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Effect on crop growth and soil physical properties under different micro irrigation systems and tillage methods in direct seeded rice

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Abstract
A field trail was carried out during *kharif* season of 2010 and 2011 on sandy loam soil under (IRRI-SVPUA&T Meerut, Uttar Pradesh) collaborative research project to evaluate crop yield and soil properties under different micro irrigation systems and tillage methods under direct seeded rice in a split plot design. Above study had showed that different micro irrigation system non-significant effect but numerically sprinkler irrigation system with reduce tillage performance better in the line of producing more yield over flood irrigation, Drip & Chaplin respectively in both the year. Moreover flood irrigation under interaction of zero tillage improved water intake. While the effect of different irrigation systems and tillage practices on soil physical properties was found non-significant. But it was not clear from data which irrigation system with tillage practice is best because most of interaction effect comes non-significant. Micro irrigation system could be batter option for rice growing particularly in those areas where ground water declivity was rapidly. For study of micro irrigation system and tillage options on soil properties may be require long term experiments.

Keywords: direct seeded rice, micro irrigation, crop performance soil properties and tillage

Introduction
In India, Rice is the staple of food for 65% of population and contributes 20-25% of the agricultural GDP (Singh *et al*. 2001) [1]. It is grown over an area of 43 million hectares with total production of 99.2 million tonnes amounting to 43% of the total food production. Stagnating productivity growth and declining input-use efficiency under the current production practices in intensive irrigated rice-wheat system of indo-Gangetic Plains (IGP) coupled with diminishing availability of water for agriculture is a major concern for food security in South Asia (Ladha 2003, Gupta and Seth, 2007, Saharawat 2009) [3, 4]. Improving resource-use efficiency and crop productivity is of utmost importance in IGP, where water is the most limiting input for rice productivity (Gupta and Sayre, 2007) [3]. Water and labour scarcity is becoming major concern for the productivity and sustainability of the rice-wheat cropping system in South Asia. Agriculture's share of fresh water supplies is likely to decline by 8-10% because of increasing competition from the urban and industrial sectors (Seckler *et al*. 1998) [6]. In many parts of Asia, over exploitation and poor management of groundwater has led to dropping water table and negative environmental impacts. Conventional flooded rice receiving the largest amount of fresh water compared to any other crop is the major contributor to the problems of declining groundwater table (0.1-1.0 m year) and increasing energy use (Singh *et al*. 2001) [1]. The problem has further been intensified with the timely unavailability of labour and increasing labour wages. Micro-irrigation systems (sprinkler and drip) coupled with alternative tillage and crop establishment methods have the potential to improve resource-use efficiency as compared to the conventional flood-irrigated system, where water-use efficiency is only 35-40%. Saharawat *et al*. (2009) [4] and Ladha *et al*. (2003) have reported that dry direct-seeding of rice and wheat after no-tillage performed as well as the conventional practice but with significant savings in water and labour use. Micro-irrigation systems are prevalent from last two decades. Research studies on micro-irrigation systems conducted in India by various institutions indicate water saving of about 40-80% and the yield increase up to 100% for different crops especially in fruit, vegetables and plantation crops.

Materials and Methods
Experimental site
A medium term study was conducted at Chirrori research farm of the Sardar Vallabhbhai Patel

University of Agriculture and Technology, Meerut (U.P.) during kharif 2010 and 2011, located in Indo-Gangetic plains of Western Uttar Pradesh, India (290 13' 96‖ N, 770 68' 43‖ E). The region enjoys semi-arid and subtropical climate with average rainfall 806 mm (75-80% of which is received during June-September). Extremes of hot weather in summer and cold in winter season. Seasonal weather data including rainfall, evaporation rate, minimum and maximum temperature, during the two years are presented in Fig. 1. The site was under a continuous R-W system for many years before the establishment of the experimental farm. The initial soil characteristics from experimental site of upper layers were saline in nature, loam in texture, low in organic carbon & nitrogen and high in available phosphorus and potassium.

