Int.J.Curr.Microbiol.App.Sci (2017) *6*(9): 4174-4183

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 7 (2017) pp. 4174-4183**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.607.432

Effect of Different Crop Establishment Methods, Tillage and Residue on Yield, Yield Attributes and Economics of Ricein RW System of Northern Plains of IGP

J.M. Sutaliya* and U.P. Singh

Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India- 221 005
**Corresponding author*

Keywords

Crop establishment methods, Rice, Yield, Economics, Tillage, DSR, ZTDSR, and Residue

Article Info

Accepted:
29 June 2017
Available Online:
10 July 2017

A B S T R A C T

The suitable crop establishment options with appropriate amount of residue retention may lower weed infestation, better crop growth, productivity, profitability and soil health. The overall goal of the present experiment was to assess the impacts of different crop establishment options on rice growth and yield in eastern Uttar Pradesh, India. Specific objective of the study was to determine the effects of different crop establishment methods on productivity and profitability of rice.The strategy was to assess yield response measured during two consecutive seasons of the rice with different crop establishment methods. The impacts on rice yield, yield attributes and economics were assessed for different crop establishment [RE_1:- Puddled transplanted rice (PTR), RE_2:-Reduced till-direct seeded rice (RT-DSR), RE_3:-Zero till-direct seeded rice (ZT-DSR) and RE_4:-Zero till-direct seeded rice with 30cm anchored wheat residue (ZT-DSR+AR)]. The field experiment was laid out according to a complete randomized block design with four replications. The different crop establishment methods did not influence significantly the yield and yield attributes [panicles m^{-2} (no), panicle length (cm), panicle weight (g), grains $Panicle^{-1}$ (no), 1000 grains weight (g)]of rice except number of panicle m^{-2} in both the years but higher value of yield and yield attributes were recorded by ZT-DSR+AR followed by ZT-DSR and RT-DSR. The highest gross return (₹ ha^{-1}), net return (₹ ha^{-1}) and B: C ratio recorded in ZT-DSR+AR that followed by ZT-DSR and RT-DSR crop establishment methods, whereas lowest with PTR.

Introduction

Rice and wheat are staple food crops of the world cultivated on an area around 370.4 m ha. A large proportion of world population relies on rice and wheat for daily caloric intake, income and employment. Rice-wheat cropping system is one of the major cropping systems in South Asia and is practiced in 14 million hectares area (Singh *et al.*, 2010) providing food for more than 400 million people.

The rice–wheat production systems are fundamental to employment, income, and livelihoods for hundreds of millions of rural and urban population of South Asia (Saharawat *et al.*, 2010). This system covers about 10.5 million hectares in India contributes 26% of total cereal production, 60% of total calorie intake and about 40% of the country’s total food basket (Sharma *et al.*, 2015).In India rice occupies nearly 44.1

million hectares area, 105.5 million tonnes total production with a productivity of 2291 kg/ha productivity for the year 2014-15 (Anonymous, 2016). Rice is the most important staple food in Asia, where more than 90% of the world's rice is grown and consumed.

Tillage is one of the basic inputs of crop production, actually tillage alters the rhizosphere environment by modifying most of the physical properties of the soil, *viz*. bulk density and soil strength, hydraulic conductivity and aggregates stability, infiltration rate and porosity due to formation, destruction and rearrangement of soil particles and aggregates and alternation in clod size distribution (Guzha, 2004).In the conventional systems involving intensive tillage, there is gradual decline in soil organic matter by quicker oxidation and burning of crop residues causing pollution, greenhouse gases emission, and loss of valuable plant nutrients. However, the extent of the impacts of tillage is variable depending upon the inherent soil characteristics and climatic conditions.

Efficient management of costly input like diesel, at present having substantial subsidy, can help in reducing the cost of production, and thereby making, the produce more competitive. In conventional practice of rice growing with manual transplanting of rice seedlings in random geometry after intensive dry, wet tillage and puddling contributes significantly to these challenges, making this system unsustainable.

Puddling effects adversely on soil-physical condition for establishment and raising the succeeding crops (Tripathi *et al.*, 2003). This practice is water, capital and energy intensive, and deteriorates soil health (Sharma *et al.*, 2003). Puddling leads to the formation of a hard-pan at shallow depths deteriorates soil physical properties and delays planting of a succeeding wheat crop. Timely planting of wheat is crucial as yield reductions of 1–1.5% per day occur for each day after the optimum sowing date, November 15 in the IGP (Hobbs and Morris, 1996).

