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# Effect of Tillage, Time of First Irrigation and Nitrogen Management on Wheat Under Rice-Wheat Cropping System

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***ABSTRACT:*** *A field experiment was conducted at Crop Research Centre of G.B. Pant University of Agriculture & Technology, Pantnagar, for three consecutive* rabi *seasons of years 2001, 2002 and 2003, to find out the suitable tillage practices, time of first irrigation and nitrogen doses for wheat crop grown under rice-wheat cropping system. The experiment was conducted in split plot design, where three tillage practices* viz. *conventional tillage, zero tillage with rice residue retention and zero tillage with rice residue burning were kept in main plot. Sub plot contained time of first irrigation given at 10, 20 and 30 days after sowing. Sub plot contained three doses of nitrogen i.e. 120, 150 and 180 kg/ha. Results revealed that maximum wheat growth and yield was obtained with rice residue retention under zero tillage. First irrigation at 20 days after sowing resulted in significantly higher grain yield. Application of 180 kg N/ha had maximum growth and yield attributing characters and grain yield which all were at par with nitrogen dose of 150 kg /ha. Nitrogen uptake by wheat was highest with residue burning in zero tillage, first irrigation at 20 days after sowing and 180 kg/ha of nitrogen application. From the overall study it is recommended to growing wheat crop in zero tillage system with previous rice residue retention and irrigating for first time at 20 DAS with application of 150 kg/ha nitrogen is the best practice in terms of crop growth, yield and monetary return.*

***Key words****: Tillage practices, Time of first irrigation, Nitrogen doses, Wheat.*

## INTRODUCTION

Wheat (*Triticum aestivum*) is a major contributor in food security system of the country, occupying nearly 27.7 million hectare and producing 74.9 million tones yield [1]. Based on the present population growth rate (1.5% per annum) and per capita consumption of 180 g of wheat per day in the country, the demand for wheat is expected to be around 109 MT by 2020 [2]. Wheat grown in rotation with rice is the major crop sequence for the Indo- Gangetic plains and this system has been proved a boon for national food security, but badly taxing the two most important natural resources i.e. soil and water [3], which resulted to stagnate wheat yield of the system. Farmers started zero tillage wheat sowing after combine harvesting of rice for time saving for field preparation and cost saving of wheat production. Earlier they practiced zero tillage after partial or complete burning of rice straw to facilitate seed-bed preparation and to avoid possible yield losses of wheat but the residue burning causes nutrient and resource loss and adversely affects soil properties, thus calling attention for proper residue management [4]. On the other hand saving in irrigation water in rice-wheat cropping system is challenging issue because of rapid depletion of ground water and constant recession in the water table. Zero tillage save water approximately 10 cm/ha, or 1 million l/ha and this savings are generally reported for the first irrigation [5]. Chemical fertilizer especially nitrogen is still the main components for meeting the increased crop nutrient needs of the country. Thus the changing scenario for wheat growing condition needs an understanding of the responses of wheat in respect to tillage practices, time of first irrigation and nitrogen doses. To find out the effect of these three components of wheat production, this investigation was undertaken at *tarai* region of Uttaranchal.

## MATERIALS AND METHODS

A field experiment was conducted during the *rabi* season of 2000-2001, 2001-02 and 2002-2003 at Crop Research Center of G.B Pant University of Agriculture & Technology, Pantnagar on a silty clay loam soil (Typic Hapludolls), having organic carbon 1.21%,

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available N 224 kg/ha, Olsens P 29 kg/ha, and available K 240 kg/ha, bulk density 1.43 Mg/$m^3$. Rice crop var. Pant Dhan -4 was sown previous to wheat crop during all the years and recommended package and practices were followed in rice crop. Average yield of rice crop was 4.58 Mg/ha, 5.1 Mg/ha, 5.3 Mg/ha during 2000-01, 2001-02, 2002-03 respectively. In wheat, the experiment was conducted in split split plot design with four replications, where tillage practices viz conventional tillage, zero tillage (with rice residue retention) and zero tillage (with rice residue burning) were kept in main plot; three irrigation treatments viz. first irrigation at 10, 20 and 30 days after sowing were kept in sub-plots; and three nitrogen doses i.e 120, 150 and 180 kg/ha were kept in sub-sub-plot. Under zero tillage wheat sowing plots , rice crop was harvested by combine, however in case of conventional tillage plots hand harvesting of rice crop was done, burning of crop residue was done in desired plot. The seed of variety PBW-343 was sown @ 100 kg/ha in the first week of November during all the years. The sowing was done by the seed drill in conventional tillage plot and zero-till cum ferti-seed drill in zero tillage plots. The row to row spacing of 21 cm was maintained. Nitrogen (as per treatment), $P_2O_5$ (60 kg/ha) and $K_2O$ (40 kg/ha) were applied. The sources of N, P and K were urea, diammonium phosphate and muriate of potash. Half dose of N was applied at the time of sowing and rest half dose of nitrogen was top dressed after first irrigation. Irrigation after first irrigation was given at 0.9 IW/CPE (Irrigation depth was 6 cm and CPE was recorded from meteorological observatory). Crop was harvested in first week of April during all the years. Grain yield and N uptake were recorded during all the three years but the yield contributes were recorded only during 2001-02 and 2002-03. The statistical analysis was done following the method given in Steel and Torrie [6] for Split-split plot design.

