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Research Article

Comparative Assessment of Different Methods of Rice (*Oryza sativa*) Cultivation in Relation to Water Management Practices Under Vertisols of Rajasthan

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ABSTRACT

Afield experiment was carried out during three consecutive rainy seasons (2014 to 2016) at Agricultural Research Station, Kota, Rajasthan to compare different methods of rice cultivation in relation to water management practices and productivity under south eastern, Rajasthan. The experiment was laid out in randomized block design with four replication comprising of 6treatments (irrigation at 100, 125 & 150% PE through sprinkler method with conventional transplanting, irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting, intermittent light irrigation upto panicle initiations and then shallow standing water through surface method with SRI practices and irrigation at 150% CPE through surface method with DSR). The results revealed that intermittent light irrigation upto panicle initiation and then shallow standing water with SRI method recorded significantly higher plant height (106 cm), effective tillers/m^2 (1435), filled spikelet/panicle (135.2), grain yield (5850 kg/ha), straw yield (8495 kg/ha), net return (Rs.135658/ha), B:C ratio (4.13), water productivity (Rs.35.34/ha-M^3) and lower weed dry weight at harvest (5.45 g/m^2), nitrogen (1.26 kg/ha), phosphorus (0.259 kg/ha) and potassium (1.15 kg/ha) uptake by weeds over irrigation at 100, 125 and 150 % PE through sprinkler method with conventional transplanting , irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting and irrigation at 150 % CPE through surface method with direct seeded condition of rice. However, irrigation at 150 PE through sprinkler method with conventional planting, irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting and irrigation at 150 % CPE through surface method with direct seeded condition of rice with respect to growth and yield attributes, grain yield, net return and water use efficiency of rice remained on par and with each other's

Keyword: *Rice, Irrigation schedule, Method of cultivation, Profitability, Water productivity*

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INTRODUCTION

Rice (*Oryza sativa* L.) is the most prominent crop of India as it is the staple food for most of the people of the country. This crop is the backbone of livelihood for millions of rural households and plays vital role in the country's food security, so the term "rice is life" is most appropriate in Indian context. India occupies an important position both in area and production of rice. Demand for rice is expected to further increase in future as population is continuously increasing, so production of rice also needs to be increased. Major constraints in relation to productivity and sustainability of rice in the country are the inefficient use of inputs (fertilizer, water, labour), increasing scarcity of water and labour especially for rice cultivation, new emerging challenges from climate change, rising fuel prices, increasing cost of cultivation, and socioeconomic changes such as migration of labour, urbanization, less liking for agricultural work by youths, and concerns from environmental pollution. The only way to sustain rice production for meeting the increasing population demand is to increase the productivity per unit area of rice with enhanced resource use efficiency. Crop production techniques in rice that could increase factor productivity by efficient utilization of inputs (water, fertilizers, pesticides, etc.) reduce cultivation cost, enhance profit, and provide safe environment must be explored. I rrigated agriculture is by far the biggest user of freshwater, accounting for more than 70 % of the water withdrawals worldwide. More than 50 % of all water used for irrigation is used to irrigate rice (Dahiya, 2018). The water use efficiency of rice is much lower than that of other crops. On an average, 2500 litres of water is used, ranging from 800 litres to 5000 litres to produce 1 kg of rough rice (Bouman, 2009). A 10 % increase in irrigation efficiency can help to bring additional 14 million ha area under irrigation. Method of rice cultivation in relation to water management plays a pivotal role in increasing the productivity of rice. Water use efficiency and water productivity of rice in vertisols of south eastern Rajasthan are very low due to percolation losses and faulty method of rice cultivation. Keeping above facts in view, field experiment was carried out to assess best method of rice cultivation in relation to water management practices under vertisols of south eastern Rajasthan.

