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Tillage, irrigation and nitrogen management on plant height, dry matter, bulk density and soil pH after wheat harvest. Yield and protein content of wheat (*Triticum aestivum* L.)

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Abstract
Field experiment entitled "Irrigation and nitrogen management under different tillage systems in wheat (*Triticum aestivum* L.)", comprised of three tillage options as main plot, four irrigation schedules in sub plot and three nitrogen levels in sub-sub plot, was conducted in split-split plot design with four replications, to evaluate irrigation and nitrogen levels in respect of growth, yield and quality parameters under different tillage systems in wheat. Conventional tillage resulted 13.88 percent higher dry matter yield, 9.27 percent higher biological and 9.28 percent higher grain yield than zero- tillage. But the differences between conventional tillage to zero tillage+mulch were non significant. Seven irrigations applied at 15 DAS, CRI, Late tillering, Late jointing, Flowering, Milking, dough had significantly higher plant growth and biological yield Whereas, the grain yield was highest with six irrigations applied at CRI, Late tillering, Late jointing, Flowering, Milking, dough which, was 9.14 percent higher than the four irrigation level. Nitrogen application @ 150 kg N /ha resulted 4.0, 9.16 and 10.26 percent higher dry matter, biological and grain yield over 120 kg N application. Protein content in grains remained unaffected due to tillage, irrigation regimes and N application. Slight favorable alteration in soil pH was registered after wheat harvest although the differences were statistically non significant.

Keywords: *Triticum aestivum*, Zero tillage, irrigation techniques, nitrogen levels

Introduction
India ranks second in the world with 80.6 million tones production of wheat contributing approx. 12 percent of the world wheat production from an area of 28.6 m ha. Productivity of wheat was 3832 kg/ha in China during 2007 while in India it was only 2742 kg/ha (Fertilizer Statistics, 2007-2008). So, there is good scope to increase the productivity of wheat with the adoption of improved production technology like improved tillage techniques, nutrient management, irrigation scheduling, weed management, disease and pest management. Delayed sowing of wheat due to late harvesting of rice and soil wetness is the biggest challenge before farmers and agronomists. Also, poor rice residue management, multiplicity of tillage operations and non-availability of power source also aggravate the problem. Therefore, the late sowing situation of wheat in rice-wheat cropping system seems to be very critical where about 80 per cent of the area under wheat, are sown late after harvesting of rice resulting into reduced productivity (Erenstein, 2009) [12]. This loss can be saved through early seeding of wheat by zero-tillage or reduced tillage techniques. This technique advances the sowing operation by 10-15 days. If rice crop is harvested from certain height of 10-15 cm above the ground for zero-till drill system the stubbles may help in conserving the moisture after first irrigation, after falling on the ground (Hong-Yong Sun, *et al*., 2006) [13]. Thus zero-tillage technique improves the soil environment for crop growth, reduces erosion, conserves time and energy and decreases the cost of cultivation. Recent estimates suggest that, 1.45 m ha is under no-till/zero till agriculture in South Asia. In India zero-till wheat was planted to nearly 0.85 m ha in 2009.

Materials and methods
The experiment was conducted during the two consecutive cropping seasons of Rabi of 2007-2008 and 2008-2009 at Research Farm of R.K.P.G. College, Shamli, District Muzaffarnagar, (U.P), to evaluate the response of levels of irrigation and nitrogen on different growth, yield, quality and physico-chemical properties of soil under different tillage options in wheat.

The experimental soil was sandy loam in texture medium in available potassium (155kg K2O/ha), and medium in available phosphorus (22.6kg P2O5/ha). The soil was found to be slightly alkaline in reaction with ph 7.8 and E.C. of 0.6 mhos/cm at 25°C. The rice straw was applied @5 ton/ha. Wheat cv. PBW 343 was sown as per treatments. The line spacing was kept 20 cm apart where. The sowing under zero tillage as well as Zero tillage + mulch were done with the help of Pantnagar zero-till ferti seed dril The whole amount of Phosphorus and potassium and half amount of nitrogen was applied at the time of crop sowing, Whereas, the remaining half amount of nitrogen was applied at 25 DAS stage. The crop was weeded with the help of khurpi at 35 DAS sowing to check the weed below threshold level. The soil bulk density was determined at three depths ie. 0-15 cm, 15-30 cm and 30-45 cm depth after wheat harvest. However, the soil pH was determined after wheat for treatments for composite sample from the furrow slice.

