J Krishi Vigyan 2023, 11 (2) : 81-88 DOI : 10.5958/2349-4433.2023.00014.4

# Effect of Rice Stubble and Irrigation Scheduling on Growth and Yield of Wheat Crop

**Hrishikesh Nath[1], Rajan Kumar[2], Britan Rahman[3*], Saikat Sarkar[4], Apurba Baruah[5], Pranjeet Kalita[6] and Sonamoni Turi[7]**

Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar-848125

## ABSTRACT

A field experiment was conducted during the winter *Rabi* season of 2021 at Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, in order to study the possibility of improving the growth and yield of wheat under the effect of rice stubble and irrigation scheduling. The experiment was laid out in split-plot design, having 5 main-plot treatment, *viz.,* $I_1$, one irrigation at crown-root-initiation(CRI) stage; $I_2$, two irrigation at the CRI +booting stage; $I_3$, two irrigation at the CRI + milk stage; $I_4$, three irrigation at the CRI + late jointing +milk stage; $I_5$, four irrigation at the CRI + maximum tillering + flowering + dough stage and 3 subplot treatment, viz., $R_1$ (rice stubbles cut at a height of 5 cm); $R_2$ (rice stubbles cut at a height of 20 cm) and $R_3$ (rice stubbles cut at a height of 35 cm)with 3 replication. Resulted indicated that, the growth parameters and yield attributes viz., of plant height, number of tillers/mrl, no. of tillers/m$^2$, spike length, number of grains/ear, crop emergence (number of plants/m$^2$), dry matter accumulation (g/m$^2$) and crop growth rate (g/m$^2$/day) were found to be maximum with $I_5$ irrigation level, which was significantly superior to $I_1$, $I_2$, and $I_3$ but statistically at par with $I_4$. 4 irrigations ($I_5$) and rice stubbles cut at a height of 20 cm ($R_2$) resulted in the highest growth and yield-attributing characters. The grain yield and straw yield were increased up to 4 irrigations ($I_5$). Treatment $R_2$ gave the highest grain and straw yields which was at par with $R_1$ treatment. The highest grain and straw yields were recorded with $I_5R_2$ treatment combination.

**Key Words:** Growth, Irrigation Scheduling, Rice, Stubble, Treatment, Yield

## INTRODUCTION

Wheat (*Triticum aestivum* L.) is not only a major food source, but it is also an important crop for national food security due to its significant contribution to food grain buffer stock. Irrigation is one of the most important and costly inputs that have a direct impact on wheat growth and yield, and irrigation at the right time and quantity can increase yield. A change in the optimal temperature during wheat's vegetative and reproductive growth has a negative impact on the rate and duration of growth, as well as the yield. Irrigation can be timed to create a favourable soil moisture regime. The degree, duration and timing of the imposed soil-moisture deficit under limited irrigation determine grain yield reduction. The procedure for determining irrigation scheduling refers when and amount of water should be applied per irrigation. Proper scheduling of irrigation is critical to maximise the water, energy, and other manufacturing inputs. Three significant factors influence scheduling of irrigation: (a) crop water requirements; (b) Irrigation water availability; and (c) water in the root system storage capacity. Crop water requirements are critical in determining irrigation timing during the crop-growing season in irrigation projects.

Corresponding Author's Email:britan.rahman@aau.ac.in

[1,2,4,5,6&7]Dr.Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar-848125

[3]SCS College of Agriculture, Assam Agricultural University, Rangamati, Dhubri, Assam-783376

Furthermore, the biological and biochemical benefits of composted stubble are not significantly greater than those of incorporated stubble. Stubble incorporation aids in the degradation of organic matter, the stimulation of nitrogen fixation, and the stimulation of phosphorus, all of which result in an increase in plant available nutrients in the soil. Furthermore, repeated cultivation under rice stubble improves soil structure, which benefits the wheat crop and internal drainage, which benefits the rice crop. Wheat yield is maximised when wheat seeds are sown directly in a field containing rice