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MATERIALS AND METHODS

The field experiment was conducted during *Kharif* seasons of2014 to 2016 at Agricultural Research Station, Kota (26º North latitude, 76º-6' East longitude and 260 m above mean sea level), Rajasthan. The study area falls under humid south eastern plain zone of Rajasthan. The soil of the experimental field was in order of vertisols having pH 7.56, EC 0.30 ds/m and Cation exchange capacity 35 Cmol/kg. The soil had a very low infiltration rate (0.25 cm/hr) on surface but at deeper layer (1.2 to 1.5 m)was impermeable. The potential moisture retention capacity of soil is 120 mm of water in 1 m depth. The soil of the experimental field was medium in organic carbon 4.6 g/kg, available nitrogen (273.4 kg/ha), available phosphate (23.51 kg P_2O_5/ha) and high in available potash (285.8 kg K_2O /ha).The bulk density of soil was 1.48 Mg/m^3.Various methods of rice cultivation were tested in relation to water management practices. The experiment comprised of 4 methods of rice cultivation (i.e. Conventional transplanting and irrigation with sprinkler method, conventional transplanting and irrigation with surface method, system of rice intensification and direct sown rice with surface method of irrigation).Treatments are T_1- irrigation at 100% pan evaporation (PE) through sprinkler method with conventional transplanting, T_2- irrigation at 125 % PE through sprinkler method with conventional transplanting,, T_3-irrigation at 150 % PE through sprinkler method with conventional transplanting,, T_4- irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting, T_5- irrigation at 150% cumulative pan evaporation (CPE)through

surface method with direct seeded condition (DSR) and T_6- intermittent light irrigation upto panicle initiations and then shallow standing water through surface method with SRI practices). Sprinkler method of irrigation was used in treatment T_1, T_2&T_3after transplanting of rice seedling under puddle condition (conventional method) and irrigation was applied on the basis of pan evaporation (PE) i.e 100 %, 125 % & 150 % PE. In treatment T_4, conventional method of rice cultivation along with surface irrigation was used under puddle condition. All the principle of direct seeded rice and system of rice intensification were followed in treatments T_5 and T_6, respectively. The experiment was laid out in randomized block design with 4 replications. Recommended dose of fertilizers (120 kg N, 60 kg P_2O_5,and50 kg K_2O/ha) was used in all treatment except system of rice intensification (SRI). Under SRI,recommended dose of fertilizers was given through inorganics (75 %) and organics (25 %). High yielding variety of rice: Pusa sugandha-4 was used during all the year of investigation. 30 kg/ha seed of rice was used in direct seeded rice.Crop geometry of 20 cm x 15 cm(25 days old seedling)and 22.5 cm x 10 cm were followed under conventonal and direct seeded cultivation of rice. SRI method include planting at 12 days old single seedling hill^{-1},25 cm x 25 cmspacing, weeding by conoweeder (started from 10 days after transplanting and repeated at 10 days interval up to panicle initiation). Seeds were sown on 30 June, 3 July and 25 June of 2014, 2015 and 2016, respectively for nursery raising and DSR. 25 days old seedlings were transplanted as per treatment in conventional method and 12 days old seedling grown on raised bed was transplanted in SRI blocks of treatment. Crop was harvested on 5, 7 & 4 November, 2014, 2015 and 2016 in conventional & SRI methods and 26, 30 & 27 October of respective year in DSR, respectively. Weeds were manage in direct seeded rice by application of pre-emergence herbicide i.e. pendimethalin 30 EC @ 1.0 kg/haat 3-4 DAS and followed by post-emergence herbicide i.e. bispyribac-sodium @ 35 g/ha at 15-20 DAS. The total rainfall received and evapotranspiration (table 1) during the growing seasons of rice were 734.6 mm&520.4 mm, 592.2 mm&799.3 mm and 895.4&441.5 mm in 2014, 2015 and 2016, respectively. Water requirement of the crop as per treatments was fulfilled by rainfall and through irrigation. Supplemental irrigation was given in case of less rainfall at scheduled irrigation treatment. Measurement of water was done on the basis of discharge rate of the pump. The plant protection measures were taken up as and when required to ensure healthy crop. Basal application of nitrogen and full doses of P and K were appliedthrough, diammonium phosphate and muriate of potash, respectively. The remaining nitrogen was top dressed as urea aat the time of tillering. In each plot five plants were randomly selected and tagged to record biometric observations on growth and yield attributes. For counting weed density (No./m^2), weed dry weight (g/m^2) of the plots were sampled randomly at 2 places in each plot with help of 1.0m^{2}quadrates at 45 days and at harvest.At maturity, data on plant height, effective tillers/m^2, dry matter accumulation/m^{2}panicle length, panicle weight, filled spikelet/panicle, test weight, biological yield and grain yield were recorded. Harvest index was calculated by dividing economical yield to total biomass production. Net returns as well as B:C ratio were also work out on prevailing market prices. Nutrients uptake by weeds was estimated on the basis of nutrients content in weeds.

