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Research Article

Variability of Soil Infiltration Rate in Different Grass Based Cropping System in Central India

Bheru Lal Kumhar, K. K. Agrawal*, A. K. Jha and H. K. Rai

College of Agriculture, Jabalpur, Jawaharlal Nehru Agricultural University, Jabalpur-482004

*Corresponding Author E-mail: kkagrawal59@gmail.com

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ABSTRACT

Field study was conducted during two consecutive years (2018-19 and 2019-200) at Research Farm, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur to evaluate the infiltration behaviour of soil under eight grass based cropping system combinations. The recommended dose of 150 kg N, 80 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied through urea, single super phosphate and muriate of potash. Results revealed that highest (6.1 and 11.6 m hr^{-1}) infiltration rate at the initiation (July, 2018) and end (June, 2020) of the study, respectively, was recorded under pearl millet napier hybrid in paired rows + ricebean - egyption clover system, however, sole cropping of guinea grass (GG) system recorded lowest (5.0 and 7.4 mm hr^{-1}) infiltration rate at above respective times which were higher than that recorded before initiation of the study (4.5 mm hr^{-1}) during 2016.

Keywords: *Vertisols, Infiltration rate, Cumulative infiltration, Grasses and Cropping system.*

INTRODUCTION

Infiltration is the hydrological process which specifies the knowledge of movement of water into the soil from surface sources such as precipitation and irrigation. Infiltration is the process of water entering in soil from the soil surface (Hillel, 1988) and the rate by which it enters into the soil is called the infiltration rate (Haghighi et al., 2010). It is influenced by many internal and external factors, such as rainfall characteristics, slope gradients, soil properties, suction head, humidity, water content, types of impurities and surface sealing and cropping system which, makes infiltration hard to quantify (Herrada et al., 2014). The infiltration rate of soil is reliant on several factors such as soil type, soil density, soil texture and moisture content (Angelaki et al., 2013). Infiltration rate of soil is inversely proportion to the water-holding capacity of soil (Singh et al., 2014). Physical changes in soil caused by differential rooting behaviour of crops also affect the infiltration rate (Gupta & Gupta, 2008). Different cropping system has variable potentials to alter the soil properties (carbon content, aggregation, porosity, bulk density and water retention and release behaviors) and also affect the water infiltration rate of the soil.

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Overall the infiltration rate is higher at the beginning which decreases in elapsed time as it approaches the saturated hydraulic conductivity. The constant rate at which water enters into the soil after attaining saturation is termed basic infiltration rate (Singh et al., 2019). The intake rate relies upon the physical, chemicals, and organic properties of the surface soil, the underlying dispersion of water in soil preceding irrigation, the transmission and redistribution of water over the surface. The measure of infiltration of water into the soil is an important indication concerning the efficiency of irrigation and drainage, optimizing the availability of water for plants, improving the yield of crops and minimizing erosion. The information about water transmission rate into the ground is vital concerning the productivity of water system and seepage, advancing the accessibility of water for the plants, enhancing the yield of harvests, limiting degradation of soil and wastage of the water. Therefore present study entitled "Variability of soil infiltration rate in different grass based cropping system in Central India" was under taken.

MATERIALS AND METHODS

Field study was conducted at Research Farm, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh during 2018-2019 to 2019- 2020 to assess the variability in water infiltration rate of a Vertisol as affected by different grass based cropping system. The study was comprised of eight treatments of grass based cropping systems *i.e.* pearlmillet napier (PN) hybrid sole crop (T_1), guinea grass sole crop (T_2), PN hybrid in paired rows + ricebean (*kharif*) - egyption clover (*rabi*) (T_3), PN hybrid in paired rows + *Desmanthus* (T_4), PN hybrid in paired rows + *Sesbania grandiflora* (T_5), guinea grass in paired rows + ricebean (*kharif*) - egyption clover (*rabi*) (T_6), guinea grass in paired rows + *Desmanthus* (T_7) and guinea grass in paired rows + *Sesbania grandiflora* (T_8) replicated thrice in randomized block design.. The recommended dose of 150 kg N, 80 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied through urea, single super phosphate and muriate of potash. Study was started 01.06.2018 as pre-establish crop from 01.06.2016 by using three months old root slips for planting of both PN hybrid and guinea grass. All the observations were recorded and common package of practices was adopted for raising the crops.