**Table 1. Effect of rice stubble and irrigation scheduling on plant height (cm) and number of tillers/ meter row length (mrl)**

| **Treatment** | **Plant Height ( in cm)** | | | | **No. of tillers/meter row length (mrl)** | | | |
|---|---|---|---|---|---|---|---|---|
| **Irrigation Scheduling (I)** | **30 DAS** | **60 DAS** | **90DAS** | **HARVEST** | **30DAS** | **60 DAS** | **90 DAS** | **HARVEST** |
| $I_1$ - Irrigation at CRI Stage | 18.06 | 45.48 | 72.77 | 80.85 | 32.15 | 66.95 | 59.52 | 51.01 |
| $I_2$ –Irrigation at CRI+boot Stage | 18.45 | 48.72 | 77.95 | 86.60 | 32.55 | 73.81 | 64.63 | 55.39 |
| $I_3$ –Irrigation at CRI+ milk Stage | 18.59 | 50.77 | 81.23 | 90.24 | 33.00 | 76.49 | 71.95 | 61.67 |
| $I_4$ –Irrigation at CRI + late jointing + milk Stage | 18.75 | 56.77 | 90.83 | 100.91 | 33.84 | 86.97 | 84.13 | 72.11 |
| $I_5$ –Irrigation at CRI + maximum tillering+ flowering+ dough Stage | 19.00 | 57.00 | 91.20 | 101.32 | 34.34 | 88.58 | 85.98 | 76.43 |
| SEm(±) | 0.22 | 1.52 | 2.44 | 2.71 | 0.85 | 1.99 | 2.08 | 1.79 |
| LSD( $p$= 0.05) | NS | 5.27 | 8.43 | 9.36 | NS | 6.90 | 7.21 | 6.19 |
| Rice stubbles(R) | | | | | | | | |
| $R_1$- Rice stubble cut at 5 cm height | 18.47 | 51.67 | 82.67 | 91.85 | 30.62 | 78.46 | 73.17 | 63.28 |
| $R_2$- Rice stubble cut at 20 cm height | 18.86 | 54.21 | 86.74 | 96.36 | 30.91 | 81.79 | 76.66 | 66.27 |
| $R_3$- Rice stubble cut at 35 cm height | 18.38 | 49.36 | 78.98 | 87.74 | 30.20 | 75.43 | 69.89 | 60.42 |
| SEm(±) | 0.23 | 0.93 | 2.22 | 2.47 | 0.78 | 1.82 | 1.93 | 1.66 |
| LSD ($p$= 0.05) | NS | 2.78 | 6.66 | 7.40 | NS | 5.45 | 5.79 | 4.99 |
| Interaction (IX R) | NS | NS | NS | NS | NS | NS | NS | NS |

**Table 2. Effect of rice stubble and irrigation scheduling on Dry matter accumulation ($g/m^2$) and Crop growth rate ($g/m^2/day$)**

| Treatment | Dry matter accumulation ($g/m^2$) | | | | Crop growth rate ($g/m^2/day$) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Irrigation Scheduling (I) | 30 DAS | 60 DAS | 90DAS | HARVEST | 0-30 | 30-60 | 60-90 | 90-120 | 120-Harvest |
| I-Irrigation at CRI Stage | 22.19 | 182.49 | 364.94 | 656.89 | 0.74 | 5.34 | 6.08 | 8.52 | 1.22 |
| $I_2$ –Irrigation at CRI+boot Stage | 22.01 | 198.15 | 396.27 | 713.29 | 0.73 | 5.87 | 6.60 | 9.25 | 1.32 |
| $I_3$ –Irrigation at CRI+ milk Stage | 22.31 | 220.60 | 441.17 | 794.11 | 0.74 | 6.61 | 7.35 | 10.29 | 1.47 |
| $I_4$ –Irrigation at CRI + late jointing + milk Stage | 22.41 | 239.21 | 478.38 | 861.09 | 0.75 | 7.23 | 7.97 | 11.16 | 1.59 |
| $I_5$ –Irrigation at CRI + maximum tillering+ flowering+ dough Stage | 22.54 | 257.96 | 515.87 | 928.56 | 0.75 | 7.85 | 8.60 | 12.04 | 1.72 |
| SEm(±) | 0.75 | 6.39 | 12.77 | 23.01 | 0.02 | 0.21 | 0.21 | 0.30 | 0.04 |
| LSD( $p$= 0.05) | NS | 22.10 | 44.20 | 79.63 | NS | 0.71 | 0.74 | 1.03 | 0.15 |
| Rice stubbles(R) | | | | | | | | | |
| $R_1$- Rice stubble cut at 5 cm height | 22.25 | 219.36 | 438.68 | 789.63 | 0.74 | 6.57 | 7.31 | 10.24 | 1.46 |
| $R_2$- Rice stubble cut at 20 cm height | 22.42 | 230.02 | 460.00 | 828.00 | 0.75 | 6.92 | 7.67 | 10.73 | 1.53 |
| $R_3$- Rice stubble cut at 35 cm height | 22.21 | 209.67 | 419.30 | 754.74 | 0.74 | 6.24 | 6.99 | 9.78 | 1.40 |
| SEm(±) | 0.52 | 5.77 | 11.66 | 20.78 | 0.02 | 0.20 | 0.19 | 0.27 | 0.04 |
| LSD ($p$= 0.05) | NS | 17.30 | 34.95 | 62.29 | NS | 0.59 | 0.58 | 0.82 | 0.12 |
| Interaction (IX R) | NS | NS | NS | NS | NS | NS | NS | NS | NS |