The field data obtained for three years were analysed yearly and pooled over three years and statistically analysed using "F" test (Gomez and Gomez, 1984). The results have been discussed at the probability level of five per cent. The test of significance of treatments differences were done on the basis of "t" test. The significant difference between mean of treatments were computed with critical differences at 5 % level of probability. Soil samples (0-15 cm) were collected from the each plot and analysed for electrical conductivity.

RESULTS AND DISCUSSIONS

Effect on weeds

The dominant weed species present in the experimental field during 2014, 2015 and 2016 were *Echinochloa crus-galli*, *E. Colonum* and *Cynadondactylon* among the grasses, *Cyprus deformis* and *Cyprus iria* in sedges and *Phyllanthus niruri*, *Commelina benghalensis*, *Euphorbia hirta* and *Eclipta alba* among broad leaved weeds. The grasses, sedges and broad leaved weeds constituted 33.5, 41.8 and 24.7 % of the total weed flora, respectively. Emergence of broad leaved weeds was noticed earlier than of sedges and grasses. Weed density and weed dry weight at 45 days after sowing (DAS) were higher than at harvest. This was perhaps due to death of some weeds and shading effect of the tall weeds like *Echinochloa crus-galli* and crop plants on short-stature weeds. Cultivation of rice under different methods in relation to water management practices had significant effect on weed density at 45 DAS/planting and at harvest (Table 3). Minimum weed density and weed dry weight at 45 DAS/planting and at harvest were observed in SRI method of rice cultivation. Under sprinkler method of irrigation, increasing levels of irrigation enhanced weed density and weed dry weight at both the stages. This was due to higher germination of the weeds with increasing moisture availability. However, Maximum dry weights of weeds at 45 DAS and at harvest were found when irrigation applied @ 150% CPE under rice grown in direct seeded condition. Nitrogen, phosphorus and potassium uptake by weeds at 45 DAS and at harvest was significantly influenced by different method of rice cultivation. The lowest uptake of these nutrients by weeds was recorded under SRI method of rice, while the uptake by weeds with irrigation schedule at 150 %, 125 % PE under sprinkler method and irrigation at 150 % CPE with surface method of irrigation under DSR were comparable with each other. Weeds grow faster than crop plants and thus absorb the available nutrients quickly, leading to inadequate supply of nutrients to the crop. Increased soil moisture through the irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water with surface method provided better environment for availability of nutrients to crop after depressing weeds and thereby, lower dry matter accumulation of weeds resulted in lesser nutrient uptake by weeds. Similar results were reported by Narolia et al. (2018).

Growth and yield attributes

Growth parameters and yield attributes were significantly influenced by different method of rice cultivation (table 2). Highest growth parameters, *viz.* plant height (106 cm), total number of .tillers/m^2(330) and dry-matter production (1435 g/m^2) at harvest and yield attributes, *viz.* effective tillers/m^2(311), panicle length (30.1 cm), panicle weight (3.11 g), filled spikelet/panicle (135.2), test weight (23.9 g) were recorded in SRI method of rice cultivation. Among sprinkler method of irrigation, maximum growth parameters and yield attributes were recorded with the irrigation at 150 % PE with conventional transplanting resulted from higher moisture availability during the growth period which was followed by irrigation at 125 % PE with conventional transplanting, irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting and irrigation at 150 % CPE through surface method under direct seeded condition. Intermittent light irrigation up to panicle initiations and then shallow standing water through surface method with SRI increased dry matter production and effective tillers/m^2 by 79.4 & 35.2, 57.8 & 26.9, 52.6 & 24.4, 48.5 & 22.0 and 56.9 & 25.9 % as compared to sprinkler method (irrigation at 100, 125 & 150 % PE), irrigation at 5 ± 2 cm standing with surface method and irrigation at 150 % CPE through surface method under direct seeded condition, respectively. Increase in growth parameters and yield attributes under SRI method of rice cultivation might be due to adequate availability of moisture throughout the growing period and better root development resulting higher tillers/plant of

rice. These results are in conformity with of Biplab et al. (2018).

