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MOISTURE RETENTION PATTERN OF SOIL IN CONVENTIONAL AND CONSERVATION AGRICULTURAL PRACTICES IN DIFFERENT SOWING DATES AFTER WHEAT HARVEST IN RICE-WHEAT CROPPING SYSTEM

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ABSTRACT

A field experiment was conducted at the agronomy farm of the Institute of Agriculture and Animal Science (IAAS), Rampur during winter season of 2014/2015 to find out the moisture retention pattern of soil under different tillage practices. There were six treatments consisting of two tillage practices as main plots i.e. conventional agriculture and conservational agriculture; three sub plots with three sowing dates (November 14, November29 and December 14) were arranged in split plot design in three replicates. Wheat variety *Vijay* was sown and moisture content of the soil was determined by two methods i.e., gravimetric method and gypsum blocks. There was a positive correlation between the two methods whereas the moisture of the soil was influenced by the establishment methods of depth (0-10 cm) at 45, 60 and 75 Days after sowing (DAS). The moisture content of the soil was higher in conservation tillage at reproduction and maturity stages. Conservation agriculture helps to conserve the moisture in the upper depth more significantly than lower depth. Hence, Conservation agriculture provides good soil moisture retentive capacity for wheat productivity in Terai region of Nepal.

Keywords: Dates of sowing, conservation tillage, conventional tillage, effective tiller, grain yield, soil moisture.

1. INTRODUCTION

Wheat (*Triticum aestivum L.*) is the most widely cultivated cereal crop in the world. Eighty nine countries have 2.5 million wheat consumers worldwide. Wheat is grown on 215 million hectare of land each year which is equivalent to 17% of total cultivated land (CIMMYT, 2013*)*. According to USDA, the global wheat production of wheat in 2016 was 754.1 million tons. In Nepal it is the third most important cereal crop after rice and maize. It accounts for 22.19% area (735470 ha) of total cereal crop and 20.84 % (1727346 tons) of the total cereal production of the country with a productivity of 2.46 t ha^{-1} (MOAD, 2017). The low land ecosystem with heavier soil texture and excess soil moisture causes serious problem in establishment of winter crop necessitating resource conservation technology such as zero tillage. Conservation agriculture (CA) defined as the minimal soil disturbance (no-till/zero till or minimum till), and permanent soil cover (mulch or residue retention) combined with rotations, as a more sustainable cultivation system for the future (Hobbs, 2006) whereas zero-tillage may be defined as the placement of seed into the soil by a seed drill without prior land preparation (Hobbs, 1997). Reduced tillage with suitable machinery increases net income indicating their sustainability and superiority over conventional tillage (Tripathi, 2010). Conservation tillage systems generally improves soil organic matter content, plant available water capacity, soil aggregation and soil water transmission capacity than conventional tillage and also enhances the infiltration characteristics and saturated hydraulic conductivity (Bhattacharyya *et al.*, 2008). The conventional tilled soil has higher water holding capacity than the conventional tillage and the soil water content depend on the tillage system as well as depth of the soil from where the soil sample is taken. Moreover, the conservation tillage leads to the soil compactness which affect the yield of the crop. The gravimetric water content of the soil at different depth is higher in the conservation tillage than in conventional tillage (Kosutic*et al*., 2000).

Drought after flowering stages reduces the kernel weight, number of kernel, plant height, tiller number, spike number, spikelet, stem weight and single plant yield (Gevrek*et al*., 2012). The evapotranspiration, grain yield, biomass, WUE and harvest index depends on soil moisture content. Highest moisture content gives the highest biomass and high evapotranspiration but the highest grain yield found in appropriate controlled moisture.