stubble and nitrogen is applied recently until wheat tillering. It is a novel idea that will benefit farmers by saving them time when sowing wheat, resulting in increased overall production. Cultivation on rice Stubble will allow farmers to plan water rotation between fields to minimize crop water stress, as well as maximising the yield, in addition to increasing net returns through increased crop yields and crop quality. Rice stubbles on the plot will be cut at various heights, allowing crop residues left on the field to replenish soil moisture. We will be able to observe irrigation treatments at various stages of wheat growth.

## MATERIALS AND METHODS

During the Rabi season, an experimental trial was carried out at Dr. Rajendra Prasad Central Agricultural University's research farm at Pusa, Bihar. It is located on the Burhi Gandak river's southern bank, at $250\ 5900^0$ N latitude and $840\ 400^0$ E longitude, at an elevation of 52.3 m above mean sea level (mean sea level). The research field had a consistent topography and textural make-up and was linked to the main irrigation channel, which was linked to the farm tube well for consistent and timely irrigation. During the research period, drainage system arrangements were available to remove excess water. The trial was carried out in a calcareous sandy loam type of soil texture which comes under the soil order entisol. The soil testing results showed alkaline type of reaction with lower values of organic carbon, N, P and K. It was found that pH was 8.28, low organic carbon (0.42 %), low available nitrogen (201.2 kg/ha), high available phosphorus ($P_2O_5$) (17.18 kg/ha) and medium available potassium ($K_2O$) (120.05 kg/ha). The experiment was carried out in split-plot design (SPD) with three replications. It consisted of 5 main plots and 3 subplot *viz*., $I_1$(one irrigation at CRI stage), $I_2$ (two irrigation at the CRI +booting stage), $I_3$ (two irrigation at the CRI + milk stage), $I_4$ (three irrigation at the CRI + late jointing + milk stage), $I_5$ (four irrigation at the CRI + maximum tillering + flowering + dough stage) and sub-plot consists of $R_1$ (rice stubbles cut at a height of 5 cm), $R_2$ (rice stubbles cut at a height of 20 cm) and $R_3$ (rice stubbles cut at a height of 35 cm). The variety used for wheat was HD2733. The RDF (Recommended Fertilizer Dose) of wheat was 120:60:40 kg/ha (NPK) respectively. The spacing was maintained at 20 cm (R x R). Line sowing and by manual broadcasting was done as per the treatment and mixed it with a rotavator. Wheat cv. HD 2733 was sown on 2nd December in all the plots during 2021 all the treatments. A standardized nitrogen dose has been used in two parts: ½ only at planting time as basal and the other half two day's later as top dressing. Whole amount of $P_2O_5$ and $K_2O$ was applied as basal at the time of sowing. Pre-sown irrigation was applied for both seasons during 2021-2022. Common irrigation as per crop needs was applied based on moisture requirement status and crop development stages. The other management practices were adopted as per the recommendations of the crops. Rice stubbles were cut at different height i.e. 5, 20 and 35 cm from 25.11.2021 to 30.11.2021. During the trial meteorological data were suitable for normal growth of the crop. The harvesting of the wheat crop began on in the last week of April, 2022, when the crop reached maturity. Observations on the growth parameter and wheat yield were assessed on the basis of the produced recorded from the net plot (4 m × 3.4 m).The statistical analysis was carried out as described by Gomez and Gomez (1984).

