21.20	38.98	39.11
4. 150% RDF+15 t FYM ha ⁻¹	368	388	11.6	12.40	36.80	34.06	21.40	22.50	39.13	40.13
S.Em±	7.35	10.76	0.201	0.241	0.98	1.0	0.402	0.512	0.16	0.44
CD (P=0.05)	25.43	37.23	0.880	1.210	3.41	3.44	1.150	1.410	0.54	1.25
Plant growth regulators										
1. water sprays	303	306	10.80	9.80	26.17	26.32	18.90	18.20	37.85	37.72
2. CCC	306	307	10.90	11.80	28.42	28.75	20.10	19.40	37.91	37.88
3. Tubaconazole	308	315	11.50	11.60	28.90	29.76	19.10	18.40	38.05	38.19
2. CCC+Tubaconazole	313	321	12.20	11.52	27.83	27.80	20.18	20.20	39.96	39.11
S.Em±	7.08	9.48	0.208	0.280	0.92	1.34	0.406	0.506	0.77	0.43
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	2.10	1.25

Table.3 Effect of fertility levels and plant growth regulators on yield and Harvest Index of wheat

Treatments	Grain yield qha ⁻¹		Straw yield qha ⁻¹		Biomass qha ⁻¹		Harvest Index(%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Nitrogen levels								
1. Absolute Control	6.48	6.87	7.82	7.13	14.30	14.0	45.3	48.0
2. RDF (150:60:40)	46.78	43.02	43.32	41.98	90.10	85.0	51.9	50.6
3. 150% RDF	46.20	47.12	47.68	51.88	93.88	99.0	49.2	47.6
4. 150% RDF+15 t FYM ha ⁻¹	49.48	50.40	50.37	55.6	99.85	106.0	49.5	47.7
S.Em±	0.69	0.82	0.70	0.89	1.63	3.68	1.80	1.60
CD (P=0.05)	2.38	2.85	2.45	2.80	5.63	12.74	NS	NS
Growth Regulators								
1. water sprays	34.21	34.97	36.52	40.03	70.73	75.0	48.4	46.6
2. CCC	36.09	37.05	35.71	39.95	71.80	77.0	50.3	48.1
3. Tubaconazole	36.72	37.52	40.99	43.48	77.71	81.0	47.2	46.32
2. CCC+Tubaconazole	37.92	38.87	39.96	42.13	77.88	81.6	48.7	48.0
S.Em±	0.66	0.95	1.60	1.80	1.53	3.38	1.48	1.51
CD (P=0.05)	1.92	2.78	NS	NS	4.45	NS	NS	NS

The results of study are in accordance with the results of Joergensen *et al.*, 2010. The combined application of CCC + Tebuconazole resulted in significantly lowest plant height compared to water spray but statistically at par with other growth retardants. The combined application of CCC + Tebuconazole reduced the plant height of wheat with the magnitude of 22.0 and 20.3% as compared to the water spray during both the years, respectively. However, all the growth retardant found statistically at par for dry matter accumulation. Plant height and strength of basal internodes are closely related to lodging resistance (Zhang *et al.*, 2010 and Wei *et al.*, 2008). Based on the above results, it may be suggested that, the combined application of CCC + Tebuconazole can avoid risk of lodging occurred by altering the plant height. The results of study are valuable for enhancing lodging resistance by reducing plant height of wheat to prevent lodging and improving grain yield and quality.

Effect of fertility levels and growth retardants on yield attributes of wheat

The data indicated that nutrient management practices had significant effect on yield attributes of wheat (number of effective spike/m², spike length and test weight) of wheat (Table 2). The significantly higher number of spike (368 and 388/m²), spike length (11.60 and 12.40 cm), number of grains (36.80 and 34.06/spike) and test weight (39.13 and 40.13g) were registered with 150% RDF+FYM as compared to 100% RDF. Whereas, minimum number of spike (169 and 166/m²), spike length (6.50 and 7.20 cm), number of grains (16.9 and 11.94 /spike) and test weight (35.12 and 34.53 g) were recorded under control during both the years, respectively. However, crop supplied with the 100% RDF and 150% RDF recorded statistically similar results for aforesaid yield attributes compared with 150 RDF+FYM.

The optimal and balanced supply of nutrient (macro and micronutrient) from both the sources led to higher growth and development of plants and side by side improve the physical, chemical, biological and hydrological properties of soil which further provide an optimum environment for higher growth and development of plants reflected by higher yield attributes of plants (Behera *et al.*, 2007). The number of spike and spike length under different growth retardant were found statistically at par, although highest values were recorded with combined use of CCC +Tebuconazole (Table 2). However, the growth regulators led significant effect on test weight as compared to water spray and the maximum values were recorded with the combined application of CCC +Tebuconazole during both the years. Similar results on wheat with the use of plant growth retardants were also reported by Rajala *et al.*, (2002).

Effect of fertility levels and growth retardants on crop productivity

Present findings revealed that fertility levels had significant effect on wheat productivity (Table 3). The maximum grain and straw yield of wheat were recorded with 150% RDF+ FYM which were 50.87 and 12.26% and 50.31 and 15.92% higher compared to control and 100% RDF, respectively. However, the wheat crop fertilized using 150% RDF was found statistically at par with 150% RDF+ FYM. Similarly the mean total biomass (grain+straw) was also found maximum with application 150% RDF+ FYM. It enhanced the biomass yield of wheat by 50.56 and 14.27 % compared to control and 100% RDF, respectively. Similar to grain and straw yield, the crop fertilized using 150% RDF yielded statistically similar biomass compared to 150% RDF+ FYM. This increment in crop productivity might be result of higher plant growth, dry matter accumulation and yield attributes with the combined application of

organic and inorganic compared to when chemical fertilizer applied alone. Similar results were also reported by many other researchers which state that integration of chemical and organic sources led to higher crop productivity (Manna *et al.*, 2003). Wheat yield (grain, straw and biomass) due to different growth retardant treatments were found statistically at par, although highest values of were recorded with combined use of CCC and Tebuconazole over others treatments. The magnitudes of increase in mean grain, straw yield and biological yield with the combined spray of CCC and Tebuconazole over water spray were 9.37, 3.57 and 6.24%, respectively. These results are in close agreement with the results of earlier researchers (Tripathi *et al.*, 2003) who stated that growth inhibitor significantly reduced plant height and simultaneously produced equal biomass over no application.

Based on the finding of two years it may be conclude that application of 150% RDF + 15 t FYM/ha with CCC(Lihocin) + Tebuconazole (Folicur 430) resulted in significantly higher grain yield of wheat.

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doi: <https://doi.org/10.20546/ijcmas.2021.1001.321>