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Effect Of Soil Moisture Regime On Aerobic Hybrid Rice Under Different Sowing Dates

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ABSTRACT
Present field trial was conducted in experimental field of Birsa Agricultural University, Ranchi, Jharkhand during Kharif season, 2013. Four hybrid varieties of rice viz. DRRH-3, PAC – 837, ARIZE TEJ and DRRH -2 were directly sown on an interval of 10 days: 21st June, 2013; 1st July, 2013 and 11th July, 2013. Experimental design was SPD (Split plot design). Soil moisture regimes under the aerobic rice crop at two depths (0-15 cm, 15-30 cm) was monitored throughout the growing period at certain intervals under all sowing dates. Crop sown on 11th July (D3) experienced more variation in soil moisture than early sown crop (D1 and D2). Variation of soil moisture between upper and lower soil layers was more pronounced in case of last sowing (11th July) than preceding sowing (21st June and 1st July). Timely sowing of aerobic rice varieties on and around 21st June performed the best (all four varieties) compared to subsequently delayed sowing.
Key words: *Soil, moisture, regime, rice, dates, depth*

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INTRODUCTION

Cumulative and consecutive periods of dryness and moistness in the soil moisture control the entire section of soil profile. It directly influenced the uptake of essential nutrients of plant. Soil moisture is a key variable in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transpiration. As a result, soil moisture plays an important role in the development of weather patterns and the production of precipitation.

Rice is immensely important to food security of Asia. Out of 24 species only two species *O. glaberima* and *O. sativa* are cultivated. In the world, rice has occupied an area of 157.48 million hectares with a total production of 469.51 million tonnes (FAOSTAT 2013). India is the second largest producer of rice after China has an over of 42.41 million hectares with the production of 104.40 million tonnes (FAOSTAT 2013). Jharkhand occupies an area around 17 lakh hectares with an average production of 33 million tonnes (Directorate of Agril. Govt. of Jharkhand 2013-2014).

Microclimatic fluctuation greatly influences the agricultural productivity in any region. Agricultural production and productivity of any region is being regulated by the prevailing climate of that area through temperature, humidity, rainfall and duration and intensity of sunshine etc.

The water crisis is the main threat for the sustainability of the rice and food security in Jharkhand. Food security could be ascertained by developing technologies and strategies to grow more even under scarce water availability. Transplanted rice grow under water condition is much extensive use of water and as such calls for proper water conservation in areas where irrigation potential is menace. In Asia, more than 80% of the developed freshwater resources are used for irrigation purposes; about half of which is used for rice production (Dawe 1998). Rapidly depleting water resources threaten the sustainability of the irrigated rice and hence the food and livelihood security of rice producers and consumers. In Asia, 17 million hectares (Mha) of irrigated rice areas may experience "physical water scarcity" and 22 Mha may have "economic water scarcity" by 2025 (Tuong and Bouman, 2002). Rice is very sensitive to water stress and any attempt to reduce water input may tax true yield potential (Tuong 2004). Rice being a very high water requiring crop, is now becoming difficult to be successfully grown in Jharkhand under the abnormal and erratic behaviour of monsoon. Particularly, maintenance of submerged conditions in medium land and lowland transplanted paddy fields is becoming very difficult. Direct seeded upland rice often faces soil moisture scarcity due to frequent agricultural drought.

Guled (2013) studied the effect of soil moisture content, transpiration rate and stress degree day on pod development of groundnut. He reported that soil moisture content during pod development were found to have significant influence in transpiration rate attaining higher pod yield whereas as the stress degree day beyond 0.94^{0}C had resulted in 77% variation in the pod development of the groundnut.

Cabangon et.,al. (2003) reported and to compare the effects of different water saving irrigation regimes on yield, irrigation input and water productivity of aerobic and lowland (hybrid and inbred) rice varieties in different water table conditions. The response of yield, and water productivity to irrigation regimes depended on the depth of the groundwater.