**Growth parameter**

Crop emergence, plant height, the number of tillers per metre row length (mrl), dry matter accumulation, and crop growth rate (CGR) were all measured in each plot at 30, 60, 90, and 120 days after sowing (DAS), as well as at harvest.

$$CGR = \frac{W_2-W_1}{(T_2-T_1)\ P}$$

**Crop Growth Rate (CGR):** The amount of dry matter produced per area of land per unit time, as well as the crop growth rate (CGR), were calculated using the formula & expressed in g/m$^2$ /day.

Where,

$W_1$: weight of dry matter at time $t_1$

$W_2$: weight of dry matter at time $t_2$

P: Land area

Yield and Yield Parameters

Yield attributing parameters were recorded at physiological maturity. All these observations include effective tillers/m$^2$, length of spike (cm), No. of grains/ear, test weight (1000 grains in gm), biological yield (grain + straw) and harvest index (%).

$$\textbf{H.I.} = \frac{\text{Economic yield ( e.g. grain)}}{\text{Biological yield ( e.g. grain + straw)}} \times 100$$

$$= \frac{\text{Sink}}{\text{Source}} \times 100$$

## RESULTS AND DISCUSSION

**Growth Parameters**

Wheat plants grown with irrigation level at $I_5$ (irrigation at CRI +Maximum Tillering + Flowering + Dough Stage) showed maximum plant height as shown in (Table 1). 101.32 cm at harvest which was significantly superior to irrigation level at $I_1$ i.e. irrigation at CRI stage, $I_2$ i.e. irrigation at CRI + Boot stage and $I_3$ *i.e.,* irrigation at CRI+ Milk

**Table 3. Effect of rice stubble and irrigation scheduling on yield and yield attributes and harvest index(%)**

| TREATMENT | No. of effective tiilers/m² | Spike or ear length(cm) | No. of grains/ear | Test Weight (g) | Grain Yield(t/ha) | Straw Yield(t/ha) | Harvest Index (%) |
|---|---|---|---|---|---|---|---|
| **Irrigation scheduling (I)** | | | | | | | |
| $I_1$ - Irrigation at CRI Stage | 284.76 | 8.10 | 30.27 | 38.53 | 2.90 | 4.73 | 37.96 |
| $I_2$ –Irrigation at CRI+boot Stage | 319.03 | 8.67 | 33.91 | 39.07 | 3.25 | 5.29 | 38.14 |
| $I_3$ –Irrigation at CRI+ milk Stage | 332.45 | 9.04 | 35.34 | 39.55 | 3.38 | 5.48 | 38.20 |
| $I_4$ –Irrigation at CRI + late jointing + milk Stage | 384.84 | 10.10 | 40.91 | 40.32 | 3.92 | 6.27 | 38.47 |
| $I_5$ –Irrigation at CRI + maximum tillering+ flowering+ dough Stage | 392.92 | 10.15 | 41.77 | 40.48 | 4.00 | 6.32 | 38.77 |
| SEm(±) | 9.97 | 0.27 | 1.06 | 1.04 | 0.10 | 0.16 | 0.26 |
| LSD( $p$= 0.05) | 34.49 | 0.94 | 3.67 | NS | 0.35 | 0.57 | NS |
| Rice stubbles(R) | | | | | | | |
| $R_1$- Rice stubble cut at 5 cm height | 342.30 | 9.20 | 36.39 | 39.12 | 3.48 | 5.63 | 38.35 |
| $R_2$- Rice stubble cut at 20 cm height | 358.93 | 9.65 | 38.15 | 39.32 | 3.65 | 5.90 | 38.42 |
| $R_3$- Rice stubble cut at 35 cm height | 327.17 | 8.79 | 34.78 | 38.92 | 3.33 | 5.37 | 38.10 |
| SEm(±) | 9.11 | 0.25 | 0.97 | 0.80 | 0.09 | 0.15 | 0.25 |
| LSD ($p$= 0.05) | 27.27 | 0.74 | 2.90 | NS | 0.28 | 0.45 | NS |
| Interaction (IX R) | NS | NS | NS | NS | NS | NS | NS |

stage but statistically at par with $I_4$(100.91cm) i.e. irrigation at CRI +Late Jointing + Milk stage.This is probably due to increasing the number of irrigation at different growth stages, which maintained various metabolic processes due to the presence of adequate moisture in the soil. Saren *et al* (2004), Brahma *et al* (2007) and Kumar *et al* (2016a.) all reported significant reductions in plant height as a result of decreased irrigation levelsAt harvest, plant height was maximum at $R_2$, rice stubble cut at height 20 cm (96.36 cm) which was significantly superior to $R_3$, rice stubble cut at height 35 cm but was statistically at par with $R_1$, rice stubble cut at height 5 cm (91.85 cm) as demonstrated in (Table

1). It could be because the rice stubbles at $R_2$ could hold enough moisture, resulting in improved soil health and higher uptake of available nutrients from the soil.Familiar results has been reported by Davari *et al* (2012), Verma and Pandey (2013), Meena and Singh (2013) and Kumar *et al* (2016b.) where they revealed that highest plant height and maximum tillers per meter square under zero tillage sown with rice residue retention followed by zero tillage with residue burning in both years.

