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Tillage and nutrient management modules for increased growth and productivity of wheat (*Triticum aestivum* L.)

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Abstract
The field experiment was conducted to evaluate the effect of tillage (conventional and conservation) and nutrient management practices on growth and yield of wheat crop during *Rabi* season of 2013-13 at Norman E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture & technology, Pantnagar (Uttarakhand). Experiment was laid out in randomized block design with three replications and six treatments based on tillage (conventional and conservation) and nutrient management practice *viz.*, T_1: Conventional tillage + RDF; T_2: Conventional tillage + RDF + green manuring (before rice); T_3: Conventional tillage + RDF + 10 % extra N; T_4: Zero tillage + RDF; T_5: Zero tillage + RDF + 10% extra N and T_6: Zero tillage + RDF + 10 % extra N + 2 t FYM. Results apparently indicated that the Zero tillage with RDF + 30 % residue retention and 2 t FYM application proves better with respect to growth and yield of wheat as compared to the conventional tillage practices combining with RDF.

Keywords: Mollisols, zero tillage, conventional tillage and residue retention**.**

Introduction

Wheat (*Triticum aestivum* L.) being the integral component of Rice-Wheat cropping system is the backbone of country's food security with the yield potential of 4-6 t/ha/year (Ladha *et al.*, 2012). Wheat is grown in all the states in India except Southern and North Eastern states. Uttar Pradesh, Haryana, Punjab, Rajasthan are the major wheat producing states and accounts for almost 80% of total production in India. Traditional tillage and crop establishment methods create problems in timeliness of wheat seeding, maintenance of soil structure, irrigation management, and weeds and other pest infestation, fertilizer and crop residue management. Delayed sowing of wheat leads to yield reduction upto 30-60 kg/day (Pathak *et al*., 2003) poor tilth, restricted drainage and inadequate soil aeration due to puddling in rice are the major limitation for Wheat to express their yield potential. Conventional practices have further led to decline in soil organic carbon as low as 0.2% at the same time increase in soil compaction, creation of hard pan (Ladha *et al*., 2003). Zero tillage sowing of wheat saves time, energy in terms of labour and fuel (Erenstein and Laxmi, 2008) and reduce the cost of cultivation (Chauhan and Johnson, 2009). Conventional tillage practices generally abrade the network of mycelium by mechanical breakdown of macro aggregates (Borie *et al.*, 2006), and decrease content of soil organic matter (SOC), microbial biomass and faunal activities (Sainju *et al*., 2009). Soil management through the use of different tillage operation affect the soil aggregation directly by physical disruption of the macro aggregates and indirectly through the alteration of biological and chemical factors (Barto *et al*., 2010). Intensive tillage, residue removal or burning practiced during whole crop season accelerates the soil erosion, environmental pollution soil degradation and affects the ecosystem functions (Srinivasan *et al.* 2012). Rice-Wheat being the exhaustive in nature removes large quantity of nutrients from the soil. Since green revolution, introduction of high yielding varieties (HYVs) coupled with increased use of chemical fertilizers, irrigation, pesticides and farm implements Rice-Wheat cropping system has replaced the area of other cereals and pulses. But continuous cropping on a particular area over the years with HYVs and imbalance nutrient management practices combined with conventional method of planting have resulted in decline crop yield and leading to macro and micro nutrient deficiencies (Bisht *et al*., 2006).

Therefore adoption of rational cropping practices, such as crop residue recycling, manure application, green manuring conservation tillage would be needed for improving the soil quality and ecosystem function (Blair *et al*., 2006; Rudrappa *et al*., 2006). Green manuring of *Sesbania aculeate* can significantly improved the yield and save above 50-60% nitrogen

(Mann *et al.,* 2000). Fast growing leguminous green manure with their adaptability to different rice based cropping pattern and their ability to fix atmospheric nitrogen may offer opportunities to increase and sustain productivity and income in the rice based cropping system (Dey and Jain 2000).

