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# Root and growth indices under sowing method and irrigation scheduling of (*Triticum aestivum* L.) wheat crop in eastern UP

**Devendra Pal Singh, Rajesh Kumar, Ankit Kumar and Ravi Verma**

**Abstract**
The experiment was conducted at Agronomy Research Farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya (U.P.) during *Rabi* season of 2019-20 and 2020-21. The experiment was laid out in split plot design having three Sowing methods *i.e.* $M_1$: Conventional (Sowing after cleaning of residue), $M_2$: Sowing with happy seeder and $M_3$: Sowing after residue incorporation were allotted as main plot and three irrigation schedules *i.e.* $I_1$: 03 Irrigation (CRI, LJ and milking stage), $I_2$: 04 Irrigation (CRI, Tillering, LJ and milking stage), $I_3$: 05 Irrigation (CRI, Tillering, LJ, Milking and dough stage) kept as sub plot. The experiment was replicated three times on silty loam in texture soil and medium in fertility status having pH (8.32 and 8.26), organic carbon (0.31 and 0.32%), EC (0.28 and 0.30) $dsm^{-1}$.The highest value of root studies was recorded under Sowing method $M_2$ compared to other. However, in irrigation schedules highest value observed under $I_2$ was compared to other treatment level at 60 DAS. The maximum significant value was under observed treatment $M_2$ in sowing method and $I_3$ in irrigation scheduling with the rest of other treatment.

**Keywords:** Agronomy research farm, root and growth indices, *Triticum aestivum*, wheat crop

## Introduction
Wheat (*Triticum aestivum* L.) is one of the principal cereal crops grown worldwide and one of the important staples of world population. Wheat is the major staple food crop, providing almost half of all calories in the region of North Africa and Central Asia.

It rank first in the world among the cereal both area (223.40 m ha) and production (778.60 mt) and the average productivity 3490 kg $ha^{-1}$ (Anonymous, 2022) [1]. The major wheat cultivated countries are China, India, Pakistan Russian Federation, USA, and Australia. In India, it is cultivated on an area of 31.62 million hectare having productions of 109.52 million tones with average productivity of 3460 kg $ha^{-1}$. Uttar Pradesh rank first with respect to area 9.77 million hectare and production 34.66 million tones the productivity is much lower 3480 kg $ha^{-1}$ as compared than Punjab and Haryana 4.50 tones $h^{-1}$ (Anonymous, 2022) [11].

In India wheat is ground to prepare flour which is mainly consumed after preparing leavened bread (chapatti). Its flour is also used to prepare fried chapatti called puris and paratha. In addition to this, wheat is also consumed in various other preparations such as Dalia, halwa, sweat meat etc. One of the most important uses of wheat is to manufacture flour to prepare baking bread, pastry, biscuits etc. Wheat straw makes an important fodder, while by-product of wheat flour mills particularly bran is used as feed. Amongst the industrial uses of wheat the production of starch for paper industry is important. Rice-wheat sequential cropping is becoming increasingly popular cropping system in this tract. Long-term studies being carried out at several locations in different cropping systems indicated that application of all the needed nutrients through chemical fertilizers has deleterious effect on soil fertility leading to unsustainable yields**.** Integrating chemical fertilizers with organic manures has been found to be quite promising not only in maintaining higher productivity but also in providing greater stability in crop production (Nambiar *et al.*, 1992) [5]. Crop residues are important natural resources, and their effective recycling improves the soil physical, chemical and biological properties. On the basis of reported research results by different researchers, an analysis has been made that a rice-wheat sequence that yields 4 t $ha^{-1}$ of rice and 3 t $ha^{-1}$ of wheat removes more than 280 kg N, 26 kg P and 245 kg K $ha^{-1}$ from the soil; the residues of rice and wheat amount to as much as 6-11 t $ha^{-1}$ $yr^{-1}$.

Crop residues are good sources of plant nutrients and are important components for the stability of agricultural ecosystems. About 400 million tons of crop residues are produced in India alone. In areas where mechanical harvesting is practiced, a large quantity of crop residues are left in the field, which can be recycled for nutrient supply. About 25% of nitrogen (N) and phosphorus (P), 50% of sulphur (S), and 75% of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources. Scheduling of irrigation based on phonological stages (crown root, tillering, booting, anthesis, soft dough and hard dough stage) in wheat has been practical approach to the farmers