MATERIAL AND METHODS

Present field trial was conducted in experimental field of Birsa Agricultural University, Ranchi, Jharkhand during Kharif season, 2013. Four hybrid varieties of rice viz. DRRH-3, PAC – 837, ARIZE TEJ and DRRH -2 were directly sown on an interval of 10 days: 21st June, 2013; 1st July, 2013 and 11th July, 2013. Experimental design was SPD (Split plot design).

To study the impact of microclimatic variations and water productivity on overall performance of rice cultivars, soil moisture regime for two depth, 0-15 centimeter and 15-30 centimeter was selected. Initial soil physicochemical parameters (Table 1) were analyzed with following methods.

Table-1: Initial Soil data with their method of analysis

Particulars	Value			Methods Followed
	A. Physical Properties			
	0-15cm	15-30 cm	30-60cm	
Sand (%)	45	56	50	Hydrometer Method
Silt (%)	35	28	30	
Clay (%)	20	16	20	
Texture	Clay loam			
Bulk density (g/cc)	1.48	1.50	1.57	Core Sampler
B. Chemical Properties				
Organic carbon (%)	0.65	0.38	0.25	Walkely and Black' rapid titration method
pH	5.5	6.05	6.2	Glass electrode pH meter
EC (ds cm^{-1})	0.2	0.1	0.05	Electro-conductivity method
N(kg/ha)	283	274	258	Modified Kjeldal method
P_2O5 (kg/ha)	22	12	10	Bray's PI extractant
K_2O (kg/ha)	183	105	144	Flame photo meter

Soil physical Properties were determined using the standard methods. Bulk density of undisturbed soil was determined using core sampler (Piper, 1950). To know the texture of the soil, mechanical analysis was done using Bouyoucos hydrometer method (Bouyoucos, 1936). To know the available soil moisture storage capacity, field capacity and witting point of the soil, pressure plate apparatus was used.

Soil moisture regimes were monitored at a regular interval of 5 days from sowing to maturity. For this, soil samples from two soil depths (0-15 and 15-30cm) were collected and moisture content were determined using standard gravimetric method (Piper, 1950).

RESULTS AND DISCUSSION

Soil moisture regimes under the aerobic rice crop at two depths (0-15 cm, 15-30 cm) was monitored throughout the growing period at certain intervals under all sowing dates. The data are presented in the Table 2 and depicted through fig.1a to 1c.

In case of 21st June sowing (D1) the soil moisture in both the depths was above 20%. At sowing the soil moisture at upper depth (0-15 cm) was at 20.81% while lower depth (15-30 cm) contained highest soil moisture (23.8%), the average soil moisture at sowing was 22.3%. Lower depth (0-15 cm) maintained highest soil moisture than upper depth throughout the growing period. Variation in soil moisture content was regulated; by and large, due to receipt of varying amount of rainfall within the two observations (fig.1a). The average soil moisture increased to 25.1% at 31st DAS. There has been a sharp depletion in soil moisture from 25.1% to 18.9% in between 31st and 49th DAS in spite of having of high amount of rainfall (244.9 mm). This decrease in soil moisture is due to higher moisture uptake by well grown crop and also due to uneven distribution of rainfall. After this the crop entered into PI stage (55-56 DAS) and at boot stage (65-67 DAS). At this stage good soil moisture of 24.2% was maintained which might have favour PI and booting activities. Further to this soil moisture depleted to 21% at 70th DAS and to 19% at 86th DAS, after which soil moisture did not deplete and was maintained at little higher status from dough to maturity stages. A total of 1042.7 mm of rainfall was received during the growing period from sowing to dough stages with continued maintenance of optimum level of soil moisture throughout the growing period. Non-receipt of rainfall towards maturity might have favored the crop in proper grain filling period and timely maturity.

Table-2: Soil moisture regimes under three dates of sowing.