Retaining crop residues on the soil surface provides a source of plant nutrients, improves organic matter level in the soil and increased soil water content by reducing evaporation and increasing infiltration rate (Chastin *et al.*, 1995). Conservation tillage systems not only reduce erosion and improve the soil environment for crop growth, but also conserve energy and decrease the labour cost of farming (Triplett and Van Doran, 1977).

Due to rising cost of labour and excessive water use in puddling for transplanting rice in the irrigated eco-systems, direct seeding of rice is gaining popularity in south-east Asia (Balasubramanian and Hill, 2002). Direct-seeded rice needs only 34% of the total labour requirement and saves 29% of total cost of the transplanted crop (Ho and Romli, 2002). Important factors that are forcing a shift from the traditional puddled-transplanting system to unpuddled direct seeding of rice are shortages of labour and water, and escalating fuel prices.

Resource-conserving technologies (RCTs) such as zero-tillage (ZT) and un-puddled transplanting have been shown to be beneficial in terms of improving soil health, water use, crop productivity and farmers' income (Gupta and Sayre, 2007; Singh *et al.*, 2009).

The present experiment was conducted to determine suitable crop establishment options with appropriate amount of residue retention may lower weed infestation; improve crop growth, productivity, profitability and soil health in rice wheat cropping system.

Materials and Methods

Experimental site

A field experiment was conducted during *kharif* season of 2011 and 2012 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University (BHU), Varanasi, Uttar Pradesh, India. The experimental site is located in the south-eastern part of the Varanasi. The geographical location of the farm lies at $25^0$18'N latitude and $88^0$36'E longitude at an altitude of 128.93 meters above the mean sea level in the Northern Gangetic alluvial plains.

Crop and climate

The climate of experimental site is typically semi-arid to sub-humid, characterized by extremes of temperatures both in summer and winter with low rainfall and moderate humidity. The normal period for the onset of monsoons in this region is the third week of June and it lasts up to the end of September or sometimes extends to the first week of October. Winter showers are often experienced between December and mid-February. However, a dry spell of three months occurs from March to May. Long term average (over 1980 to 2015) of annual rainfall for this region amounts to 1081.5 mm, out of which 944.5 mm (87.33 per cent) is received during the monsoon or rainy season (June to September) and 137.0 mm (12.67 per cent) during post monsoon season or post rainy season. The winter months (with the temperature of 9.3^0C) are cool whereas summers are hot (39^0C) and dry. The coldest and hottest months are first half of January and May, respectively. The temperature begins to rise in February and reaches the maximum in May. The maximum temperature usually fluctuates between 22°C and 40.7°C while minimum temperature varies from 8.6 to 29.9°C occasionally extreme of minimum and maximum temperature variations are realized (Table 1).

Soil analysis

In order to assess the physio-chemical properties, soil samples were taken from surface soil (0-15 cm) before conducting the experiment considering all possible precautions prescribed for soil sampling (Black *et al.*, 1965). For soil sampling, each plot was divided into four grids. Within each grid cell, soil was collected from four spots and. The soil samples were air-dried in the shade, grinded and passed through a 2 mm sieve. Bulk Density (BD) was measured by core sampler methods and textural class was determined by Robinson's International pipette method (Piper, 1966). Soil pH and electrical conductivity (EC) was determined in the saturation extract of 1: 2 (soil: water suspension) solution as described by Jackson (1973). Soil organic carbon was analyzed using Walkley and Black's (1934) rapid titration method. Available P in 0.5 *M*$NaHCO_3$ extracts by Olsen *et al.,* (1954) method and exchangeable K in I*M* NH_4OAc-extracts by flame photometer method (Jackson, 1973).The experimental soils were silty loam in texture and low in nitrogen and medium in available phosphorus and potassium. The initial soil characteristics of the experimental sites are given in Table 2.