**Material and methods**

A field experiment was conducted during the winter season (Rabi) 2019-20 and 2021 at agronomy research farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (UP). This site has subtropical region Indo-Gangatic plains and situated at 26.49$^0$N latitude 82.29$^0$E longitude at an altitude of 113 meters from mean sea level under sub-tropical and sub-humid region. The region receives a mean annual rainfall of about 998 mm. It is extremely hot and dry in summer, having maximum temperature ranging between 39.5 to 39.8 $^0$C and 39.9 to 36.2$^0$C during the month of May. The winters are cold and frosty. The experiment was laid out in split plot design having three Sowing methods *i.e.* $M_1$: Conventional (Sowing after cleaning of residue), $M_2$: Sowing with happy seeder and $M_3$: Sowing after residue incorporation were allotted as main plot and three irrigation schedules *i.e.* $I_1$: 03 Irrigation (CRI, LJ and milking stage), $I_2$: 04 Irrigation (CRI, Tillering, LJ and milking stage), $I_3$: 05 Irrigation (CRI, Tillering, LJ, Milking and dough stage) kept as sub plot. The experiment was replicated three times on silty loam in texture soil and medium in fertility status having pH (8.2 and 8.1), organic carbon (0.32 and 0.40%), EC (0.24 and 0.29 dsm$^{-1}$), available nitrogen (136.5 and 158.7 kg ha$^{-1}$), available phosphorus (14.5 and 21.3 kg ha$^{-1}$) and available potassium (262 and 269 kg ha$^{-1}$). The wheat variety of 'NW-5054' was sown 4 × 5 m under experimental plot sizewith recommended dose of fertilizer 120 kg ha$^{-1}$ nitrogen, 60 kg ha$^{-1}$ phosphorus and 40 kg ha$^{-1}$ potassium was applied in the form of Urea, single super phosphate and Muriate of potash, respectively. Half dose of nitrogen and full doses of $P_2O_5$ and $K_2O$ were applied as basal dressing. Remaining half dose of nitrogen through urea was top dressed in two equal doses after first and second irrigation.

**Crop growth rate (g m-2 day)**

It was worked out by the following formula expressed as (g m-2 day) described by Watson (1947).

$$CGR = \frac{W2 - W1}{t2 - t1}$$

Where,

$W_1$and $W_2$ were dry weight of plant in g m-$^2$ at the time $t_l$ and $t_2$respectively.

**Relative growth rate (gg$^{-1}$/day$^{-1}$)**

Itwas computed by using the formula given below and expressed as gg$^{-1}$/day$^{-1}$ (Rad Ford, 1967).

$$RGR = \frac{Loge\ W2 - Loge\ W1}{t2 - t1}$$

Where,

W1andW2aretheplantdryweightattimet1andt2respectively.

**Net assimilation rate (g m$^{-2}$ day$^{-1}$)**

It is the rate of dry weight increase per unit leaf area per unit time (g m$^{-2}$ day$^{-1}$) and was calculated as suggested by Gregory (1926). It is increase in dry weight of plant per unit leaf area per unit time with the help of following formula:

$$\text{NAR} = \frac{(Loge\ W2 - Loge\ W1)(Loge\ L2 - Loge\ L1)}{(t2 - t1)(L2 - L1)}$$

Where,

Its Loge, $W_1$and $W_2$ are dry weight of the plant (g) and Loge, $l_2$ $l_1$ are total leaf area (cm$^2$) of the plant at the time $t_1$and $t_2$respectively

**Leaf Area Duration LAD (Days)**

To correlate the dry matter yield with LAI, integrated the LAI with time and called as Leaf Area Duration. LAD takes account, both the duration and extent of photosynthetic tissue of the crop canopy. The LAD express in days.

$$\text{LAD} = \frac{\text{LAI1} + \text{LAI2}}{2} \times (\text{t2} - \text{t1})$$

**Result and discussion**

The data pertaining to root studies are length, fresh weight and dry weight of root at 90 day after sowing are summarized in table -1. This data are significantly influence through sowing methods along with irrigation scheduling on wheat crop. In sowing method was maximum value is root length (50.17 and 51.20 cm), fresh weight of root (43.47 and 45.60 g) and dry weight of root (2.90 and 3.04 g) under observed treatment Sowing with happy seeder $M_2$ and which at par with Sowing after residue incorporation $M_3$ and rest of other treatment. In irrigation scheduling was maximum value is root length (50.67 and 51.73 cm), fresh weight of root (43.70 and 45.35 g) and dry weight of root (2.91 and 3.03 g) under observed treatment 05 Irrigation (CRI, Tillering, LJ, Milking and dough stage$I_3$ and which at par with 4 Irrigation (CRI, Tillering, LJ and milking stage$I_2$ and rest of other treatment. The same result were recorded by Atikullah *et al*. (2014) [2].