2. METHODOLOGY

Experimental Detail

Field layout

The experiment was conducted at Agronomy farm of the Institute of Agriculture and Animal Science (IAAS), Rampur starting from November 2014 to April 2015. The site is situated in the central Nepal of subtropical climate at an altitude of 228 meter above sea level. The experiment was laid out in a strip plot design with the combination of 6 treatments consisting of two systems of tillage and 3 different sowing dates and each treatment was replicated 3 times. The total area of the subplot was 5m X 4m. The row spacing was maintained 20 cm with continuous sowing in the row consisting of 25 rows in each plot. The central 10 rows were treated as the net plot rows for harvesting and inner two rows on the both side of net plot were used for biometrical observations leaving single row at the both side as to check border effect.

Treatment details

Main plot (Tillage practice)

T_1=Conservation agriculture (No-till + mulching)

T_2=conventional agriculture

Sub-plot (Date of sowing)

S_1 = November 14

S_2 = November 29

S_3 = December 14

Soil Moisture Determination

Gravimetric method

The gravimetric method involves taking the soil sample, weighing, and oven drying and reweighing the sample. The loss in the weight which is considered the moisture content is then expressed as a percentage of the oven dry weight of soil (Reynolds, 1970). This is the weight

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basis of expressing the soil moisture content. The soil sample from the three depths 0-10 cm, 10-20 cm and 20-30 cm were collected in every 15 days interval using a core auger and soil moisture content was determined gravimetrically.

Soil Moisture Meter method

Soil moisture content is determined in this method by installing metallic probes in the soil and the moisture meter is used for its reading. Gypsum sensor blocks were used in all the respective plots and by using the Delhmorst Moisture meter, reading was taken within interval of 4 days. The reading was obtained in Centibars.

3. RESULTS AND DISCUSSIONS

The results obtained during the experiment are analyzed and presented in this chapter with the help of the tables and figures .

3.1 Soil moisture content influenced by establishment methods

3.1.1 Soil moisture content in % w/w basis influenced by establishment methods

The moisture content of the soil at depth 0-10 cm at the day of sowing was higher by 5.33% in conservation agriculture (Table 1 and Figure 1) but the difference was not significant. The moisture content at 45, 60 and 75 DAS was higher in conservation agriculture by 4.01, 4.10% and 1.71% respectively, which were significantly higher than the moisture content in conventional agriculture. The moisture was higher in conventional tillage by 3.23 and 0.60% at 120 and 135 DAS respectively as compared to conservation agriculture but these differences were not significant.

Table 1: Influence of conservation agriculture and conventional agriculture on soil moisture (% w/w) during 2014-15 at Agronomy Farm, AFU, Rampur, Chitwan, Nepal

DAS	0-10 cm			10-20 cm			20-30 cm		
	CA	ConA	t-value	CA	ConA	t-value	CA	ConA	t-value
0	33.65 ±0.70	28.32 ±1.29	0.073^{ns}	30.47 ±1.35	27.57 ±1.07	0.009**	26.71 ±0.50	24.63 ±0.73	0.067^{ns}
45	30.35 ±0.47	26.34 ±0.66	0.000**	26.68 ±0.85	25.73 ±0.75	0.373^{ns}	25.16 ±0.45	24.12 ±0.49	0.026*
60	32.44 ±0.83	28.34 ±0.82	0.01**	26.2 ±1.02	25.85 ±0.97	0.701^{ns}	25.10 ±1.54	26.67 ±1.07	0.557^{ns}
75	28.24 ±0.62	26.53 ±0.72	0.038*	22.79 ±0.79	24.01 ±0.87	0.187^{ns}	22.73 ±0.70	21.64 ±0.52	0.033*

90	28.93 ±0.76	23.87 ±2.43	0.066^{ns}	23.73 ±0.69	23.72 ±2.42	0.997^{ns}	22.91 ±0.41	23.69 ±1.67	0.668^{ns}
120	22.55 ±0.89	25.78 ±1.64	0.098^{ns}	20.42 ±0.82	18.69 ±1.32	0.323^{ns}	21.48 ±0.64	22.38 ±1.34	0.493^{ns}
135	20.52 ±1.39	19.92 ±0.79	0.745^{ns}	20.96 ±1.67	17.87 ±2.25	0.234^{ns}	18.19 ±0.93	18.19 ±0.93	0.429^{ns}

Note: CA, Conservation agriculture; ConA, Conventional agriculture; DAS, Days after sowing; ns, non-significant; *, significant at 5% level of significance; **, significant at 1% level of significance.

