Journal of Agrometeorology 21 (1) : 93-96 (March 2019)

Short Communication

Effect of resource conservation technologies (RCT's) on yield and water productivity of wheat (*Triticum aertivum L.*) under vertisols of Tungabhadra project command area of Karnataka

R. H. RAJKUMAR[1*], A.T. DANDEKAR[2], S.R. ANAND[3], J. VISHWANTHA[4], A.V.KAREGOUDAR[4] and P.H. KUCHNUR[5]

[1]Directorate of Research, UAS, Raichur-584 104, Karnataka*

[2]College of Agricultural Engineering, Raichur-584 104, Karnataka

[3]AICRP on Potential crops, UAS, GKVK, - Bangalore Karnataka

[4]AICRP on Management of Salt Affected Soils and Use of Saline Water in Agriculture, Agricultural Research Station, Gangavathi-583 227, Karnataka

[5]College of Agriculture Bheemarayangudi, Karnataka

**Corresponding author E-mail: halidoddiraju@gmail.com*

The resource conservation technologies (RCT) such as precision land leveling (laser guided land leveling), zero-tillage (ZT) and bed planting have been shown to be beneficial in terms of improving soil health, water use, crop productivity and farmers' income (Gupta and Seth 2007). Laser-assisted precision land leveling considered as a precursor technology for RCTs have been reported to improve crop yield and input-use efficiency including water and nutrients (Jat *et al.,* 2006). This also results in saving of excessive loss of irrigation water through deep percolation and increases the application efficiency up to 25 per cent (Sattar *et al.,* 2003). Precision Land leveling has been shown to improve water management and it saves up to 50 per cent of irrigation water. Other benefits of laser land leveling include improved crop stand and crop productivity and micro-environment (Jat *et al.,* 2006; Wakchaure *et al.* 2015).

Zero tillage (ZT) cultivation accelerates oxidation of organic matter by soil micro-organisms through change in soil water relationship, aeration and temperature regimes and nutritional environment (Doran *et al.,* 1987). In wheat, ZT reduces irrigation requirements compared with conventional-tillage by using residual water more effectively (Gupta *et al.,* 2003). The intensive tillage operations after the harvest of transplanted rice not only require a huge amount of energy and time but also increase the cost of production. To make system economically viable, it is essential to reduce the cost of input per unit. Under such situation, zero tillage in laser leveled land technology could be a valid option to reduce the turn around time, cost and establishment of good plant stand of wheat without loss in productivity and sustainability of natural resources with increase in water production efficiency. Many studies were conducted on RCTs based single crop in rice-wheat system but no attempt has been made to study the effect of combined RCTs (precision land leveling, zero tillage and residue management) in wheat in Tungabhadra project (TBP) command areas,hence this study was proposed.

The experiment was conducted during 2012-13 to 2014-15 at Agricultural Research Station (A.R.S) Gangavathi of Koppal district, Karnataka state having latitude of 15°27'22.34" N and longitude of 76°31'54.59" E.The study area is situated in the north-eastern dry zone of the state (Altitude of 419 m above mean sea level) which is having average annual rainfall of 572 mm. The average effective rainfall during the cropping season (October to March) was 149.1 mm. The average evaporation of the experimental site during cropping season was 3.55 mm day^{-1}. The experiment was laid out in eight plots with an area of 0.06, 0.06, 0.05, 0.06, 0.08, 0.08, 0.11 and 0.11 ha. Before implementation of the experiment the initial slopes of the experiment site was measured and the slope ranges from 0.25 to 0.30 per cent and land was well prepared with two times tillering and one time rotovator for first sowing only. The experiment consisted of eight treatments *viz*.,

T_1 : Control (Farmer's practice i.e. normal leveled with bullock sowing)

T_2 : zero tillage with 100 per cent previous crop residue retained

T_3 : zero tillage in 100 per cent previous crop residue removed

T_4 : zero tillage with 50 per cent previous crop residue retained

T_5 : laser leveling with zero tillage and 100 per cent previous crop residue retained

T_6 : laser leveling with zero tillage and 50 per cent previous crop residue retained

T_7 : laser leveling with zero tillage and100 per cent previous crop residue removedand

T_8 : laser levelingwith farmer's practice.