**Table 1:** Effect of sowing method and scheduling irrigation on root studies at 90 DAS of wheat

| Treatment | Root length (cm) | | Root fresh weight (g) | | Root dry weight (g) | |
|---|---|---|---|---|---|---|
| | 90 DAS | | 90 DAS | | 90 DAS | |
| | 2019-20 | 2020-21 | 2019-20 | 2020-21 | 2019-20 | 2020-21 |
| **Sowing methods** | | | | | | |
| $M_1$ | 44.00 | 44.83 | 37.89 | 39.16 | 2.53 | 2.61 |
| $M_2$ | 50.17 | 51.20 | 43.47 | 45.60 | 2.90 | 3.04 |

| | | | | | | |
|---|---|---|---|---|---|---|
| $M_3$ | 48.40 | 49.40 | 42.08 | 43.47 | 2.81 | 2.90 |
| SEm± | 1.170 | 1.240 | 0.964 | 1.038 | 0.070 | 0.078 |
| C.D. at 5% | 4.592 | 4.868 | 3.786 | 4.078 | 0.273 | 0.308 |
| **Irrigation schedules** | | | | | | |
| $I_1$ | 44.67 | 45.57 | 38.66 | 40.19 | 2.58 | 2.68 |
| $I_2$ | 47.23 | 48.13 | 41.09 | 42.70 | 2.74 | 2.85 |
| $I_3$ | 50.67 | 51.73 | 43.70 | 45.35 | 2.91 | 3.03 |
| SEm± | 1.028 | 0.983 | 0.909 | 0.985 | 0.060 | 0.059 |
| C.D. at 5% | 3.167 | 3.029 | 2.802 | 3.035 | 0.184 | 0.182 |

The data pertaining to growth indices are crop growth rate (g $m^{-2}$ $day^{-1}$), relative growth rate (mg $g^{-1}$ $day^{-1}$), net assimilation rate (g $m^{-2}$ $day^{-1}$) and leaf area duration in days at 90 day after sowing are summarized in table -2. This data are significantly influence through sowing methods along with irrigation scheduling on wheat crop. In sowing method was maximum value is CGR (15.97 and 16.04), RGR (28.77 and 27.73) NAR (3.70 and 3.66) and LAD (145.45 and 148.55) under observed treatment Sowing with happy seeder $M_2$ and which at par with Sowing after residue incorporation $M_3$ and rest of other treatment. In irrigation scheduling was maximum value is CGR (16.02 and 16.17), RGR (28.06 and 26.86) NAR (3.65 and 3.61) and LAD (146.55 and 149.70) under observed treatment 05 Irrigation (CRI, Tillering, LJ, Milking and dough stage$I_3$ and which at par with 4 Irrigation (CRI, Tillering, LJ and milking stage $I_2$ and rest of other treatment. The same result was reported by Kumar *et al*. (1994b, Kumar *et al*. (2017) [3, 4].

**Table 2:** Effect of sowing method and scheduling irrigation on growth indices at 90 DAS of wheat

| Treatment | CGR (g $m^{-2}$ $day^{-1}$) | | RGR (mg $g^{-1}$ $day^{-1}$) | | NAR (g $m^{-2}$ $day^{-1}$) | | Leaf area duration (in Days) | |
|---|---|---|---|---|---|---|---|---|
| | 60-90 DAS | | 60-90 DAS | | 60-90 DAS | | 60-90 DAS | |
| | 2019-20 | 2020-21 | 2019-20 | 2020-21 | 2019-20 | 2020-21 | 2019-20 | 2020-21 |
| **Sowing methods** | | | | | | | | |
| $M_1$ | 15.67 | 15.82 | 23.99 | 22.76 | 3.30 | 3.27 | 127.40 | 130.00 |
| $M_2$ | 15.97 | 16.12 | 28.77 | 27.73 | 3.70 | 3.66 | 145.45 | 148.55 |
| $M_3$ | 15.89 | 16.04 | 25.00 | 24.16 | 3.40 | 3.37 | 140.55 | 143.45 |
| SEm± | 0.442 | 0.482 | 0.806 | 0.580 | 0.076 | 0.076 | 3.032 | 3.380 |
| C.D. at 5% | 1.734 | 1.893 | 3.166 | 2.277 | 0.300 | 0.299 | 11.906 | 13.270 |
| **Irrigation schedules** | | | | | | | | |
| $I_1$ | 15.71 | 15.86 | 23.95 | 23.10 | 3.29 | 3.26 | 129.55 | 132.20 |
| $I_2$ | 15.80 | 15.95 | 25.75 | 24.69 | 3.46 | 3.42 | 137.30 | 140.10 |
| $I_3$ | 16.02 | 16.17 | 28.06 | 26.86 | 3.65 | 3.61 | 146.55 | 149.70 |
| SEm± | 0.349 | 0.329 | 0.571 | 0.588 | 0.077 | 0.074 | 3.000 | 3.265 |
| C.D. at 5% | 1.076 | 1.015 | 1.758 | 1.812 | 0.239 | 0.229 | 9.245 | 10.062 |

## Conclusion

The maximum root development were recorded in sowing method of Sowing with happy seeder and in irrigation scheduling in 05 Irrigation (CRI, Tillering, LJ, Milking and dough) stage. The value of CGR, RGR, NAR, LAD was significantly superior in Sowing with happy seeder fallowed by $M^3$ and $M^1$ along with (I3) 05 Irrigation CRI, Tillering, LJ, Milking and dough stage of scheduling irrigation for growth indices of wheat with timely sown condition in eastern up.

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