Experimental detail

The experiment was laid out in 3 replications in a split plot design with 5 treatments viz. T1 Farmer practice of water, T2: drip irrigation, T3: sprinkler irrigation, T4: Chapin (It was same as drip but cheap due to material used in chapin was low quality), T5: Low energy water application (LEWA) in main plots and two tillage (zero and reduced) in sub plots. The sub-plot size was 50m x 20m.

Crop management

The site was cultivated and laser levelled two year prior establishment of the experiment. The reduced tillage plots were prepared by two harrowing and cultivators followed by wooden planking. However zero tillage plots were not disturbed. The rice crop was direct seeded on 19th June in 2010 and 15 June during 2011 with the short duration (115 days) hybrid variety Arize 6129 using a seed cum fertilizer drill. Seed rate was 25 kg/ha with row spacing of 20 cm.

Fertilizer application

In DSR, Recommended dose of fertilizer 150 kg N/ha as urea and DAP, 32.3 kgP/ha as DAP and 62.5 kg K/ha as MOP and 5.25 kg Zn as ZnSO4.7H2O was applied. Basal dose of N and whole amount of P, K and Zn was applied at the time of sowing and after that nitrogen was top dressed in two splits at 20-25 DAS and 40-45 DAS, respectively. Apart from that three foliar sprays of 1% ferrous sulphate were given for correcting iron deficiency.

Results and Discussion

Yield

It is evident from the data presented in table 1 during both the study years the effect of treatments and its interaction was non-significant except tillage practices in year 2010. However, numerically higher grain yield was recorded with sprinkler followed by drip under reduced tillage condition during both the years. Only in year 2010 grain yield was significantly higher under reduced tillage than zero tillage, however in 2nd year the yield was statistically comparable in both the tillage practices. However total biomass and straw yield were exhibited statistically differences in between treatments. Effect of treatments on Straw and biomass yield was also found statistically comparable. However, Sprinker under reduced condition was produced numerically higher biomass and straw yield than any other treatments. The grain yield was slightly higher in 2010 than 2011 might be due to in 2011 higher amount of rain at the time of germination. It is also reported that due to uniform distribution of water micro irrigation system improved the rice grain yield significantly than flooded application. In contrast to research study in first year yield was higher in RT might be due to lower weed infestation in RT plots than ZT. However, weed dynamics was not made in present study. Although from second year our study results are in concurrence with the Liu and Kang (2006) [8], Yasser *et al*. (2009) [9], Gathala *et al*. (2011) [10], and Saharawat *et al*. (2009) [4]. The improvement of yield attributes might be due to change in the micro-climate under different micro irrigation systems and ZT plot along with residue management that helps in moisture conservation, regulate soil temperature as compare to reduced tillage. Prevent puddling is known for improvement of physical properties in both RT and ZT, and in turn improves overall soil health, water-use efficiency, crop productivity, and farmers' income.

Soil bulk density: It is clear from that the bulk density at different depth of soil was not affected. Either by irrigation and tillage method and their interaction effect was also non-significant. In general, soil bulk density increased with increasing soil depth. In every irrigation system and at similar depth more bulk density was found in reduced tillage as compared to zero tillage exception of 11-15 cm in the year of 2011. This was attributed mainly due to more pore spaces created in the beds through modified land configuration and irrigation system by accumulations the topsoil. These results are in conformity with those reported earlier by Hobbs and Morris (1996) [11].

Infiltration rate: Infiltration rate in soil as shown in was non-significantly affected by irrigation systems, and tillage method was non-significant. Highest value of infiltration (.18 cm/hr) was recorded in flood irrigation higher than sprinkler, drip & Chaplin drip respectively both the year. Although infiltration rate was not affected significantly by tillage methods but higher rate was recorded in zero tillage when compared to reduced tillage both the year, the highest infiltration rate (0.17 cm/hr) was found in zero tillage in the year of 2011. It was mainly due to tillage destroys soil aggregates, breaks capillary pores, reduces permeability in sub-surface layers and forms hard pans that have a negative effect on the present and succeeding crops (Ladha 2003, Gupta and Seth, 2007, Saharawat 2009) [3, 4].