Material and Methods

The field experiment was conducted in Norman E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture & technology, Pantnagar (Uttarakhand) during *Rabi* season of 2013-14 which is situated at 29°N latitude, 79.3°E longitude and at an altitude of 243.84 meters above sea level in *tarai* belt. Soil of experimental site was classified as "Mollisols" (Deshpande *et al*., 1971). The soil of Tarai region (Mollisols) has developed from calcareous medium, to moderately coarse textured parent material under the predominant influence of forest vegetation with poor to moderately condition. The climate of Pantnagar is humid subtropical. Soil organic Carbon content, available nitrogen, phosphorous and potash was 0.79%, 246, 22 and 146 kg/ha respectively with the pH of 7.6. Experiment was laid out in randomized block design with three replications and six treatments viz., T_1: Conventional tillage + RDF; T_2: Conventional tillage + RDF + green manuring (before rice); T_3: Conventional tillage + RDF + 10 % extra N; T_4: Zero tillage + RDF; T_5: Zero tillage + RDF + 10% extra N and T_6: Zero tillage + RDF + 10 % extra N + 2 t FYM. Wheat variety PBW – 343 releases in 1996 was used. During *Rabi* season, wheat was sown on 31st October with the help of Zero till seed drill (T4, T5 and T6). For the remaining treatments (T1, T2, and T3 followed by conventional sowing with the help of Seed drill on 31st October. 50 % basal Nitrogen and full P&K through different fertilizer sources were applied with seed drill (T4 and T5) and FYM (T6) whereas in conventional it was done manually. Remaining Nitrogen was applied in two equal splits at CRI and maximum tillering stage.

Results and discussion

In the present study, highest number of shoots, shoot height and root biomass (325, 93.1 cm and 4.22 g respectively) was recorded in treatment T6 (ZT+ RDF + 10% extra N + 2t FYM) which was statistically at *par* with T2 (CT+RDF+GM) and T_5 (RT+RDF+10% extra N) treatments having 322, and 91.3 cm and 308 and 89.8 cm respectively being significantly superior over rest of the treatments (Table-1). Similarly Dry matter accumulation was highest under T6 (ZT+ RDF + 10% extra N + 2t FYM) but it found non-significant. In case of root biomass, it was maximum (4.22g) in T6 (ZT+ RDF + 10% extra N + 2t FYM) being at *par* with T5 (RT + RDF + 10 % extra N) and T4 (RT + RDF) having 4.19 and 4.17 g biomass plant^{-1} respectively.

As the maximum number of shoots, plant height and dry matter accumulation were recorded under T_6 (ZT+ RDF + 10% extra N + 2t FYM), T2 (CT+RDF+GM) and T_5 (RT+RDF+10% extra N) which might be due to better aggregation, soil aeration, availability of better moisture and nutrient availability helping in faster emergence and growth of wheat seed under zero tillage, reduced tillage in which residue and organic matter application was done (Bhagat and Verma, 1991). Surface residue retention under zero and reduces tillage system leads to better physical, chemical (nutrient cycling, CEC, soil reaction etc.) and biological (SOC sequestration microbial biomass, diversity in soil biota) condition of soil through and also modified the soil temperature which cut down the water evaporation (Singh *et al.,* 2008; Fengyun *et al*., 2011). Residue in wheat crop stimulated vegetative growth of wheat on account of adequate and prolonged supply of essential nutrients in treatments of organic matter retention resulted into higher dry matter production and translocation, and the remobilization of photosynthates into reproductive parts (Singh *et al*., 2017). The values of root biomass were higher in residue retention treatments viz., T6, T5 and T4 which might be due to the reduced mechanical resistance by conserving the soil and water, soil aggregation and aeration thus enhanced root growth (Rahman *et al*., 2005; Sharma and Acharya, 2000).