Treatment details and field layout

The field experiment was laid out according to a complete randomized block design with four replications. The experiment comprised of 4 treatment combinations consisting four methods of crop establishment [RE_1:- Puddled transplanted rice (PTR), RE_2:-Reduced till-direct seeded rice (RT-DSR), RE_3:-Zero till-direct seeded rice (ZT-DSR) and RE_4:-Zero till-direct seeded rice with 30cm anchored wheat residue (ZT-DSR+AR)]. The gross and net plot size was 22 × 4 m, 21 × 3.26 m, respectively. The distance between the Main irrigation channel cum replication border and plot border were1m and 0.5 m on both sides.

Variety

The variety Sarjoo 52 (FH-132) which has been released in year 1980 was bred from tall and dwarf cross (TN1 x Kashi) in the Department of Genetics and Plant breeding at N.D.U.A.T., Kumarganj, Faizabad (U.P.). It is an Indica x Indica hybrid synthesized from parent T136 short duration tall Indica with slender grain and a Russian strain 2652. Sarjoo 52 is of dwarf statured (82-87 cm), stiff grain, non-lodging, moderate tillering (9-14), medium broad leaves with delayed senescence leaf sheath and dull straw colour. It matures in 130-135 days and is moderately resistant to BLB, Brown leaf spot and blast. It is recommended for eastern U.P. under irrigated condition for early planting. Its grain size is long and bold. Yield varies from 50-60 q ha^{-1}.

Cultural practices and observations

A uniform dose of 120 kg N, 60 kg P_2O_5, 60 kg K_2O and 5 kg Zn ha^{-1} was applied for rice crop in all the treatments through urea (46 % N), DAP (18% N & 46% P_2O_5), muriate of potash (60 % K_2O) and $ZnSO_4$ respectively. Half of total nitrogen and full dose of P_2O_5, K_2O and Zn were applied to rice crop as basal (sowing/transplanting) and remaining half dose of nitrogen in the form of urea was top dressed in two equal splits, at active tillering and panicle initiation stage during both the years, respectively. In RTDSR and ZT rice treatments sowing was done by tractor drawn zero-till seed-cum-fertilizer drill with a row spacing of 18.5 cm apart and seeding depth was maintained at 2–3 cm using depth control wheel of the planter. Rice variety "Sarjoo 52" was used at the rate of 25 kg ha^{-1}.Seeding was done on 24th June during 2011 and 23th June during 2012 in RTDSR and ZT Rice treatments. On the same day seeds were sown in nursery for conventional till rice (puddled transplanted) and 20 day old seedlings were manually transplanted randomly (farmers practice) in both the years. The herbicide glyphosate (1 kg ha^{-1}) was applied in zero-till treatments before the seeding to knock down the weeds, pendimethalin 1kg ha^{-1}(pre-emergent) *fb* bispyribac 25g ha^{-1}at 20 DAS/DAT were appliedby using knap sack sprayer with flat fan nozzle for weed control. The crop was harvested at maturity stage. First, the border rows were harvested and separated. Later, crop from net plot was harvested and sun dried. The harvested material from each net plot was carefully bundled, tagged and brought to the threshing floor separately. Threshing was done plot-wise and grains were cleaned, dried and weighed separately for each net plot and computed in terms of kg ha^{-1} at 14% moisture level. The straw yield was also recorded plot wise after sun drying and computed to kg ha^{-1}.Test weight (g) of 1000-seeds from each plot was recorded. The economics are calculated *viz.* Gross and return (₹ ha^{-1}) and B: C ratio separately.

Statistical analysis

The data recorded for different crop parameters were analyzed using analysis of variance (ANOVA) technique (Gomez and Gomez, 1984) for complete randomized block design. Where ANOVA was significant, the treatment means were compared using LSD procedure at 5% level of significance.

Results and Discussion

Moreover, yield parameters (Table 3) *viz.*, number of panicles m^{-2}significantly influenced by crop establishment method ZT-DSR + AR in comparison with PTR (279.25, 277.25 vs 239.50, 233.25) during the both years respectively, followed by ZT-DSR, RT-DSR.