MEASUREMENT OF INFILTRATION RATE

In this study, the infiltration rate was measured using double ring infiltrometer (Perroux & White, 1988) which consists of two concentric metal rings and gauge. The diameter of the inward and outward rings was 30 and 60 cm individually and both had an equivalent height of 30 cm. Double rings were used to eliminate the problems of over estimating the infiltration rate due to three dimensional flows. Rings are put concentrically and hammered with the help of rammer to ensure 10 cm insert of rings into the soil consistently and measuring gauge has been placed on the rings. A thin sheet of plastic was used inside the ring to avoid the surface soil disturbance due to splashing action of poured water. The water poured over the plastic sheet up to a depth of 15–20 cm. The plastic sheet was removed slowly and the outer ring filled with water up to the same level as inside or more but not less than inside water level. Infiltration readings were recorded using hook gauge fixed over the gauging stand and rate of fall in water level was measured at 30 minutes time interval till constant value of infiltration at two time intervals achieved (Pandey & Pandey, 2019). The readings of infiltration were plotted on a graph against the time to compute the infiltration rate.

RESULTS AND DISCUSSION

Analysis of data was carried out for every 30 minutes elapsed time. Test of significance was carried out by prepared ANOVA Table. Analysis of infiltration rate under eight grass based cropping system was also done.

CUMULATIVE INFILTRATION (mm)

Data pertaining to variability in cumulative infiltration under different grass based cropping systems have been depicted in Figure 2 and 3. Result indicated that highest cumulative infiltration (58.0 and 112.0 mm) at

initiation (July 2018) and end (June 2020) of the study, respectively, was obtained under pearl millet napier hybrid in paired rows + ricebean - egyption clover system and lowest (44.5 and 71.0 mm) at above respective time have been under sole cropping of guinea grass (GG) system.

INFILTRATION RATE (mm hr^{-1})

Data pertaining to variability of infiltration rates in different grass based cropping systems are given in Table 1 and depicted in Figure 3. Result showed that both initial (July 2018) and final (June 2020) infiltration rate was maximum (6.08 and 11.63 mm hr^{-1}) under PN hybrid in paired rows + ricebean - egyption clover cropping system which was statistically at par with guinea grass in paired rows + ricebean - egyption clover system (5.98 and 10.34 mm hr^{-1}) and PN hybrid in paired rows + *Desmanthus* system (5.92 and 9.52 mm hr^{-1}) but significantly superior over those found under other cropping systems. Minimum infiltration rate (5.00 and 7.39 mm hr^{-1}) was found under sole cropping of Guinea grass system which have been statistically on par with those obtained under PN hybrid sole cropping (5.04 and 7.50 m hr^{-1}) and GG in paired rows + *Sesbania grandiflora* system (5.21 and 7.97 mm hr^{-1}), respectively during both the years of experimentation.

The higher rate of infiltration under pearlmillet napier hybrid in paired rows + ricebean - egyption clover is may be due to deep, fibrous and tap root system, minimum tillage practices, surface covered throughout the year, stubble decomposition and timely irrigation. Increase in infiltration rate to enhanced soil aggregates, stable aggregates and content reduction in bulk density due to inclusion of legume crops in perennial grass based cropping system is directly related to soil infiltration (Srivastava et al., 2018). Reduction of bulk density enhance the soil porosity and volume leads to faster infiltration rate. Sand and clay content is the most crucial factor, which affects the soil infiltration rate. The bulk density (BD) and moisture content showed another possible input as these properties inversely related to infiltration characteristics (Pandey & Pandey, 2019). The organic carbon (OC) content of the soil showed a positive correlation with infiltration. The similar results confirmed by (Pandey & Pandey, 2018), (Verma & Sahu, 2007) and (Chouhan, et al., 2018). Higher rate of infiltration may be attributed to lower bulk density, higher organic carbon content and better soil aggregation which improve the movement of water in soil (Brar et al., 2015).