## RESULTS AND DISCUSSION

### Effect of tillage

Different growth parameters of wheat crop were found to be significantly affected with various treatments (Table 1). Zero tillage with residue retention produced significantly taller plants, more leaf area index, dry matter, chlorophyll content and highest rate of photosynthesis, however it was found to be on par with conventional tillage practices in respect of plant height and leaf area index. Highest nitrogen uptake by plant was also observed in zero tillage with residue retention which was 2.65 and 12.33 percent more over conventional tillage and zero tillage with residue burning, respectively. In respect of yield attributing characters, zero tillage with residue retention was found responsible for higher values of these attributes which reflects its effect on grain yield also which was 7.11 and 14.10 percent higher over conventional tillage and zero tillage with residue

**Table 1**
**Effect of tillage practices, time of first irrigation and nitrogen doses on yield contributing characters and Nitrogen uptake of wheat crop (pooled of three years)**

| *Treatment* | *Plant height at 90 DAS (cm)* | *Leaf Area Index at 90 DAS* | *Dry matter at harvest ($g/m^2$)* | *Chlorophyll content (SPAD reading) at 90 DAS* | *Rate of Photosynthesis ($\mu$ moles $cm^{-2}$ $s^{-1}$) at 90 DAS* | *Nitrogen uptake (Kg/ha)* |
|---|---|---|---|---|---|---|
| ***Tillage Practices*** | | | | | | |
| Conventional tillage | 85.30 | 3.81 | 1124.60 | 42.66 | 15.95 | 153.05 |
| ZT with residue retention | 88.58 | 4.05 | 1219.60 | 44.70 | 18.57 | 157.10 |
| ZT with residue burning | 75.88 | 3.19 | 1034.52 | 38.98 | 16.22 | 139.85 |
| C.D. (0.05 ) | 7.24 | 0.21 | 85.00 | 2.68 | 1.74 | 11.75 |
| ***Time of first Irrigation*** | | | | | | |
| 10 DAS | 83.50 | 3.79 | 1163.80 | 42.84 | 15.66 | 156.75 |
| 20 DAS | 85.65 | 4.11 | 1193.27 | 42.35 | 17.65 | 158.90 |
| 30 DAS | 80.60 | 3.26 | 1022.45 | 41.14 | 17.42 | 139.20 |
| C.D. (0.05 ) | 4.97 | 0.34 | 103.45 | NS | NS | 11.75 |
| ***Nitrogen doses*** | | | | | | |
| 120 kg/ha | 77.28 | 3.31 | 1001.29 | 37.06 | 15.30 | 140.45 |
| 150 kg/ha | 85.35 | 3.84 | 1168.25 | 43.31 | 16.91 | 149.25 |
| 180 kg/ha | 87.12 | 4.01 | 1209.18 | 45.56 | 18.52 | 157.50 |
| C.D (0.05) | 7.84 | 0.48 | 161.55 | 2.10 | 1.28 | 11.75 |

(ZT- Zero tillage, DAS – Days after sowing).

burning, respectively. However in case of number of effective tillers, spiklets per spike and grains per spike, it was found to be on par with conventional tillage. These findings of tillage practices might be due to the various favorable factors under zero tillage with residue retention. Zero tillage facilitate advancing the sowing dates, proper seed placement and availability of high moisture, which might have helped the crop for better yield contributing characters and yield. Residue retention may also increase infiltration rate, soil organic matter which facilitate easy nutrient availability to the plants, resulted better plant growth and development and yield. These results confirmed by the findings of Kumar and Yadav [7]. Zero tillage with residue retention also produced numerically highest gross and net return and B:C ratio which were 830.30 USD, 579.10 USD and 2.31, respectively.

**Effect of time of first irrigation**

All the growth attributes were found to be significantly higher with irrigating the crop firstly at 20 DAS over giving the first irrigation at 30 DAS, except chlorophyll content and rate of photosynthesis, where no one treatment showed the noticeable difference. However in case of plant height, leaf area index, plant dry matter and nitrogen uptake, irrigating the crop for first time at 10 DAS and 20 DAS were found to be on par with each other. Irrigating crop for first time at 20 DAS also proved its superiority on various yield attributing characters and yield also, where it produced significantly higher seed yield of 4.27 t/ha which was 5.17 and 7.83 percent higher over irrigation at 10 DAS and 30 DAS, respectively. However it was found unable to produce significant effect on spiklets per spike and 1000 grain weight. This might be due to the proper moisture is provided at the most water critical growth stage i.e. CRI by irrigating the crop at 20 DAS, which reflects all its advantages in growth, development and yield of crop. Similar results were also be noticed by Hussain *et al* [8]. Highest gross return (810.35 USD), net return (551.78 USD) and B:C ratio (2.13) were recorded in irrigating the wheat crop for first time at 20 DAS.