The experiment was laid out as per the randomized completely block design (RCBD). The soil of the site was medium black clay in texture (clay, silt and sand in the proportion of 48.9, 29.0 and 22.1 per cent, respectively) having an infiltration rate of 5.5 mmh^{-1}. The mean bulk density and soil porosity of the experimental site ranged between 1.4 to 1.5g cc^{-1} and 42.2 to 47.1 per cent respectively.The soil moisture was measured with gravimetric method for three times (Initial, 90 days after sowing and at harvest) at a depth of 0-15 and 15-30 cm.Laser leveling was done in different blocks as per the treatments (T_5, T_6,$T_7$and T_8). For the second season onwards the residue of harvested wheat was retained and sowing was done with the help of zero till seed cum fertilizer drill with inclined plate disc for the treatments of T_2, T_3,T_4,T_5, T_6 and T_7.The wheat was sown during *rabi* with row spacing of 23cm between two rows and for conventional tillage (T_1, T_8) the traditional method of sowing with bullocks was followed with same spacing.For zero tillage treatments, the pre emergent and post emergent sprayers were taken for the control of weeds and for conventional tillage methods the hand weeding was done. The quantum of irrigation water applied at each time for all the eight treatments were measured with cut-throat flume along with duration of irrigation. The applied irrigation depth was calculated by using the following equation:

QT=AD

Where Q = Discharge (cubic $metreh^{-1}$); T = Time (h); A = Area (hectare), and D = Depth (mm).

The amount of water (m^3) applied to each treatment was determined by multiplying the discharge at field outlet with the time of application. The total amount of water applied was computed for the entire crop season for all the four treatments. Irrigation water productivity (IWP) was computed as follow:

IWP ($kg\ m^{-3}$) = Yield ($kg\ ha^{-1}$) / Total volume of water applied (m^3ha^{-1})

Yield and its attributes

Pooled data of three years results revealed that significantly higher grain and straw yield was recorded in laser leveling with zero tillage and 100 per cent previous crop residue retained treatment (2450 and 2756 kg ha^{-1}, respectively) which was on par with laser leveling with zero tillage and 50 per cent previous crop residue retained treatment (2340 and 2654 kg ha^{-1}, respectively) as compared to other treatments and significantly lower yield (1850 kg ha^{-1}) was recorded with control (Farmers practice). Data's onnumber of seeds in five plants, panicle length, plant height and number of tillers per square meter were also recorded and found significantly higher in laser leveling with zero tillage and 100 per cent previous crop residue retained treatment and lowest in control (Table 1). This could be attributed to laser land leveling which may have helped in equal distribution of salt on the upper soil crust and moisture was retained in residue mulching which helps in lesser evaporation from the soil surface and leads to favorable condition to the growth of crop. These results are in line with the finding of Jat *et al. (*2009)

Water used and irrigation water productivity

Among eight treatments the quantum of irrigation water applied (includes effective rainfall) was less in case of laser leveling with zero tillage and 100 per cent previous crop residue retained treatment (454 mm) followed by laser leveling with zero tillage and 50 per cent previous crop residue retained treatment (462 mm) but was more in case of farmers practice i.e. in control treatment (530 mm). The total water saving was to the extent of 14.3 per cent in case of laser leveling with zero tillage and 100 per cent crop residue retained treatment over control treatment (Table 2). The saving in the applied irrigation was mainly because of the precision land leveling which helps in attaining the equal height of ponded water all over the corner. The irrigation water productivity for the wheat crop was calculated and it was observed that higher irrigation water productivity was recorded in case of laser leveling with zero tillage and 100 percent previous crop residue retained treatment (0.54 kg m^{-3}) followed by laser leveling with zero tillage and 50 per cent previous crop residue retained treatment (0.51 kg m^{-3}) and least in case of control treatment (0.35 kg m^{-3}) (Table 2).

Soil moisture and irrigation water productivity relation

The soil moisture in T_5 treatment during 90 DAS was

Table 1: Effect of precision land leveling, zero tillage and residue on wheat growth parameters (Pooled data of three years)

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	No of seeds in 5 plants	Length of spike (cm)	Plant height (cm) at harvest	No. of tillers per m^2
T_1	1850	1955	232	6.3	58.7	320
T_2	2040	2320	240	7.5	66.1	360
T_3	1880	2100	223	6.4	58.8	327
T_4	1890	2220	237	6.9	59.6	333
T_5	2450	2756	278	7.8	71.5	431
T_6	2340	2654	255	7.6	70.5	423
T_7	2130	2365	240	7.5	68.2	329
T_8	2010	2218	245	7.5	66.7	333
SE.m±	34.12	36.25	8.65	0.25	1.94	15.30
CD @ 5%	112.2	120.5	33.5	0.86	5.6	48.4

Table 2: Effect of precision land leveling, zero tillage and residue on total quantity of irrigation applied under vertisols (Pooled data of three years)