Table 1

Tillage	Irrigation System	Rice Yield (t ha-1)					
		Grain Yield		Straw Yield		Biological Yield	
		2010	2011	2010	2011	2010	2011
ZT	Flood	4.63	4.56	7.20	6.53	11.83	11.09
	Drip	4.78	4.43	7.38	6.79	12.16	11.22
	Chapin	5.06	4.50	7.08	6.68	12.14	11.18
	Sprinkler	5.16	4.56	7.35	6.83	12.51	11.39
	LEWA	4.91	4.63	7.43	6.75	12.34	11.38
RT	Flood	5.36	4.83	7.95	7.04	13.31	11.86
	Drip	5.50	4.82	7.98	6.93	13.47	11.75

	Chapin	5.24	4.69	7.75	6.78	12.98	11.48
	Sprinkler	5.54	5.02	8.50	7.36	14.04	12.38
	LEWA	5.12	4.94	7.83	6.97	12.95	11.90
Mean of T	ZT	4.9	4.5	7.3	6.7	12.2	11.3
	RT	5.4	4.9	8.0	7.0	13.4	11.9
Mean of IS	Flood	5.0	4.7	7.6	6.8	12.6	11.5
	LEWA	5.1	4.6	7.7	6.9	12.8	11.5
	Chapin	5.1	4.6	7.4	6.7	12.6	11.3
	Sprinkler	5.3	4.8	7.9	7.1	13.3	11.9
	Drip	5.0	4.8	7.6	6.9	12.6	11.6
LSD 0.05							
IS		NS	NS	NS	NS	NS	NS
T		0.4	NS	NS	NS	NS	NS
IS X T		NS	NS	NS	NS	NS	NS

Table 2

Tillage	Irrigation System	BD 0-5		BD 6-10		BD 11-15		BD 16-20		IFL	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
ZT	Flood	1.48	1.46	1.61	1.58	1.73	1.70	1.76	1.72	0.18	0.18
	Drip	1.47	1.45	1.60	1.57	1.75	1.71	1.77	1.73	0.15	0.18
	Chapin	1.45	1.44	1.62	1.58	1.75	1.71	1.77	1.74	0.14	0.15
	Sprinkler	1.46	1.44	1.61	1.58	1.73	1.69	1.75	1.71	0.13	0.17
	LEWA	1.48	1.45	1.58	1.55	1.75	1.72	1.77	1.74	0.15	0.16
RT	Flood	1.47	1.46	1.63	1.60	1.74	1.71	1.76	1.72	0.16	0.14
	Drip	1.51	1.47	1.58	1.55	1.76	1.72	1.78	1.74	0.15	0.16
	Chapin	1.49	1.44	1.63	1.59	1.75	1.71	1.78	1.74	0.13	0.14
	Sprinkler	1.46	1.45	1.63	1.60	1.75	1.72	1.78	1.75	0.14	0.16
	LEWA	1.50	1.47	1.63	1.60	1.75	1.71	1.78	1.75	0.14	0.15
Mean of T	ZT	1.47	1.45	1.60	1.57	1.74	1.71	1.76	1.73	0.15	0.17
	RT	1.49	1.46	1.62	1.59	1.75	1.71	1.77	1.74	0.14	0.15
Mean of IS	Flood	1.48	1.46	1.62	1.59	1.74	1.70	1.76	1.72	0.17	0.16
	LEWA	1.49	1.46	1.59	1.56	1.75	1.72	1.77	1.74	0.15	0.17
	Chapin	1.47	1.44	1.62	1.59	1.75	1.71	1.77	1.74	0.13	0.14
	Sprinkler	1.46	1.45	1.62	1.59	1.74	1.70	1.77	1.73	0.13	0.16
	Drip	1.49	1.46	1.61	1.57	1.75	1.72	1.78	1.74	0.15	0.15
LSD 0.05											
IS		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
T		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
IS X T		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

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