During the course of experiment, yield attributes of wheat were increased in T_6 (ZT+ RDF + 10% extra N + 2t FYM) treatment. Highest number spikes m^{-2}, Number of Grains spike^{-1} and 1000 grain weight 321, 12.3 and 54 g was recorded in T_6 (ZT+ RDF + 10% extra N + 2t FYM) which was found to be at par with T2 (CT+RDF+GM) and T_5 (RT+RDF+10% extra N) while significantly superior over all other treatments. Similarly grain, straw and biological yield 58.5, 63.5 and 122.0 qha^{-1} respectively was maximum under was recorded in T_6 (ZT+ RDF + 10% extra N + 2t FYM) which was found to be at par with T2 (CT+RDF+GM) and T_5 (RT+RDF+10% extra N). Minimum grain yield (43.1 q ha^{-1}) was recorded in t1 (CT + RDF). Grain yield increment over control in T6, T2 and T5 was 35.7, 31.1 and 24.8 % respectively.

Yield attributes of wheat were higher in T_6 (ZT+ RDF + 10% extra N + 2t FYM) which might be due to proper placement of seed, early emergence of wheat seedling, higher availability nutrients and moisture which ultimately leads to better growth and development of crop (Kumar and Yadav, 2005; Gupta *et al.,* 2011). As the grain yield is the function of different yield attributing characters such as number of spikes, number of grains per spike and 1000 grain weight (test weight). In the present experiment, all the yield attributing characters were higher under T_6 (ZT+ RDF + 10% extra N + 2t FYM), T2 (CT+RDF+GM) and T_5 (RT+RDF+10% extra N) which contributed towards the higher grain yield than other treatments. ZT with straw retention also may reduce the surface soil crusting, better soil surface aggregation, increased water infiltration and retention, reduced run off and gives higher grain yield (Karlen *et al*., 1994; Mohammad *et al*., 2012). Research revealed that ZT with residue cover had higher aggregate stability, aggregate size and total SOC than CT (Madari *et al*., 2005). ZT has been sown to increase wheat yields in India by 5-6 %, further boosting the farmer returns (Erenstein 2009). ZT with residue retention increases soil organic matter and total soil N and there're induces major changes in N management. Zero tillage (ZT) may perform better than other tillage methods if N management is optimized (Sah *et al*., 2013). ZT is more safe practice compared to CT regarding its impact on soil, water and environment (Edwards and Daniel 1992).

Table 1: Growth of wheat as influenced by different tillage and nutrient management practices

Treatments	No. of shoot m^{-2}	Shoot height (cm)	DMA (g/m^{-2})	Root Biomass ($g\ plant^{-1}$)
T_1- CT +RDF	294.7	81.4	961.2	2.77
T_2-T_1 +GM	321.7	91.3	1014.2	3.36
T_3- T_1+ 10% extra N	302.7	85.5	985.1	3.31
T_4-RT + RDF	300.0	83.8	972.6	4.17
T_5- T_4 +10% extra N	308.3	89.8	1002.7	4.19
T_6- ZT+ RDF + 10% extra N + 2t FYM	325.3	93.1	1049.2	4.22
SEM±	61	0.9	31.1	0.11
CD at 5%	19.1	2.9	NS	0.35

Table 2: Yield of wheat as influenced by different tillage and nutrient management practices

Treatments	Number of spikes m^{-2}	Number of Grains $spike^{-1}$	1000 grain wt (g)	Grain yield ($q\ ha^{-1}$)	Straw yield ($q\ ha^{-1}$)	Biological yield ($q\ ha^{-1}$)
T_1- CT +RDF	298	44	40.9	43.1	50.1	93.2
T_2-T_1 +GM	317	51	43.9	56.5	61.4	117.9
T_3- T_1+ 10% extra N	306	48	42.1	47.2	55.8	102.9
T_4-RT + RDF	303	47	41.4	45.5	52.1	97.6
T_5- T_4 +10% extra N	314	51	42.9	53.8	58.6	112.3
T_6- ZT+ RDF + 10% extra N + 2t FYM	321	54	43.4	58.5	63.5	122.0
SEM±	**4.9**	**1.5**	**0.9**	**2.1**	**2.0**	**3.7**
CD at 5%	**15.4**	**4.8**	**NS**	**6.5**	**6.2**	**11.7**

Conclusion
On the basis of above findings, it may be concluded that better wheat growth and higher productivity was obtained with the collective application of conservation tillage practices *viz*., zero tillage and reduced tillage in combination with organic matter and residue retention.

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