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Spatial and Temporal Variation of Soil Moisture under Different Tillage Practices in Wheat Crop

ASHUTOSH UPADHYAYA*, SS SINGH[1], LK PRASAD[2] AND MK ROY[3]

Division of Land and Water Management, ICAR-Research Complex for Eastern Region, Patna, Bihar (India)

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ABSTRACT

In order to investigate spatial and temporal variation of soil moisture under zero tillage (ZT) and raised bed (RB) method of wheat crop establishment with respect to conventional tillage (CT) method, a field experiment was conducted at Sabajpura farm of ICAR Research Complex for Eastern Region, Patna on salty clay loam soil having sand, silt and clay of 20.8, 66.3 and 12.9%, respectively. Four depths of irrigation i.e. 3, 5, 7, and 9 cm with three replications were applied to each tillage method. The results revealed that the moisture content in the root zone for 3 cm depth of irrigation was low and there was not much variation in moisture content for 5, 7 and 9 cm depths of irrigation. In the top 0-15 cm depth of soil layer the moisture content in ZT (varying from 37.6 - 29.4%) and in the furrows of RB (varying from 37.8-30.3%) were highest followed by CT (varying from 36.5 - 25.2%) and it was found lowest on the beds of RB (varying from 30.2 - 23.8%) for 5 cm depth of irrigation. In lower layers also similar trend was observed, but there was not much difference in the moisture contents among all the methods. The rate of decrease in moisture contents between first and second irrigations was lowest and between third and fourth irrigation it was found highest in all the tillage methods.

Keywords: Zero tillage, raised bed method, conventional tillage, moisture content

INTRODUCTION

Wheat is one of the premier cereal crops of worldwide importance which is grown under a wide range of climatic conditions. India is one of the major producers of wheat and it is maintaining its second position of wheat producing nation after china (Meena *et al.*, 2013). It is widely grown through in temperate zone and some tropical and sub-tropical areas at higher elevation. The major wheat growing countries in the world are USSR, USA, China, India, Canada, Australia, France, Turkey and Pakistan. Among the major cereal grown in India, wheat stands second next to rice in area and production, but stands first in productivity. India covers about 27.54 million hectares area with total production of 80.58 million tonnes and productivity 29.54 q/ha (Anonymous, 2009). Drought is the most serious environmental factor limiting the productivity of wheat crop, with devastating economical and sociological impact. Efficient water management, being one of the good agronomic management practices, it not only leads to improve crop productivity but also minimize susceptibility from disease and insect pest under favourable environment for flourishing these biotic stresses (Singh *et al.*, 2012). In the low land rice belts of Bihar and eastern UP, sowing of wheat is delayed as the land preparation after harvesting paddy takes some time. Zero tillage is gaining popularity in this area as it eliminates the time and energy required for land preparation in conventional method (Singh *et al.*, 2014 and Upadhyaya, 2015). Adequate soil moisture in the root zone of the crop throughout the growing period is essential for better yield. Higher total moisture content in soil profile under no-till than reduced and conventional tillage (CT) was reported in literature. CT has been criticized for wasting energy and for contributing to soil erosion and related problems of air and water pollution (Mock and Erbach, 1977) whereas conservation tillage is a way to save time, fuel, and labour for increasing soil

[1]ICAR-Indian Institute of Pulse Research, Kanpur, Uttar Pradesh, India
[2]ICAR-Central Tobacco Research Institute, Rajamundari, Andhra Pradesh, India
[3]KVK West Singh Bhum (Birsa Agriculture University), Ranchi, Jharkhand, India

***Corresponding author email**: aupadhyaya66@gmail.com

water supplying capacity to crops (Phillips *et al*., 1980). According to Johnson *et al*. (1984) and AI-Darby and Lowery (1986) when water stress occurs in northern latitudes, grain yields can be higher under no-till (NT) than under CT because NT has more available soil water in rooting profile. Raise bed planting is also being popularized by various stakeholders in 1GB for water saving but studies on moisture variation are lacking. Keeping this in view, an experiment was undertaken to study the status of soil moisture in four layers of soil and its variation between irrigations for ZT, CT and RB tillage methods on silty clay loam soil of Bihar (Laik *et al*., 2014).