D1-21.6.13					
DATE	**DAS**	**0-15cm**	**15-30 cm**	**Average**	**RBTO (mm)**
21.6.13	0	20.81	23.82	22.32	23
1.7.13	9	19.92	22.87	21.40	38.6
25.7.13	31	20.28	29.97	25.13	134.3
10.8.13	49	18.66	19.32	18.99	244.9
26.8.13	65	24.15	24.34	24.25	36.8
10.9.13	70	17.11	25.03	21.07	80.6
26.9.13	86	18.96	20.09	19.53	238.9
12.10.13	102	18.67	20.45	19.56	245.6
30.10.13	120	19.37	23.52	21.45	0
14.11.13	135	19.67	23.2	21.44	0
D2-1.7.13					
DATE	**DAS**	**0-15cm**	**15-30 cm**	**Average**	**RBTO (mm)**
1.7.14	0	19.92	22.87	21.40	29.8
11.7.13	10	25.37	26.47	25.92	131.7
1.8.13	30	19.2	20.4	19.80	34.2
16.8.13	45	22.92	21.2	22.06	263.9
31.8.13	60	15.45	21.15	18.30	42.4
16.9.13	76	16.02	20.25	18.14	214.6
7.10.13	97	22.22	25.43	23.83	275.7
17.10.13	107	22.47	25.56	24.02	35.6
4.11.13	124	20.15	23.12	21.64	0
D3-11.7.13					
DATE	**DAS**	**0-15cm**	**15-30 cm**	**Average**	**RBTO (mm)**
11.7.14	0	25.37	26.47	25.92	12.5
20.7.13	9	19.68	29.37	24.53	136.8
5.8.13	25	17.87	21.05	19.46	74.8
21.8.13	41	35.79	24.17	29.98	208.9
5.9.13	56	20.23	26.69	23.46	78.5
21.9.13	72	20.46	36.4	28.43	175.3
7.10.13	88	26.73	24.27	25.50	290.3
22.10.13	103	20.37	22.19	21.28	21
9.11.13	121	19.32	22.65	20.99	0