Table.1 Mean standard monthly meteorological data recorded at Meteorological Observatory, IAS, Varanasi (35 years mean)

Month	PET (mm)	Rainfall (mm)	Temperature (°C)		Relative humidity (%)	
			Max.	Min.	Max.	Min.
January	25.9	63.2	23.2	09.3	80	51
February	18.1	88.7	26.4	11.8	68	37
March	12.5	149.9	33.4	17.3	47	24
April	05.4	188.2	38.6	22.7	36	20
May	14.4	229.1	41.4	26.7	44	24
June	86.8	185.5	39.0	28.2	59	45
July	293.3	127.1	33.6	26.2	82	73
August	336.9	113.8	32.4	25.8	85	79
September	227.5	118.6	32.7	25.0	82	74
October	49.1	120.5	32.5	20.7	73	55
November	07.2	80.5	28.6	13.3	67	47
December	04.6	60.1	24.3	09.6	76	51
Annual	1081.4	1525.2	32.2	19.7	76	48

Table.2 Mean initial soil characteristics of experimental sites

Particulars	Values (%)	Method employed
Organic carbon (%)	0.33	Wet digestion method (Walkley and Black,1934)
pH	7.63	Glass electrode digital pH meter (Jackson, 1973)
Bulk density (g cm^{-3})		
0-10 cm	1.28	Core sampler method (Piper, 1966).
10-20 cm	1.42	
Electrical conductivity (dS m^{-1})	0.63	Systronics electrical conductivity meter (Jackson, 1973)
Available nitrogen (kg ha^{-1})	180.03	Alkaline permanganate method (Subbiah and Asija,1956)
Available P_2O_5 (kg ha^{-1})	19.09	0.5 *N* $NaHCO_3$ extractable (Olsen *et al.*, 1954)
Available K_2O (kg ha^{-1})	217.90	Ammonium acetate extractable flame photometer (Jackson,1973)

Table.3 Influence of different crop establishment methods on yield attributes of rice

Treatments	Panicles m^{-2} (No)		Panicle length (cm)		Panicle weight (g)		Grains Panicle^{-1} (No)		1000 grains weight (g)	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Crop establishment methods										
PTR	239.50	233.25	23.60	22.35	2.50	2.47	90.35	86.01	24.55	24.53
RTDSR	266.25	259.75	23.98	22.68	2.55	2.49	95.18	90.80	24.46	24.35
ZTDSR	272.75	268.75	24.55	23.53	2.58	2.52	98.51	91.89	24.47	24.36
ZTDSR + AR	279.25	277.25	25.43	24.30	2.64	2.58	99.50	95.05	24.48	24.38
SEm±	5.61	5.93	0.83	1.03	0.04	0.05	3.67	3.12	0.15	0.15
CD (P=0.05)	17.93	18.96	NS	NS	NS	NS	NS	NS	NS	NS

Table.4 Influence of different crop establishment methods on yield of rice

Treatments	Grain yield(kg/ha)		Straw yield(kg/ha)		Biological yield(kg/ha)		Harvest index (%)	
	2011	2012	2011	2012	2011	2012	2011	2012
Crop establishment methods								
PTR	3622.87	3592.94	5527.82	5434.41	9150.70	9027.35	39.64	39.81
RTDSR	3713.23	3662.25	5725.25	5548.37	9438.48	9210.62	39.36	39.76
ZTDSR	3767.55	3700.95	5825.25	5725.18	9592.80	9426.13	39.28	39.28
ZTDSR + AR	4045.94	3971.30	6061.25	5924.45	10107.19	9895.75	39.97	40.14
SEm±	160.50	114.18	205.57	194.61	319.82	306.38	0.92	0.21
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table.5 Influence of different crop establishment methods on economics of rice

Treatments	Gross return(₹ /ha)		Net return(₹ /ha)		B:C ratio	
	2011	2012	2011	2012	2011	2012
Crop establishment methods						
PTR	41890.93	47628.97	14314.03	20052.07	0.52	0.73
RTDSR	42965.53	48552.27	18773.63	24360.37	0.78	1.01
ZTDSR	43602.12	49124.47	20991.22	26513.57	0.93	1.17
ZTDSR + AR	46726.80	52603.48	22615.90	28492.58	0.94	1.18