MA TERIALS AND METHODS

A field experiment was conducted at Sabajpura farm of ICAR Research Complex for Eastern Region, Patna during three winter seasons. The study area was located at latitude of 25°27' N, longitude of 85^{0}10' E. The characteristics of the soil were: sand 20.8, silt 66.3 and clay 12.9%, saturated hydraulic conductivity 0.3 cm h^{-1}, unsaturated hydraulic conductivity 9.79 x 10^{-5} cm h^{-1}, porosity 48%, bulk density 1.40 g/cm^3 and organic carbon 0.60. The experiment consisted of four irrigation depths i.e. 3, 5, 7, and 9 cm, applied to three tillage methods (ZT, RB and CT). The soil moisture was measured in 0-15, 15-30, 30-45 and 45-60 cm depth of soil layers of each tillage practice. Weekly measurements started after two days of each irrigation were taken. The measurement of soil moisture was done by Time Domain Reflectrometry (TDR), which gives volumetric moisture content of the soil.

RESULTS AND DISCUSSION

Effect of Depth of Irrigation in Moisture content in Root Zone

Four depths of irrigation i.e. 3, 5, 7 and 9 cm were applied to each tillage methods and moisture content at four depths of soil layers i.e (0-15, 15-30, 30-45 and 45-60 cm) were measured. Average moisture contents after each irrigation are presented below in Figs. 1, 2, 3 & 4, respectively. It may be observed that for 3 cm depth of irrigation in top 0-15 cm depth of soil layer, the moisture content was lower i.e. CT (31.8%), ZT (33.7%), RB (B) (27.4%) and RB(F) (33%) than other depths of irrigation applied in tillage methods.. Though for 5, 7 and 9 cm depth of irrigation, the moisture content was found to increase with the depth of irrigation water but the increase was not significantly higher. It was also observed that difference in moisture content in lower

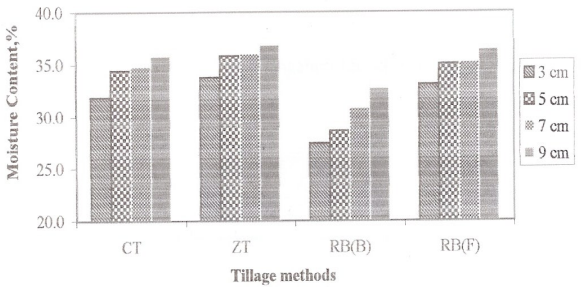

Fig. 1 : Average Moisture Content after each irrigation for different depth of irrgation in 0-15 cm soil layer

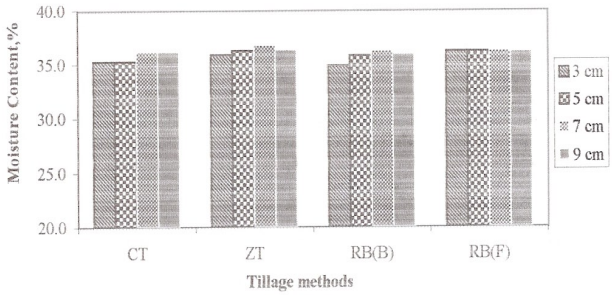

Fig. 2 : Average Moisture content after each irrigation for different depth of irrgation in 15-30 cm soil layer