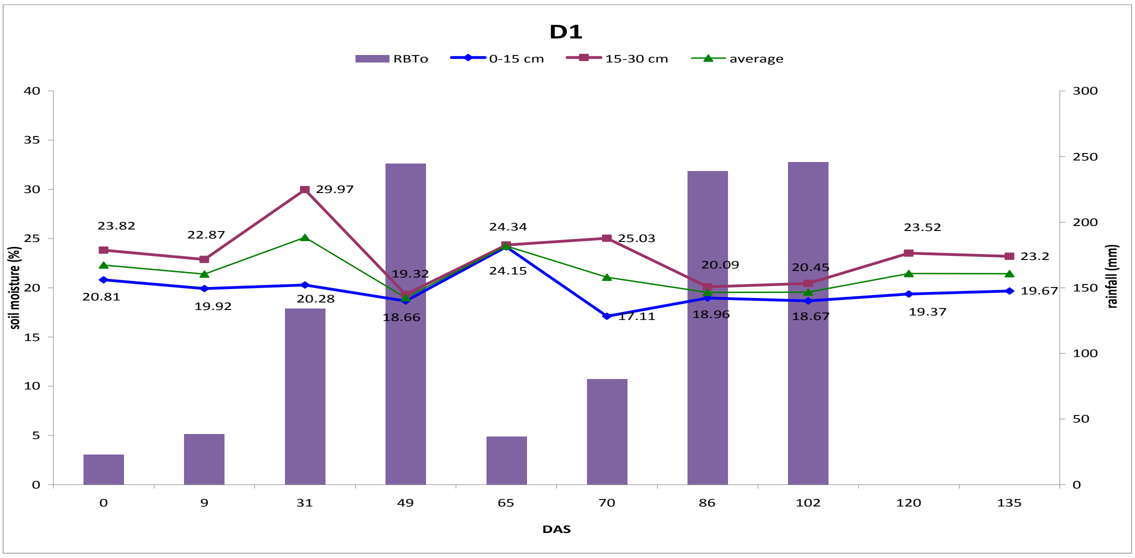

Fig. 1a

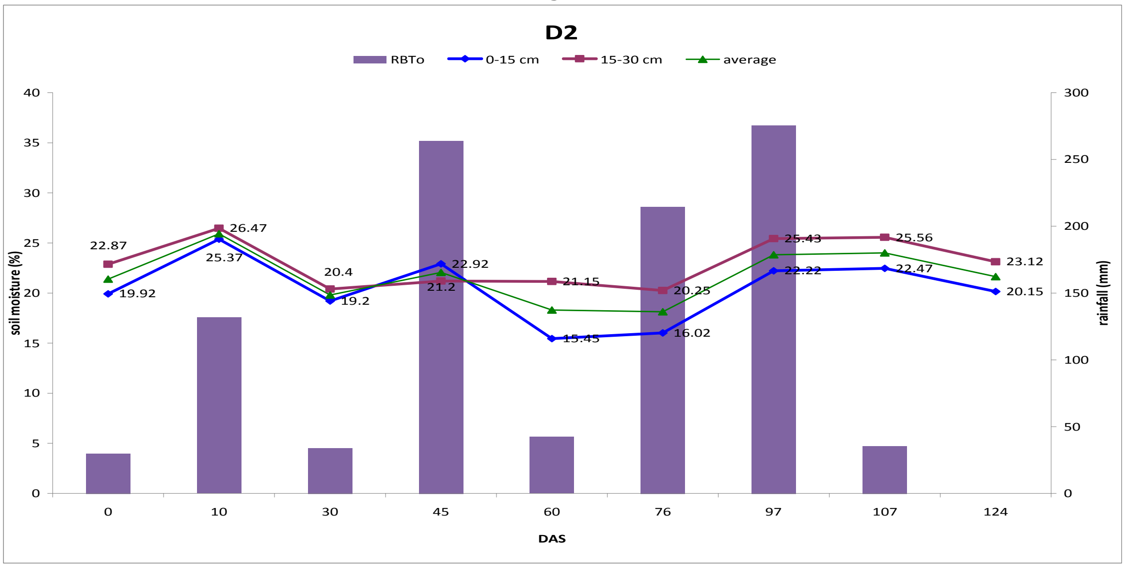

Fig.1b

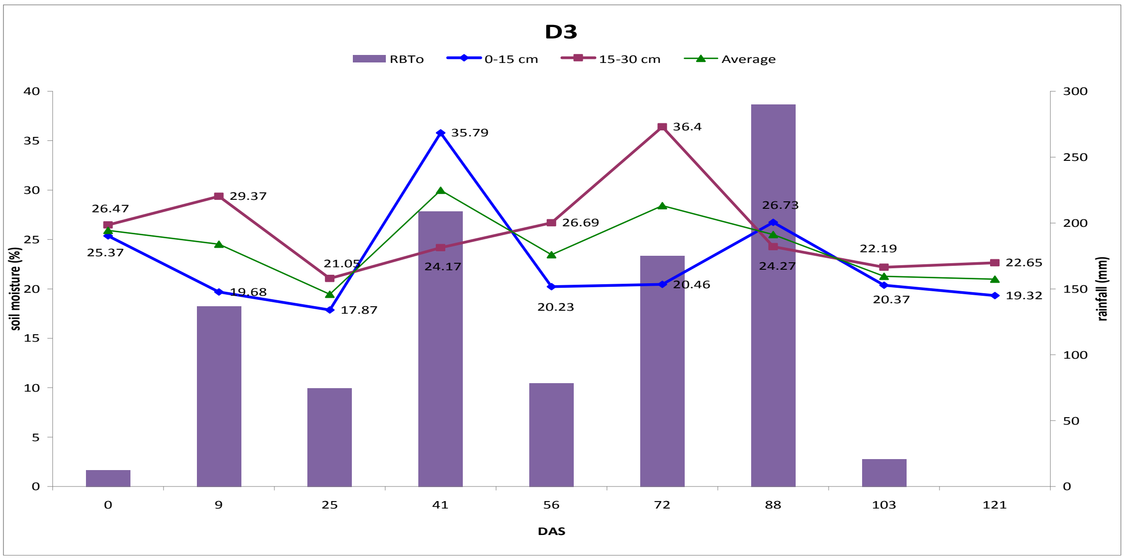

Fig. 1c

Fig.1a-1c Soil moisture regimes under three different dates of sowing.

In case of 1st July sowing (D2) initial soil moisture at sowing was maintained between 19.92% (0-15 cm) and 22.87% (15-30 cm) with an average of 21.39%. The soil moisture value, in both the depths increased up to 10 DAS then depleted to19.2% (0-15 cm) and 20.4% (15-30 cm) at 30th DAS having an average value of 19.8%. Again, the soil moisture registered little increased to 22.9% (0-15 cm) and to marginal increase to 21.2% (15-30 cm) with an average of 22.06 % at 45th DAS. In spite of having very good amount of rainfall in between 30th and 45th DAS only marginal increase in soil moisture may be attributed to higher soil moisture uptake by well grown crop. Subsequent to this, soil moisture depleted sharply to 15.45% in upper layer at 60th DAS while deeper layer (15-30 cm) did not deplete. However, more or less same moisture level was maintained till 76th DAS. Maintenance of lower moisture level, particularly in upper layer (0-15 cm) during this period (45th DAS to 76th DAS) coinciding with important phonological stages PI (56-57 DAS) and boot (66-68 DAS) might have affected the physiological process little adversely. However, the subsequent stage of crop like flowering (85-99 DAS) and dough (96-114 DAS) might have got favored soil moisture condition as the average soil moisture rose to 23.8% at 97th DAS and was maintained more or less at this level till 107th DAS. A total of 1027.9 mm rain was received during the crop growing period (till dough stage) which could maintain optimum soil moisture level except during 45th DAS to 76th DAS when soil moisture, particularly in 0-15 cm depth was maintained at lower level (15-16%) due to uneven distribution of rainfall during this period.