Table 1: Effect of grass based cropping systems on infiltration rate a Vertisol

Cropping Systems		Infiltration rate (mm hr^{-1})	
		2018-19	**2019-20**
T_1	Pearl millet Napier (PN) hybrid sole cropping	5.04	7.50
T_2	Guinea grass (GG) sole cropping	5.00	7.39
T_3	PN hybrid in paired rows + Ricebean - Egyption clover	6.08	11.63
T_4	PN hybrid in paired rows + *Desmanthus*	5.92	9.52
T_5	PN hybrid in paired rows + *Sesbania grandiflora*	5.44	8.16
T_6	GG in paired rows + Ricebean - Egyption clover	5.98	10.34
T_7	GG in paired rows + *Desmanthus*	5.69	9.38
T_8	GG in paired rows + *Sesbania grandiflora*	5.21	7.97
SEm ±		**0.107**	**0.549**
CD (*p=0.05*)		**0.318**	**1.606**
Initial value		4.5 mm hr^{-1}	

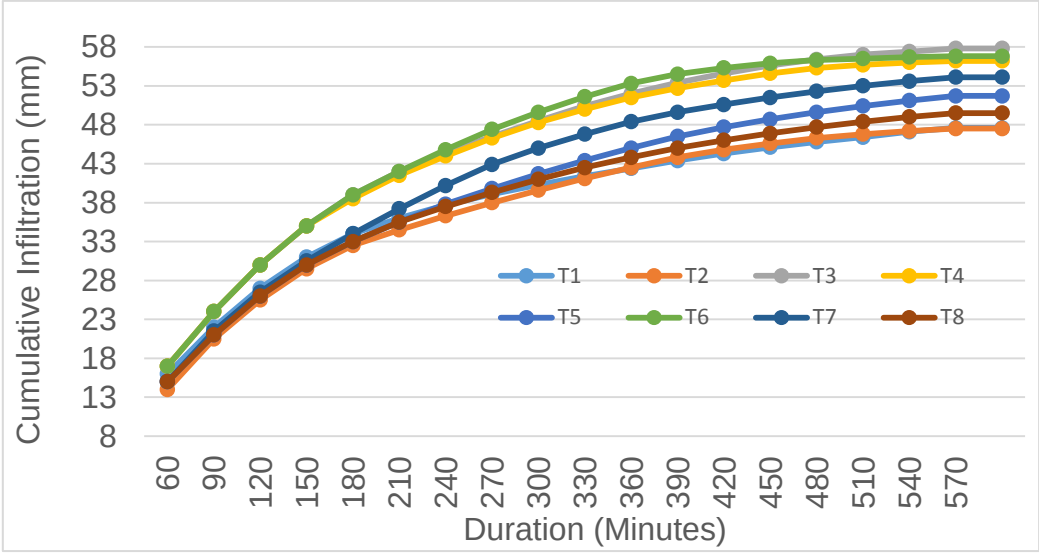

Fig. 1: Effect of grass based cropping systems on cumulative infiltration of a Vertisol during 2018-19