**Effect of nitrogen levels**

Application of nitrogen with the rate of 180 kg/ha was produced all the growth attributes significantly higher over 120 kg N per hectare, however the values of these parameters were statistically equivalent with the application of 150 kg/ha nitrogen except the rate of photosynthesis. There was not found the significant difference on various yield attributing characters and yield of wheat crop with 180 and 150 kh/ha nitrogen application. However, both these doses produced all these attributes significantly higher over application of 120 kg/ha nitrogen. These results might be due to the fact that crop responses to N fertilization which not only increases plant shoot and root growth but also increases yield contributing characters and finally yield and nutrient uptake. These results are in close agreement with findings of Ali *et al*. [9] and Gupta *et al*. [10]. The gross return and net return obtained from 150 kg/ha and 180 kg/ha nitrogen has no wide difference. Though these values were higher in application of 180 kg/ha nitrogen, the highest B:C ratio (2.03) was observed in application of 150 kg/ha nitrogen.

**Table 2**
**Effect of tillage practices, time of first irrigation and nitrogen doses on yield attributing characters and grain yield of wheat crop (pooled of three years)**

| *Treatment* | *Effective tillers/m²* | *Fertile Spikelets/spike* | *Grains/spike* | *Grain weight (g) / Spike* | *1000 grain weight (g)* | *Grain yield (t/ha)* |
|---|---|---|---|---|---|---|
| ***Tillage Practices*** | | | | | | |
| Conventional tillage | 293.50 | 18.30 | 49.05 | 1.84 | 37.55 | 4.08 |
| ZT with residue retention | 315.50 | 18.95 | 49.90 | 1.96 | 39.35 | 4.37 |
| ZT with residue burning | 276.50 | 16.80 | 45.30 | 1.72 | 37.30 | 3.83 |
| C.D (P=0.05) | 23.55 | 1.185 | 3.535 | 0.05 | 0.63 | 0.16 |
| ***Time of First Irrigation*** | | | | | | |
| 10 DAS | 287.00 | 17.90 | 47.85 | 1.83 | 38.20 | 4.06 |
| 20 DAS | 312.50 | 18.30 | 50.10 | 1.91 | 38.30 | 4.27 |
| 30 DAS | 285.50 | 18.05 | 46.4 | 1.79 | 37.70 | 3.96 |
| C.D (P = 0.05) | 19.50 | NS | 2.965 | 0.115 | NS | 0.12 |
| ***Nitrogen Doses*** | | | | | | |
| 120 kg/ha | 277.00 | 17.10 | 44.65 | 1.76 | 37.25 | 3.96 |
| 150 kg/ha | 297.50 | 18.25 | 49.05 | 1.88 | 38.55 | 4.12 |
| 180 kg/ha | 304.50 | 18.60 | 50.30 | 1.88 | 38.35 | 4.17 |
| C.D (P = 0.05) | 18.90 | 1.02 | 3.86 | 0.065 | 1.10 | 0.115 |

**Table 3**
**Effect of tillage practices, time of first irrigation and nitrogen doses on economics of wheat crop (mean of three years)**

| *Treatment* | *Gross return* | *Cost of cultivation* | *Net return* | *B : C Ratio* |
|---|---|---|---|---|
| ***Tillage Practices*** | | | | |
| Conventional tillage | 776.15 | 293.30 | 482.85 | 1.65 |
| ZT with residue retention | 830.30 | 251.20 | 579.10 | 2.31 |
| ZT with residue burning | 727.70 | 231.20 | 496.50 | 2.15 |
| ***Time of First Irrigation*** | | | | |
| 10 DAS | 771.40 | 258.57 | 512.83 | 1.98 |
| 20 DAS | 810.35 | 258.57 | 551.78 | 2.13 |
| 30 DAS | 751.45 | 258.57 | 492.88 | 1.91 |
| ***Nitrogen Doses*** | | | | |
| 120 kg/ha | 751.45 | 254.56 | 496.89 | 1.95 |
| 150 kg/ha | 782.80 | 258.57 | 524.23 | 2.03 |
| 180 kg/ha | 792.30 | 262.58 | 529.72 | 2.02 |

It was concluded from the experiment that residue retention under zero tillage responded more as compared to conventional tillage and residue burning under zero tillage in respect to wheat yield and yield contributing characters. First irrigation at 20 days after sowing responded maximum as compared to 10 and 30 days after sowing. Wheat crop responded up to the application of nitrogen @ 180 kg /ha but the application of 150 kg N/ha gave statistically similar grain yield, hence there is no need of increasing the nitrogen dose.

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