Whereas, other yield attributes *viz.* panicle length, panicle weight, grains per panicle and 1000 grain weight were non-significant effected by different crop establishment method. However, higher grain(4045.94, 3971.30 vs 3622.87, 3592.94 kg/ha) and straw (6061.25, 5924.45 vs 5527.82, 5434.41 kg/ha) and biological yield (10107.19, 9895.75 vs 9150.70, 9027.35 kg/ha) was recorded in ZT-DSR+AR in comparison to PTR followed by ZT-DSR, RT-DSR in both the years, respectively (Table 4). ZT-DSR + AR were most economical crop establishment method because it gave maximum gross return (Rs 46726.8 and Rs 52603.4), net returns (Rs 22615.90 and (Rs 28492.74) and B: C ratio (0.94 and 1.1) during first and second year, respectively. Whereas, lowest was recorded with puddled transplanted rice (Rs 41890.9 and Rs47628.9), (Rs 14314.03 and Rs 20052.07) which was 36 and 30 % lower than $RE_4$and (0.52 and 0.73) in 2011 and 2012, respectively (Table 5).Similar or high yield attributes and yield in ZT rice than conventional rice (CT/PTR) rice were reported earlier by many researchers [Choudhury *et al.,* (2007), Ladha *et al.*, (2009) and Jat *et al.*, (2009) Yadav *et al.*, (2014)].Jat *et al.,* (2014) reported that retention of crop residue in ZT based production system increase rice and wheat yield over Conventional tilled (CT) based systems.

It may be concluded that rice crop establish through zero-till direct seeded rice under anchored wheat residue (30 cm) should be followed to achieve higher yield and monitory returns from rice cultivation.

References

Anonymous, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministery of agriculture and Farmer's welfare. Govt. of India, 2016.

Balasubramanian, V., Hill, JE, Direct seeding of rice in Asia: emerging issues and strategic research needs for 21st century. In: Pandey *et al.*, (Ed.), Direct Seeding: Research Strategies and Opportunities, Proceedings of International Workshop on Direct Seeding in Asian Rice System, January 25-28, Bangkok, Thailand. International Rice Research Institute, Los Banos, Phillippines, pp.15-422002.

Black, C.A., Evans, DD, White, JE, Ensminger, LE and Clark, FE, "Methods of soil analysis", Part I–Physical and Microbiological Properties, Including Statistics of Measurement and Sampling, American Society of Agronomy, pp, 677, 1965.

Chastin, T.G., Ward, JK and Wysocki, DJ, Stand establishment response of soft winter wheat to seed bed residues and seed size.*Crop Science*.35: 213-218, 1995.

Choudhury, B.U., Bouman, BAM and Singh, AK, Yield and water productivity of rice-wheat on raised beds at New Delhi, India. *Field Crops Research,* 100: 229–239, 2007.

Gomez Kwamchai, A., and Gomez Arturo, A, Statistical procedures for Agricultural Research (2nd Ed., 1984), John Wiley and Sons Inc., New York, U.S.A., 1976.

Gupta, R.K., and Sayre, K, Conservation agriculture in South Asia. *Journal of Agricultural Sciences Cambridge*145: 207-214, 2007.

Guzha, A.C., Effect of tillage on soil microrelief, surface depression storage and soil water storage. *Soil & Tillage Research*. 55: 213-218, 2004.

Ho, and Romli, Impact of direct seeding on rice cultivation: lessons from the mudaarea of Malaysia. (In): *Proceedings of Workshop on Direct Seeding: Research Strategies and*

Opportunities, held during 25-28 January 2000, Bangkok, Thailand2000.

Hobbs, P.R., Morris, M, Meeting South Asia‘s future food requirements from rice - wheat cropping systems: priority issues facing researchers in the Post-Green Revolution era. NRG Paper, pp. 96–1011996.

Jackson, M.L., Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi, pp, 1-492, 1973.

Jat, M.L., Gathala, MK, Ladha, JK, Saharawat, YS, Jat, AS, Kumar, V and Gupta, R, Evaluation of precision land leveling and double zero-till systems in the rice-wheat rotation: Water use, productivity, profitability and soil physical properties. *Soil and Tillage Research*, 105(1): 112-121, 2009.

Jat, R.K., Sapkota, TB, Singh, RG, Jat, ML, Kumar, M and Gupta, RK, Seven years of conservation agriculture in a rice–wheat rotation of Eastern Gangetic Plains of South Asia: Yield trends and economic profitability. Field Crops Research, 164, 199–2102014.