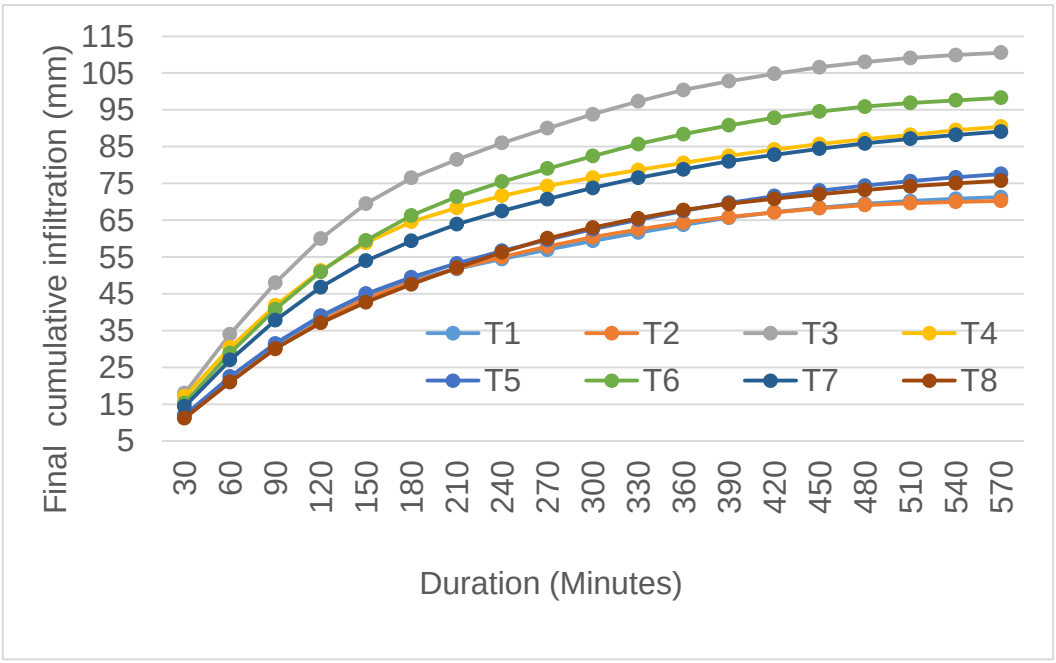

Fig. 2: Effect of grass based cropping systems on cumulative infiltration of a Vertisol during 2019-2020

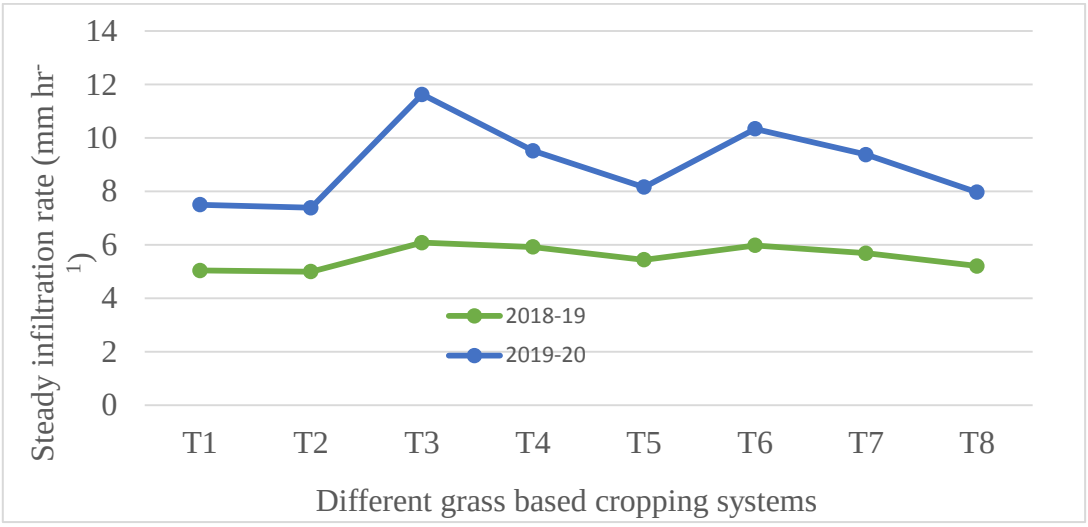

Fig. 3: Effect of grass based cropping systems on infiltration rate of a Vertisol

CONCLUSION

On the basis forgoing results it is concluded that, in grass based cropping system cumulative time is an essential parameter which affects the infiltration rate of the soil. The highest steady rate of infiltration was recorded under pearlmillet napier hybrid in paired rows + ricebean - egyption clover.

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