In case of 11th July sowing (D3) soil moisture at sowing was quiet high, on an average 25.9%, in 0-15 cm and 26.47% in 15-30 cm in a very short period of time, the average soil moisture depleted to 24.5% at 9th DAS and to 19.46% at 25th DAS. This depletion was mainly in upper depth (0-15 cm) due to rapid soil moisture extraction by plant from 25th DAS. The average soil moisture rose to 29.98% on 41th DAS, more increase was noticed in upper layer (35.79%) than lower layer (24.17%). Again, the average soil moisture depleted to 23.46% on 56th DAS, more was extracted from upper depth (fig. 1c). The reproductive stages PI (57-58 DAS), boot (67-68 DAS), flowering (80-99 DAS) and dough (96-114 DAS) were having good soil moisture percentage till 88th DAS (25.5%) and then little lower soil moisture was there on 103rd DAS (21.28%) and on 121st DAS (20.98%). A total of 917.1 mm of rainfall was received during crop growing period from sowing to 103th DAS. This crop sown on 11th July (D3) experienced more variation in soil moisture than early sown crop (D1 and D2).

CONCLUSION

Soil moisture conditions in the aerobic rice field were remain optimum (well above PWP) under all sowing dates under the weather and monsoon pattern prevailed during the Kharif season 2013.

Variation of soil moisture between upper and lower soil layers was more pronounced in case of last sowing (11th July) than preceding sowing (21st June and 1st July).

Timely sowing of aerobic rice varieties on and around 21st June performed the best (all four varieties) compared to subsequently delayed sowing.

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