Treatments	Irrigation applied (m^{3}ha^{-1})	Irrigation applied (mm)	Effective rainfall during cropping season (mm)	Total Irrigation applied (mm)	Water saving (Percentage over control)	Total water (Irrigation+ rain) use (m^3 ha^{-1})	Irrigation water productivity kg grain m^{-3} water)
T_1	3809	381	149	530	_	5300	0.35
T_2	3573	357	149	506	4.47	5064	0.40
T_3	3473	347	149	496	6.36	4964	0.38
T_4	3568	357	149	506	4.57	5059	0.37
T_5	3053	305	149	454	14.28	4544	0.54
T_6	3126	313	149	462	12.89	4617	0.51
T_7	3152	315	149	465	12.40	4643	0.46
T_8	3128	3138	149	462	12.85	4619	0.44
SE.m±	56.2	12.2	-	9.6	0.8	52.1	0.1
CD @ 5%	159.2	32.4	-	25.3	2.1	160.2	0.3

Table 3: Soil moisture content during initial, 90 DAS and at harvesting stage at 0-15 and 15-30 cm depths

Treatments	Initial soil moisture (%)		Soil moisture (%) at 90 DAS		Soil moisture (%) at harvest	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1	16.1	17.5	10.2	11.4	7.6	8.1
T_2	15.8	18.2	13.6	13.9	12.6	13.5
T_3	16.0	17.9	10.5	10.9	8.5	9.1
T_4	16.2	16.9	10.0	11.6	8.9	9.5
T_5	16.0	17.7	14.2	15.9	13.8	14.7
T_6	16.4	17.8	12.8	13.5	12.7	12.9
T_7	16.5	17.4	11.6	12.2	11.0	11.5
T_8	16.8	17.0	11.0	11.8	10.4	

14.2 and 15.9 per cent for 0-15 and 15-30cm depth respectively. Similarly soil moisture at harvesting stage was 13.8 and 14.7 per cent at a depth of 0-15 and 15-30 cm respectively (Table 3). From this it can also be seen that as depth increased soil moisture also increased, the same trend was also observed in all other treatments but the magnitude of soil moisture was less as compared to T_5 treatment. In comparison with T_1 treatment the moisture content was higher in all the treatment where leveling was carried out and a percent of residue retained. Because of less evaporation from the treatments which are having some percentage of residue acting as a cover over the soil surface, due to this it was observed the higher moisture. This led to less amount of water supply for those treatments which are having crop residue. It may also be attributed to laser leveling in uniform distribution of moisture in the field. Hence the water applied was less (454 mm) in T_5 compared to T_1 (530 mm) and the irrigation water productivity was higher (0.54 kg m^{-3}) in T_5 compared to T_1 (0.35 kg m^{-3}). These results are in line with findings of Wakchaure *et al*. *(*2015).

Thus the RCT's viz., precision land leveling, zero tillage and residue retention have effect on soil moisture, irrigation water productivity and yield of wheat crop. It was found that laser land leveling and 100 per cent residue retained treatment was found better with respect to moisture retention and irrigation water productivity which was on par with 50 per cent crop residue retention.

REFERENCES

Doran, M., Frankenberger, W. T. J and Smith, L. H. (1987). The influence of organic matter on soil aggregation and water infiltration. *J. Prod. Agri.,*2: 290-299.

Gupta, R. K., Hobbs, P.R., Jiaguo, J and Ladha, J.K. (2003). Sustainability of post-green revolution agriculture. In: Ladha, J.K., et al. (Eds.), Improving the Productivity and Sustainability of Rice–Wheat Systems: Issues and Impacts. ASA Spec. Publ. 65, ASA, CSSA, and SSSA, Madison, WI. pp. 1-25.

Gupta, R. K and Seth, A.(2007). A review of resource conserving technologies for sustainable management of the rice–wheat cropping systems of the Indo- Gangetic plains. *Crop Prot.*, 26:436-447.

Jat, M. L., Chandana, P., Sharma, S.K., Gill, M.A. and Gupta, R.K. (2006). Laser Land Leveling: A Precursor Technology for Resource Conservation. Rice-Wheat Consortium Technical Bulletin Series 7.Rice-Wheat Consortium for the Indo-Gangetic Plains, New Delhi, India.pp. 48.

Jat, M.L., Gathala, M.K., Ladha, J.K., Saharawat, Y.S., Jat. A. S., Vipin Kumar., Sharma. S. K., V. Kumar and Raj Gupta. (2009). Evaluation of precision land leveling and double zero-till systems in the rice–wheat rotation: Water use, productivity, profitability and soil physical properties. *Soil Tillage Res*., 105: 112-121.

Sattar, A., Khan. F. H and Tahir, A.R. (2003). Impact of precision land leveling on water saving and drainage requirement. J. AMA. 34: 39-41. U.S. Department of Agriculture. 1977. Research progress and needs conservation tillage. USDA-ARS, North Center Region, ARS-NS: 57.

Wakchaure, G. C., Choudhary. R. L., Khaledonkar M.J and Bal. S. K. (2015). Effect of precision land levelling on micro environment and sorghum productivity in water scarce Deccan region. *J.Agrometeorol.,*17(2): 149-157.

Received : July2018; Accepted: January 2019