Plants irrigated at $I_5$ *i.e.,* irrigation at CRI +maximum tillering + flowering + dough stage produce a greater number of tillers/mrl at 60 DAS as shown in table 1. (88.58 tillers/mrl) which was significantly superior to $I_1$ *.i.e.* irrigation at CRI stage, $I_2$ .i.e. irrigation at CRI + Boot stage and $I_3$ .i.e. irrigation at CRI + milk stage but was statistically at par with $I_4$ (86.97 tillers/mrl) i.e. irrigation at CRI + late jointing stage + milk stage,which might be due to more availability of water on I5 irrigation application. In the sub-plot treatment, plants grown with rice stubbles cut at 20 cm height i.e. R2 produce more no. of tillers/mrl (81.79 tillers/mrl) at 60 DAScompared to other treatments and was significantly superior over $R_3$ .i.e. rice stubbles cut at height 35 cm but was statistically at par with $R_1$ *i.e.,* rice stubbles cut at height 5 cm (78.46 tillers/mrl) as demonstrated in (Table 1).It might be due to increased crop residue load on the soil surface or incorporation into the soil created an impervious layer enough to hinder crop germination and subsequently its initial growth. These findings were in agreement with Kumar *et al* (2005) where increasing the rice crop residue @ 6-7 t/ha reduces the emergence of wheat as compared to residue removal and burning of residues. Also due to mortality of lately formed non-effective tillers. Similar studies were made by Singh *et al* (2006b)

Maximum dry matter accumulation was recorded at harvest at $I_5$ (928.56 g/m$^2$) i.e. irrigation at CRI +maximum tillering + flowering + dough stage which was significantly superior than $I_1$ i.e. irrigation at CRI stage, $I_2$ i.e. irrigation at CRI + boot stage and $I_3$ i.e. irrigation at CRI + milk stage but was at par with $I_4$ *i.e.,* irrigation at CRI+ late jointing+ milk stage (861.09 g/m$^2$)as presented in (Table 2). Plant photosynthetic activity is heavily reliant on dry matter accumulation in leaves and leaf area. More dry matter accumulation in leaves allowed the photosynthetic area to remain active for a longer period of time, which is responsible for overall plant growth Plants grown with rice stubbles cut at height 20 cm i.e. $R_2$ produced more dry matter (828 g/m$^2$) as compared to other treatments at harvest which was superior than $R_3$ i.e. rice stubbles cut at height 35 cm but $R_2$ was statistically at par with $R_1$ (789.63 g/m$^2$) i.e. stubbles cut at height 5 cmas presented in (Table 2). Also, in $R_2$ (rice stubbles cut at a height of 20 cm), crop height was maximised, implying that the taller the plant, the greater the dry matter production. Thapa *et al* (2019) found that zero-tillage plots with residue retention had higher dry matter.

Highestcrop growth rate (g/m$^2$/day) was found at 90-120 DASat $I_5$, irrigation at CRI + maximum tillering +flowering + dough stage (12.04 g/m$^2$/day) which was significantly superior than irrigation at $I_1$i.e. irrigation at CRI stage, $I_2$ i.e. irrigation at CRI + boot stage and $I_3$ i.e. irrigation at CRI + milk stage but was statistically at par with $I_4$, i.e. irrigation at CRI+ late jointing+ milk stage (11.16 g/m$^2$/day) as presented in (Table 2).The reason for this was that as the number of irrigations increased, so did the positive effect of water on cell division, cell enlargement, elongation, photosynthetic accumulation, and proper translocation. These findings in terms of growth parameters in the present investigation also finds support from the works of Yadav and Verma (1989), Bhan *et al* (1990) and Deshmukh *et al* (1992). In case of sub-plot treatment, maximum crop growth rate was recorded at 90-120 DAS at $R_2$, rice stubbles cut at height 20 cm (10.73 g/m$^2$/day) which was significantly superior than $R_3$ i.e. rice stubbles cut at height 35 cm but was statistically at par with $R_1$ i.e. rice stubbles cut at height 5 cm (10.24 g/m$^2$/day) shown in the (Table 2). This might be due to residue retention in case of rice stubbles and $R_2$ shows more nutrient uptake due to better moisture availability which might have showed increased organic carbon and increased microbial population and infiltration rate, resulting in more favourable conditions for crop growth and development. This result is similar with the findings of Jat *et al* (2013); Ronanki and Behera (2018). But in case of $R_3$ (rice stubbles cut at height 35 cm), due to excess moisture holding in the root zone, temperature decreases which creates an anaerobic condition and slows down the uptake of nutrients due to slow metabolic processes.