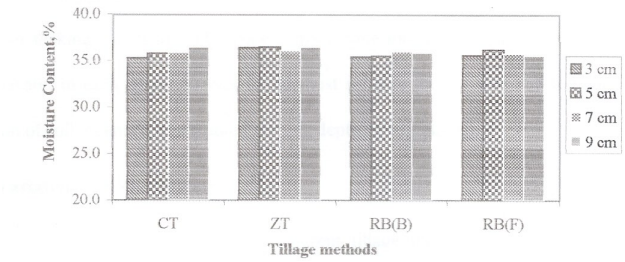

Fig. 3 : Average Moisture Content after each irrigation for different depth of irrgation in 30-45 cm soil layer

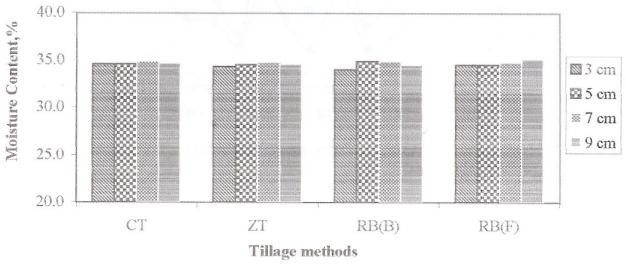

Fig. 3 : Average Moisture Content after each irrigation for different depth of irrgation in 45-60 cm soil layer

soil layers was negligible. Analysis revealed that 3 cm depth of irrigation water was not sufficient to meet the moisture deficit of the root zone and most of the irrigation water above 5 cm was not making significant difference in root zone moisture content. Singh *et al.* (2014) has also reported similar type of findings. Hence 5 cm depth of irrigation water in each irrigation was found most suitable for the area and temporal and spatial distribution of soil moisture was studied for this depth of irrigation.

Spatial Variation of Soil Moisture

Spatial variation of soil moisture under different tillage methods in different soil layers was studied for 5 cm depth of irrigation and presented in Figs. 5, 6, 7 and 8. It may be observed from above figures that in 0-15 cm depth of soil layer, moisture content differed significantly under different tillage practices and in lower layers of soil, the difference in moisture contents narrowed down. The moisture content in ZT is higher (37.6-29.4%) and on the beds of RB was lower (29.5-23.7%) than that under CT (36.5-25.2%). The moisture content in the furrows of RB was found at par to ZT method. In case of CT, the moisture contents in 15-30, 30-45 and 45-60 cm were observed nearly same and a bit higher than that at 0-15 cm depth of soil layer. On the beds of RB in 0-15 cm depth of soil layer, the moisture contents were lower as compared to deeper layers. Beyond 15 cm depth of soil layer, the moisture content was higher and at par with other tillage methods. In top 0-15 cm depth of soil layer, the rate of moisture depletion in ZT was the lowest and in CT it was the highest. In lower layers, decrease in moisture was less. It may be due to more utilization of soil moisture by crop from upper most layers owing to better root system there and comparatively higher moisture loss by environmental factors.

Temporal Variation of Soil Moisture

In order to study temporal variation of soil moisture under different tillage methods, the pooled maximum and minimum moisture contents of four soil layers between two consecutive irrigations were determined. The rate of decrease in moisture content per day between two consecutive irrigations is given below in table 1.

It may be observed from above table that the rate of depletion of moisture increased with time in all tillage methods. Among CT, ZT and RB method, the rate of depletion of moisture was highest in CT and lower in ZT. However in the furrows of RB the depletion of moisture content was the lowest. Between 1st and 2nd irrigations the depletion in moisture content was the highest in

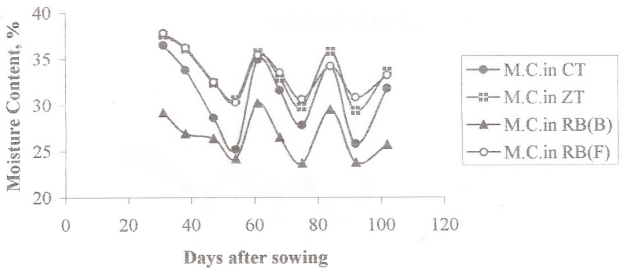

Fig. 5 : Variation in moisture content in 0-15 cm depth of soil under different tillage practices