Yields

Results obtained from the experiment revealed that various method of rice cultivation greatly influenced the grain and straw yield of rice (table 3). Maximum (5850&8495 kg/ha) grain and straw yield were recorded with intermittent light irrigation up to panicle initiations and then shallow standing water through surface method with SRIand minimum (3490 & 4498 kg/ha) with irrigation at 100 % PE through sprinkler method with conventional transplanting, respectively. Among different levels of irrigation with sprinkler method, highest grain (4105 kg/ha) and straw (5290 kg/ha) yield were recorded with irrigation at 150 % PE with conventional transplanting, which was statistically on par with grain (3979 kg/ha) yield estimated under irrigation at 125 % PE with conventional transplanting and was closely followed by irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting and irrigation at 150% CPE through surface method under direct seeded condition. However, straw yield obtained under irrigation applied at 150 % PE through sprinkler method remained on par with irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water under surface method of irrigation only. When we compare irrigation at 150% PE with sprinkler, irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water with surface and irrigation @ 150 % CPE with surface method under direct seeded condition, irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water with surface method decreased grain (4218 kg/ha) and straw (5432 kg/ha) yield to the tune of 2.75 & 2.68 %, 1.95 & 7.24 % over irrigation at 150 % PE through sprinkler method and irrigation @ 150 % CPE with surface method under direct seeded condition. Different methods of rice cultivation in relation to water management did not have any significant effect on harvest index. Highest profitability (1130 Rs./ha-day) was found in SRI method of rice cultivation. This might be due adequate availability of water and better conductive rhizosphere environment for higher uptake of nutrients and in turn boost the growth, leading to the development of higher yield attributes through supply of more photosynthetic towards the sink under system of rice cultivation. Stress during the reproductive phase might have hampered the supply of photosynthetic towards the sink resulting in poor yield attributes obtained in irrigation at 100 % PE through sprinkler method of irrigation. Whereas stress during the post-panicle initiation reduced the spikelet/panicle and during later stage reduced the grain filling, resulting in increased unfilled grain percentage and reduced test weight. (Dahiya, 2018). Favourable effect of intermittent light irrigation up to panicle initiations and then shallow standing water through surface method with SRI method on productivity of rice was also reported by Kang et al. (2019)

Economics

Maximum net return (Rs 135658/ha), B: C ratio (4.13) and profitability (Rs.1130/ha-day) among the different method of rice cultivation were obtained in SRI method (table 3). Among different levels of irrigation under sprinkler method, irrigation applied at 150 % PE with conventional transplanting gave significantly higher net return, B:C ratio and profitability of rice which were 21.8, 15.0 &21.9% higher than irrigation applied at 100 % PE with conventional transplanting. Moreover, irrigation at 150 % CPE through surface method under direct seeded condition, irrigation at 150 % PE under sprinkler method and irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water under surface method of rice cultivation remained statistically on par with each other in relation tonet return, B:C ratio and profitability of rice. This might be owing to higher production with proper moisture availability during all critical stages of rice.

Efficiency indices of water use:

Different method of rice cultivation in relation to water management practices influenced the water use efficiency and water productivity of rice significantly. Maximum WUE (98.7 kg/ha-cm) and WP (35.3 Rs./ha-m^3) were found when intermittent light irrigation upto panicle initiation and then shallow standing water was followed under SRI method.

The results further indicated (table 3) that irrigation at 150 % PE through sprinkler method with conventional transplanting significantly improved WUE (70.5 kg/ha-cm) over irrigation at 100 % PE and 125 % PE through sprinkler method with conventional transplanting by 16.5 % and 3.4 %, respectively. Maximum water requirement (1302 mm) of rice was observed under irrigation at 150% PE with sprinkler irrigation and minimum (982 mm) in SRI method. However, irrigation at 150&125 % PE through sprinkler method with conventional transplanting, irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting and irrigation at 150 % CPE through surface method in direct seeded condition remained statistically at par with each other in relation to enhance WUE and water productivity of rice. The results are in close conformity with the research findings of Haindavi et al. (2018), Duttarganvi et al. (2016).

On the basis of three year experimentation, it can be concluded that system of rice intensification along with surface method of irrigation was found with respect to water productivity in terms of net return of rice. However, irrigation at 150 % PE through sprinkler method with conventional transplanting and irrigation at 150% CPE through surface method with direct seeded condition were remained at par with each other in relation to productivity of rice.