**Yield and Yield Attributes**

The maximum number of effective tillers $m^2$ (392.92 tillers/$m^2$), length of spike (10.15 cm), and number of grains/ear (41.77 grains/ear) were obtained at $I_5$ (irrigation at CRI +maximum tillering + flowering + dough Stage), which was comparable to $I_4$ (irrigation at CRI+ Late Jointing+ Milk Stage), and showed significant superiority over $I_1$ (irrigation at CRI), $I_2$ (irrigation at CRI + boot stage), and $I_3$ (irrigation at CRI + milk stage) as described in the (Table 3). The test weight, on the other hand, was not significantly affected by irrigation scheduling treatment. Thus, under maximum irrigation level obtained with $I_5$ (irrigation at CRI +maximum tillering + flowering + dough Stage), this was favourable environment for vegetative growth and development resulted in a greater number of yield attribute characters. This finding was similar to those of Shivani *et al* (2001), Saren *et al* (2004) and Brahma *et al* (2007).Except for the test weight, which is not significant in the case of rice stubbles, all other yield attributes such as number of effective tillers $m^2$ (358.93 tillers/$m^2$) length of spike (9.65 cm), and numbers of grains/ear (38.15) were significantly influenced by rice stubbles as demonstrated in the (Table 3).

Under $R_2$ (rice stubbles cut at height 20 cm) all the yield attributing characters were maximum. The might be due to proper translocation of nutrients and availability of moisture. This results correlates with Tripathi *et al* (2015) reported that the number of grains per spike were found in zero-tillage wheat with full residue retention, followed by zero-tillage wheat without residue, and were lowest in conventional tillage wheat with full residue incorporation.

$I_5$ (irrigation at CRI + maximum tillering + flowering + dough Stage) produced the highest grain yield (4 t/ha) and straw yield (6.32 t/ha) as shown in the (Table 3). This could be attributed to adequate moisture availability, which contributed to improved growth parameters and yield characteristics. Irrigation at CRI ($I_1$) produced the lowest grainyield (2.90 t/ha)due to a lack of moisture during the growth period, which reduced yield attributes and resulted in low grain and straw yield. Kumar *et al* (2016a) and Ahmad *et al* (2016) all reported similar findings. $R_2$ grain (3.65 t/ha) and straw yield (5.90 t/ha) was significantly higher than $R_3$ in sub-plot treatment and was at par with $R_1$ as shown in the table 3, because the number of tillers was higher in $R_2$ treatment. Yadav *et al* (2005) reported similar findings.

## CONCLUSION

Irrigation at CRI +maximum tillering + flowering + dough Stage ($I_5$) was found to be optimal for the wheat crop when all growth parameters, yield attributes, and yield were considered. In case of rice stubbles, rice stubbles cut at height 20 cm ($R_2$) above the ground level produced maximum grain and straw yield which was superior over $R_1$ (Rice Stubble cut at height 5 cm) and $R_3$ (Rice Stubble cut at height 35 cm).

## REFERENCES

Ahmad A (2016). Water use efficiency, consumptive use and soil moisture extraction pattern of wheat as influenced by irrigation schedules and genotypes. *Agric Update* **11**(1): 12-15.

Bhan S C, Bishnoi O P and Rau V U M (1990). Influence of water stress in wheat crop yield. *Mausam* **41**: 593-596.

Brahma R, Janawade A D and Palled Y B (2007).Effect of irrigation schedules, mulch and antitranspirant on growth, yield and economics of wheat. *Karnataka J Agric Sci* **20** (1): 6-9.