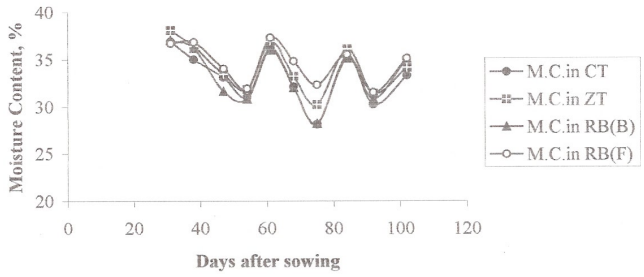

Fig. 6 : Variation in moisture content in 15-30 cm depth of soil under different tillage practices

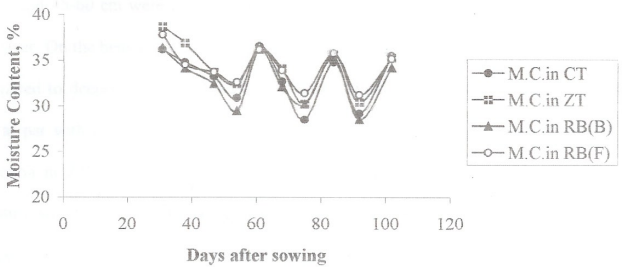

Fig. 7 : Variation in moisture content in 30-45 cm depth of soil under different tillage practices

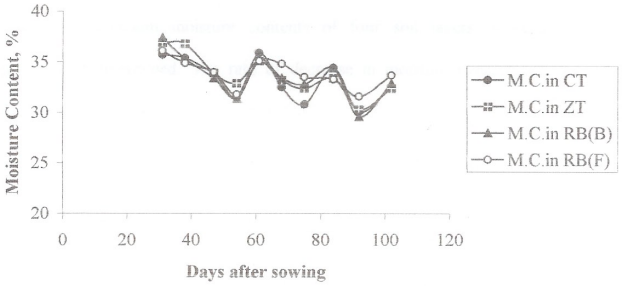

Fig. 6 : Variation in moisture content in 45-60 cm depth of soil under different tillage practices

CT (0.29%) followed by RB (B) (0.26%) and ZT (0.25%) and lowest in the RB (F) (0.24%). Between 2nd and 3rd irrigations it increased to 0.51% in CT, 0.41% in RB (B), 0.38% in ZT and 0.29% in RB (F). Between 3rd and 4th irrigation the depletion rate increased considerably in all the methods with 0.74% in CT, 0.66% in RB (B), 0.60% in CT and 0.44% in RB (F). It may also be observed that in ZT method, moisture content was higher than CT as well as RB (B) and rate of depletion of moisture content was also lower during entire crop growing season (Laik *et al*., 2014). Thus, it may be concluded that under limited water supply, the availability of water to plants is more in case of ZT than CT and RB (B) and crops may survive little longer periods if irrigation is delayed.

Table 1: Moisture depletion rate under different tillage methods

Tillage method	CT	ZT	RB(B)	RB(F)
Between 1st and 2nd irrigations	0.29	0.25	0.26	0.24
Between 2nd and 3rd irrigations	0.51	0.38	0.41	0.29
Between 3rd and 4th irrigations	0.73	0.60	0.66	0.44

CONCLUSION

In silty clay loam soils of Bihar, four irrigations (each of 5 cm depth of water) may be sufficient to meet the water needs of wheat crop. The soil moisture under ZT and in furrows of RB was found higher than that under CT and on the beds of RB method. The difference in moisture contents in 0-15 cm soil depth was maximum and in lower layers the difference narrowed down. The depletion of soil moisture increased with time in all the tillage practices, but the rate of depletion was lowest in the furrows of RB and ZT and the highest in CT method.

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