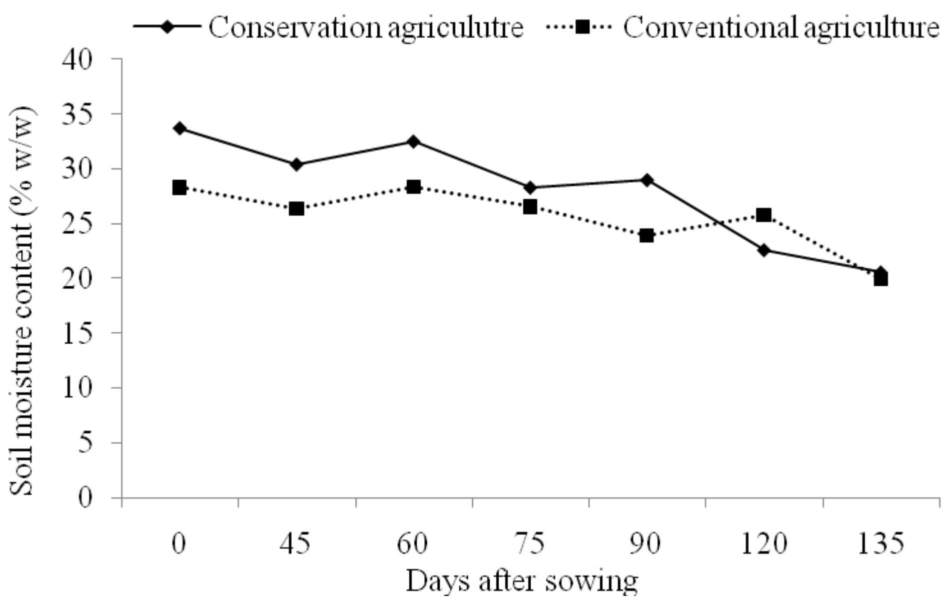

Figure 1: Influence of conservation agriculture and conventional agriculture on soil moisture of 0-10 cm soil (% w/w) during 2014-15 at Agronomy Farm, AFU, Rampur, Chitwan, Nepal

The moisture content of the soil at depth 10-20 cm was significantly higher under conservation agriculture (2.90%) at the time of crop sowing (Table 1 and Figure 2). But after 45 DAS the

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different in moisture content was not significant among conservation agriculture and conventional agriculture. Moisture content at 45 and 60 DAS was higher in conservation agriculture by 0.95% and 0.47% respectively. At 75 DAS the moisture content was found to be statistically similar but higher in conventional tillage by 1.22%. The moisture content at 60, 90, 120 and 135 DAS were statistically at par but comparatively higher in conservation agriculture.

The moisture content of the soil at depth 20-30 was found to be statistically higher in conservation agriculture at 45 and 75 DAS by 1.04 and 1.09% respectively (Table 1). The moisture content at the day of sowing was higher in conservation agriculture by 2.08% but the different was no significant. The moisture content at 60, 90 and 120 DAS was higher in conventional agriculture but the different was not significantly different. And at 135 DAS the moisture content was higher in conservation agriculture by 1.21%.