Chaturvedi G S, Aggarwal P K, Singh A K, Joshi M J and Sinha S K (1980-1981). Effect of irrigation on tillering in wheat, triticale and barley in a water-limited environment. *Irrigation Sci* **2**: 225-235.

Davari M R, Sharma S N and Mirzakhani M (2012).The effect of combinations of organic materials and biofertilisers on productivity, grain quality, nutrient uptake and economics in organic farming of wheat. *J Organic Systems* **7**(2): 26-35.

Desmukh S V, Mulay A S and Kale G M (1992). Effect of deletion of irrigation at critical growth stages on grain yield of late sown wheat in Vidharba. *Indian J Agron* **37**:47-48.

Gomez K A and Gomez AA (1984). *Statistical Procedures for Agricultural Research* (2nd edition). *John Wiley and Sons, New York*, 680p.

Jat M L, Gathala M K, Saharawatd Y S, Tetarwale J P, Gupta Raj and Singh Yadvinder (2013). Double no-till and permanent raised beds in maize–wheat rotation of north-western Indo-Gangetic plains of India: Effects on crop yields, water productivity, profitability and soil physical properties. *Field Crops Resilience***149**: 291–299.

Krishnamurthy K, Bommegouda A, Venugopal N, Jagannath M K, Raghunath C and Rajshekhar B G (1973). Investigation of the varietal differences in the growth components of maize. *MJAS***7**: 377-384.

Kumar A, Nand V and Kumar R (2016a). Effect of different levels of irrigation under integrated nutrient management (INM) on wheat (*Triticum aestivum* L.) for central plain agro climatic zone of Utter Pradesh, India. *Pl Archives* **16** (1): 395-398.

Kumar A, Nand V and Kumar R (2016a). Effect of different levels of irrigation under integrated nutrient management (INM) on wheat (*Triticum aestivum* L.) for central plain agro climatic zone of Utter Pradesh, India. *Pl Archives* **16**(1): 395-398.

Kumar S D, Pandey D S and Rana N C (2005). Economics and yield potential of wheat (*Triticum aestivum*) as affected by tillage, rice (*Oryza sativa*) residue and nitrogen management options under rice-wheat system. *Indian J Agron* **50**: 102-105.

Meena B L and Singh R K (2013). Response of wheat (*Triticum aestivum*) to rice (*Oryza sativa*) residue and weed management practices. *Indian J Agron* **58**(4): 521-524.

Ronanki S, Behera U K, Shivay Y S, Pandey R N, Kumar S N and Pandey R (2018). Effect of conservation agricultural practices and nitrogen management on growth, physiological indices, yield and nutrient uptake of soybean (*Glycine max*). *Indian J Agron* **63**(1): 33-37.

Saren B K, Dey S and Mandal D (2004). Effect of irrigation and sulphur on yield attributes, productivity, consumptive use, and consumptive use efficiency of wheat (*Triticum aestivum*). *Indian J Agric Sci* **74**(5): 257-261.

ShivaniVerma V N, Pal S K, Thakur R and Kumar S(2001). Production potential and water use efficiency of wheat *(Triticum aestivum*) cultivars under different dates of seeding and irrigation levels. *Indian J Agron* **46**(4):659-664.

Singh R and Yadav D S(2006b). Effect of rice (*Oryza sativa*) residue and nitrogen on performance of wheat (*Triticuma estivum*) under rice-wheat cropping system. *Indian J Agron* **51**(4): 247-250.

Thapa B, Khanal B R and Marahatta S(2019).Effect of conservation agriculture on yield and yield attributing properties of wheat. *Adv Plants Agric Res* **9**(2): 329-335.

Tripathi S C, Chander S and Meena R P (2015). Effect of residue retention, tillage options and timing of nitrogen application in rice-wheat cropping system. *SAARC J. Agric* **13** (1): 37-49.

Watson D J (1952).The physiological basis of variation in yield. *Adv Agron* **6**: 103-109.

Yadav D S, Shukla R P and Sushant (2005). Effect of zero tillage and nitrogen level on wheat ( *Triticuma estivum*) after rice. *Indian J Agron* **50** (1):52-53.

Yadav G L and Verma J K (1989).Effect of irigation regime, nitrogen and zinc fertilization on growth and yield of late sown wheat. *Indian J Agron* **36** (1):50-53.

*Received on 23/12/2022* *Accepted on 18/4/2023*