Results and discussion

Amongst tillage treatments, conventional tillage proved its superiority during earlier stages of sampling. But in the later stages zero tillage coupled with rice straw mulch applied @5 ton /ha maintained its superiority over zero tillage. However the conventional tillage was at par to zero tillage + mulch treatment. Tillage treatment showed the significant effect on grain yield. During first year significantly higher grain yield (5.76 t/ha) was in conventional tillage over zero tillage (5.27 t/ha) but it was at par with zero tillage with mulch (5.64 t/ha). However, there was decrease in grain yield of conventional tillage plot in second year (5.67 t/ha) while zero tillage (5.32 t/ha) and zero tillage with mulch (5.66 t/ha) showed the increase in grain yield. Conventional tillage resulted 13.88 percent higher dry matter yield, 9.27 percent higher biological and 9.28 percent higher grain yield than zero- tillage. But the differences between conventional tillage to zero tillage with mulch were non significant Improvement in soil fertility status was observed where mulch was used with zero tillage. Soil physico-chemical properties ie. Bulk density and soil pH were significantly influenced by the nitrogen levels during both the years. Bulk density was recorded minimum with zero tillage +mulch. pH of the soil also was altered positively due to application of mulch as mulch application lowered the soil pH near to neutral. Content of protein in grain also was influenced by different tillage treatments, but the differences remained statistically non significant. Higher value of different growth and yield parameters under zero tillage applied with mulch might were due to improvement in organic carbon status of soil, supplementation of nutrients contained in residues and also might due to favorable pH changes (Akhtar, 2006) [3].

Irrigation scheduling of seven irrigations applied at 15DAS, CRI, Late tillering, Late jointing, Flowering, Milking, dough recorded significantly higher value of different growth parameters, biological and grain yield during both the years. However, the harvest index (portioning coefficient) was recorded highest with four irrigations applied at CRI, late jointing, flowering, milking. Although the differences remained at par to other water regimes. Water regimes did not show significant influence on bulk density and pH alteration. Although the lower value of pH was recorded under seven irrigations applied at 15DAS, CRI, Late tillering, Late jointing, Flowering, Milking, dough however the bulk density was recorded minimal under four irrigations applied at CRI, Late jointing, Flowering, and Milking.

Seven irrigations applied at 15 DAS, CRI, Late tillering, Late jointing, Flowering, Milking, dough had significantly higher plant growth and biological yield whereas, the grain yield was highest with six irrigations applied at CRI, Late tillering, Late jointing, Flowering, Milking, dough which was 9.14 percent higher than the five irrigations Higher value of different growth parameters under seven irrigations were due to ever supplementation of moisture since very beginning till maturity of the crop and also might was because of accelerated movement/ uptake of nutrients due maintenance of better water balance. Similar results were observed by Bandyopadhyay, 1997 [5]. Slightly less biological and grain yield under seven irrigates was due to logging of crop plants.

Application of 150 kg N/ha had significant effect on biological and grain yield production during both the years. Application of 150kg N/ha and 180 kg N/ha produced statistically at par grain yield. Quality parameters viz., content of protein in grain was not altered significantly by nitrogen, but the protein yield was recorded significantly higher with application of 150 kg N /ha. Soil physico-chemical properties ie. Bulk density and soil pH were not influenced significantly by the nitrogen levels during both the years. Higher value of growth parameters and the yields with 150 kg application might was due to higher content of chlorophyll, growth hormones and also higher rate of protein assimilation in plants which ultimately led to higher rate of carbohydrate assimilation in plants, thus higher plant height and yields. The results are in accordance to Katri, *et al*., 2002 [14]. Slightly lesser yield under 180 kg N /ha might was due to increased incidence of yellow rust.

In general, zero tillage with mulch produced at par grain yield to conventional tillage. Irrespective of tillage options application of 150 kg N/ha and irrigation schedule with six irrigations applied at CRI, Late tillering, Late jointing, Flowering, Milking, dough, gave significant response during both the years. Increasing levels of irrigation beyond six irrigations level and nitrogen beyond 150 kg N had no added advantage irrespective of tillage options. Nitrogen application @ 150 kg N /ha resulted 4.0, 9.16 and 10.26 percent higher dry matter, biological and grain yieldov120 kg N application

Table 1: Effect of tillage, irrigation and nitrogen management on plant height, dry matter, biological and grain yield and protein content of wheat.