Table 1: Weekly rainfall, rainy day and evaporation during *Kharif*2014 to 2016

Standard week	Duration		Total rain fall (mm)			Rainy days			Evaporation (mm)		
	From	to	2014	2015	2016	2014	2015	2016	2014	2015	2016
27	2/7	8/7	0.00	0.00	6.40	0	0	0	64.3	51.8	38.9
28	9/7	15/7	29.2	92.8	74.8	0	5	4	63.6	35.9	20.3
29	16/7	22/7	74.0	106.4	59.8	4	4	2	22.3	13.7	27.8
30	23/7	29/7	96.4	189.2	43.2	4	5	3	23.3	5.0	24.7
31	30/7	5/8	39.0	9.40	80.0	2	3	5	27.6	25.6	28.8
32	6/8	12/8	333.6	44.4	299.2	4	2	5	7.6	11.9	19.2
33	13/8	19/8	15.4	121.8	7.60	1	4	1	21.5	10.6	25.7
34	20/8	26/8	0.00	0.00	76.4	0	0	4	27.4	56.4	22.7
35	27/8	2/9	13.4	0.00	213.8	1	0	4	26.8	60.1	25.6
36	3/9	9/9	114.8	5.80	11.0	3	1	1	17.7	65.0	30.4
37	10/9	16/9	18.8	0.00	0.00	1	0	0	17.0	66.4	29.5
38	17/9	23/9	0.00	0.00	0.00	0	1	0	30.8	52.3	29.8
39	24/9	30/9	0.00	0.00	0.00	0	0	0	30.5	68.5	31.4
40	1/10	7/10	0.00	0.00	21.8	0	0	2	33.0	68.5	28.0
41	8/10	14/10	0.00	0.00	1.40	0	0	0	30.2	68.0	26.3
42	15/10	21/10	0.00	0.00	0.00	0	0	0	27.0	62.8	32.4
43	22/10	28/10	0.00	0.00	0.00	0	0	0	25.5	59.6	32.4
44	29/10	4/11	0.00	0.00	0.00	0	0	0	24.3	59.9	22.4
			734.6	**592.2**	**895.4**	**20**	**25**	**31**	**520.4**	**782.1**	**441.5**

Table 2: Effect of improved methods of cultivation on growth and yield attributes of rice (Pooled data of 3 years)

Treatment	Plant height (cm)	DM at harvest (g/m^2)	Total No. of tillers ($No./m^2$)	Effective tillers ($No./m^2$)	Panicle length (cm)	Panicle weight (g)	Filled spikelet/ panicle	Test weight (g)
Irrigation at 100 % PE through sprinkler method with conventional transplanting	86	799.8	270	230	26.5	2.45	92.3	22.0
Irrigation at 125 % PE through sprinkler method with conventional transplanting	95	909.4	282	245	28.0	2.67	101.4	22.9
Irrigation at 150 % PE through sprinkler method with conventional transplanting	102	940.5	287	250	28.5	2.75	106.6	23.5
Irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting	103	966.1	289	255	28.6	2.78	107.2	23.6
Irrigation at 150% CPE through surface method with DSR	100	914.6	285	247	28.2	2.68	105.4	23.3
Intermittent light irrigation up to panicle initiations and then shallow standing water through surface method with SRI	106	1435	330	311	30.1	3.11	135.2	23.9
SEm+	1.60	8.12	3.74	3.34	0.17	0.11	0.52	0.16
C.D. (P=0.05)	4.56	23.1	10.7	9.5	0.48	0.31	1.48	0.46

DM= Dry matter production

Table 3: Effect of improved methods of cultivation on yields, economics and water use of rice (Pooled data of 3 years)

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha	HI (%)	Net return (Rs.ha)	B:C ratio	Profitability (Rs/ha/day)	Total water applied (mm)	WR (mm)	WUE (kg/ha -cm)	WP ($Rs./M^3$)
Irrigation at 100 % PE through sprinkler method with conventional transplanting	3490	4498	43.7	74101	2.87	574	550	1142	60.5	13.48
Irrigation at 125 % PE through sprinkler method with conventional transplanting	3979	5105	43.8	87106	3.24	675	630	1222	68.2	13.83
Irrigation at 150 % PE through sprinkler method with conventional transplanting	4105	5290	43.7	90244	3.30	700	710	1302	70.5	12.72
Irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting	4218	5432	43.7	91970	3.19	713	593	1185	72.4	15.92
Irrigation at 150% CPE through surface method with DSR	4137	5065	45.3	90599	3.50	755	640	1232	69.5	14.23
Intermittent light irrigation up to panicle initiations and then shallow standing water through surface method with SRI	5850	8495	40.8	135658	4.13	1130	390	982	98.7	35.34
SEm+	51.6	54.0	75.3	1398	0.051	11.28	-	-	1.34	0.27
C.D. (P=0.05)	147	154	NS	3982	0.14	32.1	-	-	3.81	0.76