Ladha, J.K., Kumar, V, Alam, MM, Sharma, S, Gathala, M, Chandana, P, Saharawat, YS and Balasubramanian, V, Integrating crop and resource management technologies for enhanced productivity, profitability, and sustainability of the rice-wheat system in South Asia. In: Ladha, J.K., Singh, Y., Erenstein, O., Hardy, B. (Eds.), Integrated Crop and Resource Management in the Rice–Wheat System of South Asia. International Rice Research Institute, Los Ba˜nos, Philippines, pp. 69–108, 2009.

Olsen, S.R., Cole, CV, Watanabe, FS and Dean, LA, Estimation of available phosphorus in soil by extraction with sodium bicarbonate, U.S. Department of Agriculture Circular, 939, 19-23, 1954.

Piper, C.S., Soil and Plant Analysis, Hans Publishers, Bombay, 1966.

Saharawat, Y.S., Singh, B, Malik, RK, Ladha, JK, Gathala, M, Jat, ML and Kumar, V, Evaluation of alternative tillage and crop establishment methods in a rice–wheat rotation in North Western IGP. *Field Crop Research*, 116: 260-267, 2010.

Sharma, P.C., Jat, HS, Kumar, V, Gathala, MK, Datta, A, Yaduvanshi, NPS, Choudhary, M, Sharma, S, Singh, LK, Saharawat, Y, Yadav, AK, Parwal, A, Sharma, DK, Singh, G, Jat, ML, Ladha, JK and and McDonald, A Sustainable Intensification Opportunities under Current and Future Cereal Systems of North-West India. Technical Bulletin: CSSRI/Karnal/2015/4. Central Soil Salinity Research Institute, Karnal. p.46, 2015.

Sharma, P.K., Ladha, JK, Bhushan, L, Soil physical effects of puddling in rice–wheat cropping systems. In: Ladha *et al.*, (Ed.), Improving the Productivity and Sustainability of Rice–Wheat Systems: Issues and Impacts. ASA Spec. Publ.65: American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, Madison, WI, pp. 97–1132003.

Singh, S.N., Sah, AK, Om Prakash Singh, RK, Singh, VK, Assessing the impact of zero tilled wheat growing in rice (*Oryza sativa L.*)-wheat (*Triticumaestivum L.*) cropping systems the case of central Uttar Pradesh in the Indo-Gangetic Plain. *Outlook on Agriculture*. 39 (3): 197-202, 2010.

Singh, U.P., Singh, Y, Kumar Virendra and Ladha, JK, Evaluation and promotion of resource conserving tillage and crop establishment technique in rice-wheat system of eastern India. (*In)*: Ladha JK., Singh Yadvinder, Erenstein O,Hardy B, (Eds.),*Integrated crop and resource* *management in rice-wheat system of south Asia.* International Rice Research Institute, Los Banos (Philippines), P 151-176, 2009.

Tripathi, R.P., Gaur, MK, Rawat, MS, Puddling effect on soil physical properties and rice performance under shallow water table condition of tarai. Journal of Indian Society of Soil Science 51, 118-124, 2003.

Triplett, G., and Vand Dorren, DR, Agricultural without tillage. *Scientific American.*236: 28-33, 1977.

Walkley, A., Black, CA, An examination of the method for determination of soil organic matter and proposed medication at the chromic acid titration method, Soil Sci. 37, 29-38,1934.

Yadav, A., Bir, D, Gill, G, Malik, RK, Kamboj, BR, Kumar, V, Jat, RK and Singh, A, Non-puddled direct seeded and mechanical transplanted rice sequentially with no-till wheat to sustain higher productivity and profitability in rice-wheat cropping system in India, In: Proceedings of Biennial conference of Indian Society of weed science on “emerging challenges in weed management”, Feburauary15-17, DWSR, Jabalpur, Madhya Pradesh, p. 186, 2014.

How to cite this article:

Sutaliya J. M., and Singh, U.P.. 2017. Effect of Different Crop Establishment Methods, Tillage and Residue on Yield, Yield Attributes and Economics of Ricein RW System of Northern Plains of IGP. *Int.J.Curr.Microbiol.App.Sci.* 6(7): 4174-4183.
doi: https://doi.org/10.20546/ijcmas.2017.607.432