Treatments	Plant height (cm)		Dry matter g /m2)		Biological yield (t/ha)		Grain yield (t/ha)		Protein content (%)	
	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009
Tillage management										
Z_1- Conventional tillage (6 harrowing + planking)	91.2	90.8	1452.2	1437.0	14.85	15.09	5.76	5.67	11.56	11.81
Z_2- Zero tillage	88.8	87.8	1275.0	1195.4	13.59	13.64	5.27	5.32	11.62	11.75
Z_3- Zero tillage + mulch	88.8	89.6	1425.5	1426.6	14.78	14.78	5.64	5.66	11.62	11.75
S.Em.±	1.48	1.72	27.39	26.94	0.25	0.27	0.05	0.04	0.187	0.186
C.D. (P = 0.05)	NS	NS	94.67	93.13	0.87	0.94	0.19	0.15	NS	NS
Irrigation levels										
I_1= Four irrigations (CRI, late jointing, flowering, milking)	86.6	88.5	1384.2	1343.2	14.63	14.95	5.58	5.60	11.62	11.75
I_2= Five irrigations (CRI, late tillering, late jointing, flowering, milking)	91.4	90.8	1405.5	1378.3	15.62	15.36	6.00	6.01	11.65	11.75
I_3= Six irrigations (CRI, late tillering, late jointing, flowering, milking, dough)	95.8	96.0	1413.0	1387.5	15.98	15.56	6.09	6.05	11.56	11.68
I_4= Seven irrigations (15 DAS, CRI, late tillering, late jointing, flowering, milking, dough)	97.4	98.6	1467.7	1405	16.23	16.14	6.05	6.04	11.50	11.62
S.Em.±	1.47	1.74	22.18	22.37	0.15	0.18	0.04	0.04	0.125	0.185
C.D. (P = 0.05)	4.37	5.17	65.87	66.44	0.46	0.55	0.11	0.17	NS	NS
Nitrogen levels										
N_1- 120 kg N ha^{-1}	88.0	87.8	1353.8	1322.7	13.78	13.98	5.25	5.30	11.62	11.75
N_2- 150 kg N ha^{-1}	89.4	89.2	1403.0	1371.1	15.04	15.26	5.79	5.82	11.68	11.81
N_3- 180 kg N ha^{-1}	91.5	91.3	1395.8	1365.2	14.40	14.27	5.62	5.53	11.75	11.93
S.Em.±	1.15	1.25	22.19	22.20	0.13	0.12	0.05	0.05	0.187	0.125
C.D. (P = 0.05)	3.27	NS	NS	NS	0.38	0.35	0.16	0.15	NS	NS

DAS = Days after sowing

Table 2: Effect of tillage, irrigation and nitrogen management on bulk density and soil pH after wheat harvest.

Treatments	Bulk density (Mg / M^3)						Soil pH	
	0-15 cm depth		15-30 cm depth		30-45cm depth			
	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009
Tillage management								
Z_1- Conventional tillage (6 harrowing + planking)	1.26	1.24	1.64	1.60	1.68	1.67	7.74	7.63
Z_2- Zero tillage	1.38	1.39	1.65	1.67	1.67	1.67	7.67	7.58
Z_3- Zero tillage + mulch	1.31	1.30	1.60	1.60	1.66	1.65	7.72	7.55
S.Em.±	0.009	0.009	0.005	0.007	0.02	0.02	0.13	0.13
C.D. (P = 0.05)	0.032	0.03	0.02	0.02	NS	NS	NS	NS
Irrigation levels								
I_1= Four irrigations (CRI, late jointing, flowering, milking)	1.31	1.31	1.62	1.62	1.67	1.66	7.70	7.63
I_2= Five irrigations (CRI, late tillering, late jointing, flowering, milking)	1.32	1.32	1.64	1.63	1.67	1.67	7.63	7.55
I_3= Six irrigations (CRI, late tillering, late jointing, flowering, milking, dough)	1.32	1.33	1.65	1.64	1.69	1.68	7.61	7.50
I_4= Seven irrigations (15 DAS, CRI, late tillering, late jointing, flowering, milking, dough)	1.33	1.35	1.67	1.65	1.70	1.69	7.45	7.32
S.Em.±	0.006	0.01	0.004	0.006	0.02	0.02	0.12	0.11
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Nitrogen levels								
N_1- 120 kg N ha^{-1}	1.32	1.32	1.62	1.62	1.66	1.65	7.73	7.61
N_2- 150 kg N ha^{-1}	1.32	1.32	1.62	1.62	1.67	1.67	7.68	7.58
N_3- 180 kg N ha^{-1}	1.31	1.31	1.62	1.62	1.67	1.66	7.72	7.57
S.Em.±	0.01	0.005	0.006	0.008	0.02	0.02	0.09	0.10
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS

DAS = Days after sowing

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