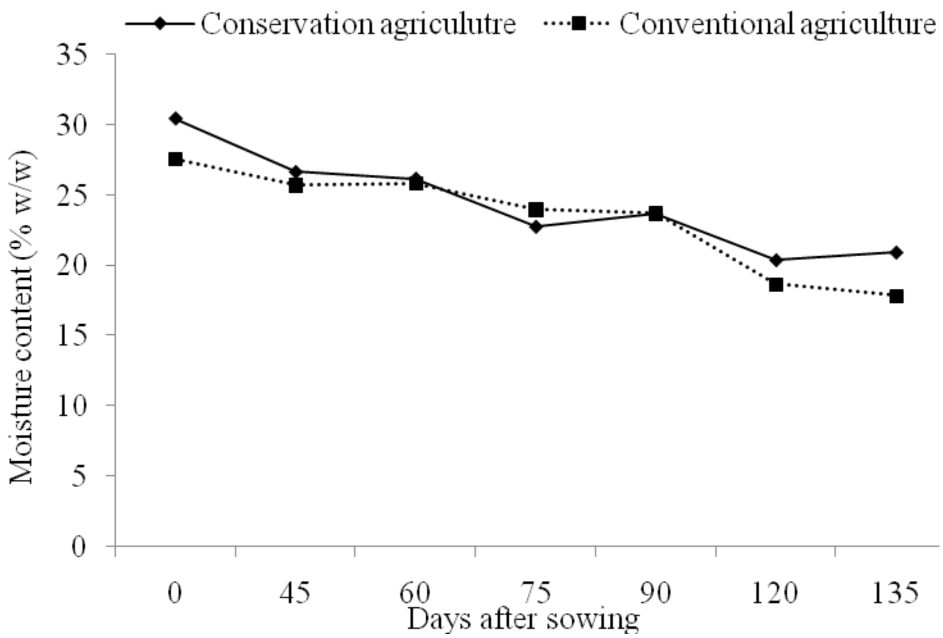

Figure 2: Influence of conservation agriculture and conventional agriculture on soil moisture of 10-20 cm soil (% w/w) at Rampur, Chitwan, Nepal in 2014-2015.

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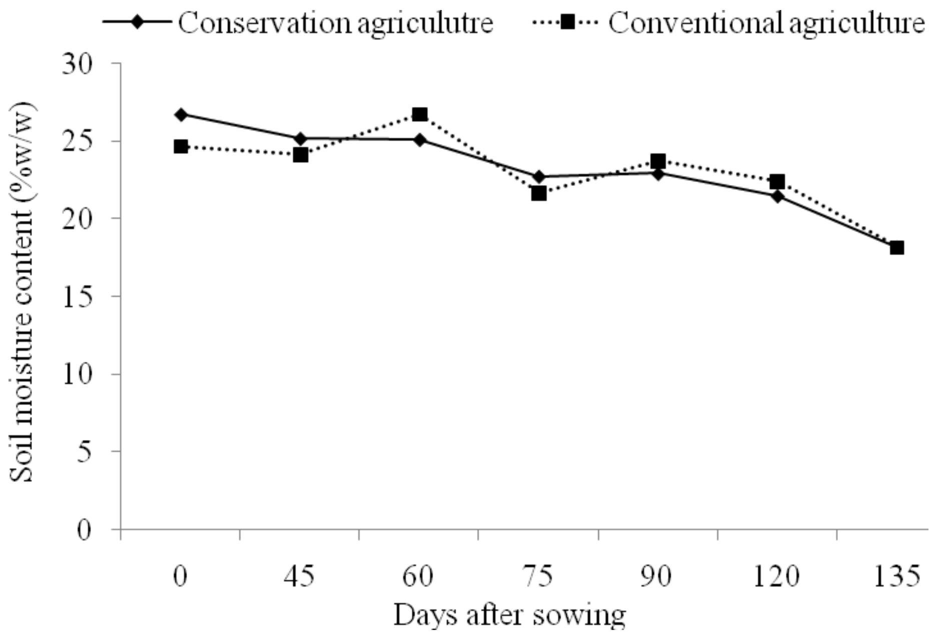

Figure 3: Influence of conservation agriculture and conventional agriculture on soil moisture of 20-30 cm soil (% w/w) at Rampur, Chitwan, Nepal in 2014-2015.