Table 4: Effect of improved methods of cultivation on weed density, weed dry weight and N, P and K uptake by weeds of rice (Pooled data of 3 years)

Treatment	Weed density at 45 days	Weed density at harvest	Weed dry weight at 45 days (g/m^2)	Weed dry weight at harvest	Nutrient uptake by weeds at harvest(kg/ha)		
					N	P	K
Irrigation at 100 % PE through sprinkler method with conventional transplanting	22.6	18.4	17.26	15.23	3.53	0.723	3.21
Irrigation at 125 % PE through sprinkler method with conventional trnsplanting	24.2	20.9	19.47	17.45	4.05	0.829	3.68
Irrigation at 150 % PE through sprinkler method with conventional transplanting	25.5	21.7	20.16	18.33	4.25	0.871	3.87
Irrigation at 5 ± 2 cm standing water and refilling it 1-3 days after disappearance of ponding water through surface method with conventional transplanting	9.0	6.2	6.75	6.46	1.50	0.307	1.36
Irrigation at 150% CPE through surface method with DSR	35.3	23.8	27.48	20.52	4.46	0.925	4.33
Intermittent light irrigation up to panicle initiations and then shallow standing water through surface method with SRI	12.5	7.0	5.43	5.45	1.26	0.259	1.15
SEm+	1.00	0.51	0.52	0.56	1.30	0.027	0.118
C.D. (P=0.05)	2.9	1.5	1.49	1.59	0.37	0.08	0.34

REFERENCES

Balamani, K., Ramulu, V., Reddy, M.D., & Umadevi, M. (2012). Effect of irrigation method and irrigation schedules on aerobic rice.*Journal of Research, Angrau 40*(4), 84-86.

Bouman, B.A.M. (2009). How much water does rice use. *Rice Today. 8*, 28-29.

Dahiya, S. (2018). Management of irrigation water in direct seeded rice: Areview:*International Journal of Chemical Studies 6*(5), 1490-1494.

Duttarganvi, S., Kumar Mahender, R., Desai, B.K., Pujari, B.T., Tirupataiah, K., Koppalkar, B.G., Umesh, M.R., Naik, M.K., & Yellareddy, K. (2016). Influence of establishment methods, irrigation water levels and weed management practices on growth and yield of rice (*Oryzasativa* L.). *Indian Journal of Agronomy 61*(2), 174-178.

Gomez, K. A., & Gomez, A. A. (1984). Statistical Procedures for Agricultural Research, end 2, pp. 680. John Wiley & Sons, New York, USA.

Haindavi, P., Chandrasekhar, K., VenkataLakshmi, N., & Ratna Prasad, P. (2018). Assessment of yield, consumptive use and water use efficiency of dry sown Rice (*Oryza sativa* L.) influenced by irrigation schedules and weed management options. *Bulletin of Environment, Pharmacology and Life Science 7*(SPL 1), 62-66.

Kang, J.S., Kaur, Jagroop and Sandhu, S.S. (2019). Performance of mechanically transplated Basmati rice (Oryzasativa) under different age of seedling and planting densities.*Indian Journal of Agronomy 64*(2), 200-203.

Pal, B., Saha, S., Saha, B., Saha, S., Pati, S., Hajra, G.C. (2019). Soil fertility and zinc application influences yield and zinc-iron nutrition in rice (*Oryza sativa*) under SRI and conventional methods. *Indian Journal of Agronomy 64*(2), 191-199.

Narolia, R.S., Baldev Ram., Meena D.S., & Meena, H.P. (2018). Effect of improved water management technology on productivity and sustainability of rice- wheat cropping system at farmers field in south eastern Rajasthan. *Annals of Agricultural Research 39*(4), 406-412.