It might be due to the effect of mulching under CA. Soil with a higher level of organic matter has a higher percentage of micro and macro-pores, which allows it to store more water than soil low in organic matter. Also, organic matter reduces the bulk density of a soil (again due to higher pore content) therefore allowing for better infiltration of rainfall and snow melt (Andrews, 2006).Mulch decreases convection, which decreases the gradient in partial pressure of water vapour between the soil and the general atmosphere. Together with lower temperature, this reduces evaporation from the soil surface and keeps soil moist for a longer period (Teasdale and Mohler, 1993). This might be the reason for greater soil moisture in CA.

The positive effect of no tillage with residue retention was abvious against the conventional tillage without residue in Rampur, Chitwan. Verhulst *et al*. (2011) evaluated soil water content (0–60 cm) in different tillage and residue management practices in the semi-arid areas of the Mexican highlands for a maize-wheat rotation. Zero tillage with residue retention had higher soil water content than zero tillage with residue removal and conventional tillage with or without residue, and the effect was more. It was due to recharged or retention of more water during winter fallow on soil profile of zero tillage causing the difference. Use of crop residue reduced the evaporation losses by 56.5%, increased aggregate distribution and increased infiltration as well (Govaerts*et al*. 2009).

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3.1.2 Relationship between moisture content of % w/w basis and moisture meter reading

The correlation between moisture reading taking by gravimetric method and moisture meter was highly significant (r = 0.5145**) and meant that reading taken by both methods were same (Figure 4).

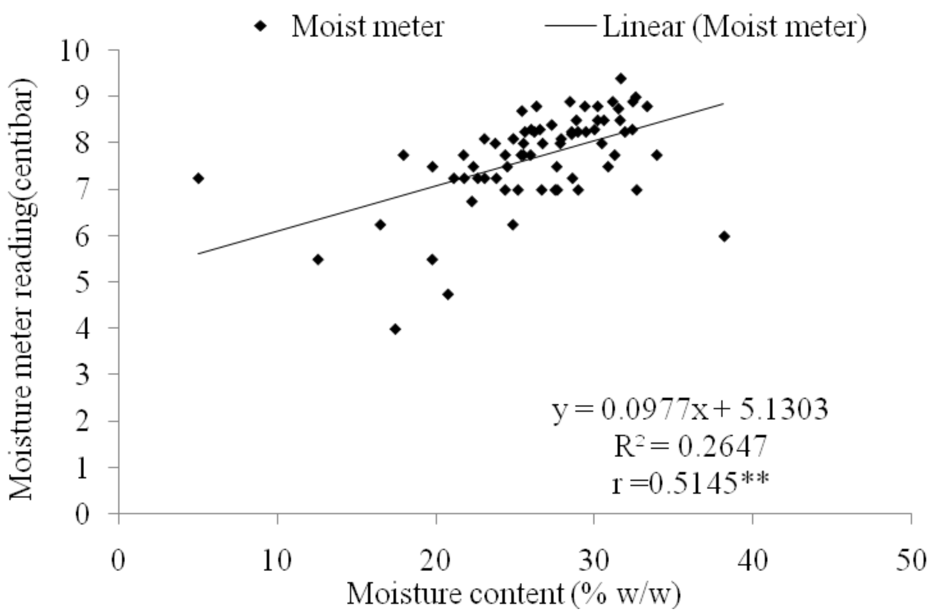

Figure 4: The correlation between moisture reading taking by gravimetric method and moisture meter at Rampur, Chitwan, Nepal in 2014-2015.

3.1.3 Content influenced by conservation agriculture (moisture meter reading)

The average moisture content of 0 -10 cm soil depth under conservation agriculture plot was higher than that of conventional agriculture (Table 2).

Table 2: Soil moisture content (average of 15 days) influenced by conservation and conventional agriculture in soil at different dates after sowing of 0-10 cm soil depth at Rampur, Chitwan, Nepal in 2014-2015.

DAS	*Conservation agriculture*	*Conventional agriculture*
15	*5.01±0.19*	*4.83±0.36*
30	*8.17±0.17*	*8.08±0.05*
45	*8.24±0.14*	*8.17±0.08*

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60	*8.54±0.13*	*8.46±0.04*
75	*7.73±0.15*	*7.54±0.02*
90	*7.68±0.12*	*7.47±0.12*
105	*7.72±0.40*	*7.25±0.14*
120	*6.07±0.44*	*5.54±0.48*

Note: DAS, days after sowing

While recording at four days interval, at initial days the moisture content was slightly higher under conventional agriculture while comparatively higher for conventional agriculture in other dates of observations (Figure 5).

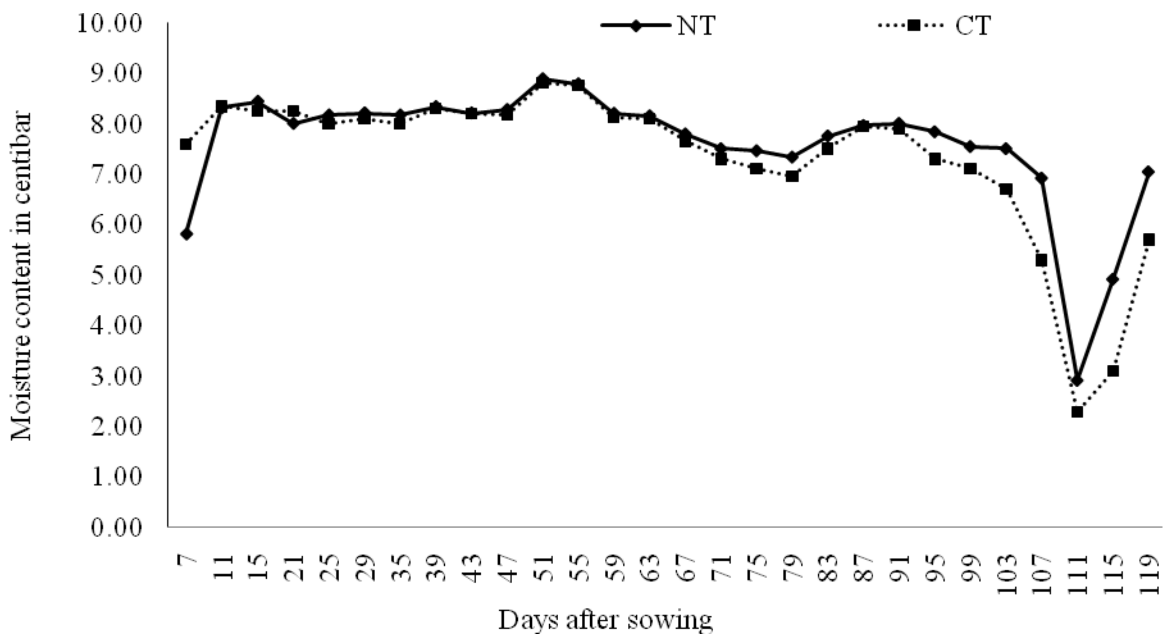

Figure 5: Soil moisture content at four days interval influenced by conservation and conventional agriculture in soil at different dates after sowing of 0-10 cm soil depth at Rampur, Chitwan, Nepal in 2014-2015.

4. CONCLUSION

Soil moisture measured at different depth (0-10, 10-20 and 20-30 cm) in conservation agriculture system and conventional agriculture system is significantly differs with each other as days passes. Soil moisture of top layer (0-10 cm) is mostly affected by conservation agriculture. However, soil moisture of lower depth 10-20 cm and 20-30 cm is less affected. After 45 days after sowing and before 90 days after sowing, there was significant moisture retention by conservation agriculture compared to conventional tillage in upper depth. Upper depth soil moisture is crucial for wheat growth in during 90 days after sowing as it directly influences the milk and dough stage of wheat grains. Additionally, moisture reading from gravimetric method and moisture probe method is significantly correlated. Moisture probe method is more accessible for daily monitoring of soil moisture fluctuation in field whereas gravimetric method is tedious to do so. Hence, soil moisture probe is useful in monitoring soil moisture in Nepal.

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