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Impact of Moisture Content and Weed Management on Direct Seeded Rice Quality

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Authors' contributions

This work was carried out in collaboration among all authors. Author AK designed the study, wrote the protocol and wrote the first draft of the manuscript. Author Rajan Kumar help in conducting the experiment and managed the analyses of the study. Authors SK and Rinki Kumari managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during rainy (*kharif*) season of 2016 at Crop Research centre Pusa, Bihar to investigate the "Effect of Moisture Regimes and Weed Management on quality of Direct Seeded Rice". The treatments consisted of three moisture regimes in main plots and five weed management practices in sub plots. The results showed that grain (3.62 t/ha) and straw yields (52.44 q/ha), harvest index (40.83%), P uptake (10.97 kg/ha) by rice grain were maximum with 3 days Disappearance of Ponded Water(DPW) which were significantly superior to 5 and 7 DPW but N (42.19 kg/ha) and P uptake (10.97 kg/ha) by rice grain, N (30.53 kg/ha), P (8.41 kg/ha) and K (74.47 kg/ha) uptake by straw were statistically at par with 5 DPW. With regard to weed management grain yield(35.62 q/ha) was maximum with W_4 treatment of weed management which was significantly superior to W_2, W_1 and W_5 but was statistically at par with W_3 treatment while, straw yield (45.12 q/ha), N(41.37 and 29.75 kg/ha), P(10.72 and 8.18 kg/ha) and K(8.80 and 7.58 kg/ha) uptake by rice grain and straw were significantly superior to W_1 and W_5 and were comparable to W_3 and W_2 treatments. In harvest index (40.97%), W_4 treatment was significantly superior to all the treatments. N, P and K content in grain and straw did not vary significantly with varying moisture regimes weed management treatments.

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1. INTRODUCTION

In the continuous changing climatic scenario of earth due to globalization and over population, agriculture productions are facing the challenges of water scarcity. Irrigation act as intervention that modifies the soil moisture regimes and increase the production and productivity of crop by stabilizing the production against the weather condition. It is forecasted that by 2025 over 17 million ha and 22 million ha of Asian's irrigated rice are may experience physical and economical water scarcity [1]. Among all agriculture crop, rice is one of the larger share holder of water consumer. Traditional rice production system is a heavy consumer of water. It is found that about 3000 to 5000 liter of water is used to produce 1 kg of rice depending upon variety and rice cultivation method. The declining rate of per capita fresh water availability along with burgeoning population necessitates the production of rice with limited water. Under this situation direct seeded rice is the need of the hour. Direct seeded in non- puddled condition eliminates the needs of raising, maintaining and subsequent transplanting of seedling. Thus, it saves labour and water. Besides early maturity of crops, it allows the timely sowing of subsequent crop too [2].

Among the various factors of rice production, weed infestation is one of the major constraints in direct seeded rice. Uncontrolled weed causes 50 to 80% reduction in yield [3] and sometimes resulted in complete failure of crop. It competes with crops for nutrients, water, light and space. It is found that competition is more severe in the early growth stage of rice as compare to later stages. So early control of weed is important, there are various methods of weed control like chemical, biological, mechanical and agronomical methods. Out of all the methods of weed control, chemical method is most effective and quick in response. Application of pre emergence herbicides help in control of weed in early growth stages of plant which is most critical for crop weed competition after that post emergence application of herbicides control weed of later grown. One time application of herbicides can't solve the purpose of weed control in direct seeded rice. Thus, combination of herbicides are taken to control the diverse weed flora in rainy season.

2. MATERIALS AND METHODS

A field experiment was conducted during rainy (*kharif*) season of 2016 at Crop Research centre, Department of Agronomy, DRPCAU, Pusa, Bihar, situated at 25°59 North latitude and 85°48´ East longitude with an altitude of 52.92 meters above mean sea level. Climate of the study site was sub-tropical and sub humid with an average rainfall of 1276.1 mm out of which nearly 1026.0 mm is received during the monsoon between June to September. The experiment was laid out in split plot design (SPD) with three replications. In main plots treatments were I_1-Irrigation at 3 days Disappearance of Ponded Water (DPW) I_2-Irrigation at 5 days DPW and I_3-Irrigation at 7 days DPW and in sub plots W_1-Chlorimuron + Metsulfuron @ 20 + 4 g/ha at 15 DAS, W_2-Pendimethalin @ 1 kg/ha at 0-3 DAS *fb* Chlorimuron + Metsulfuron @ 20 + 4 g/ha at 15 DAS, W_3-Pendimethalin @ 1 kg/ha at 0-3 DAS *fb* Bispyribac sodium @ 30 g/ha at 20 DAS, W_4-Weed free (20, 40 and 60 DAS) and W_5-Weedy check. Sugandh-5 was taken as test of cultivar. Soil of the experimental plot was sandy loam in texture, alkaline in reaction (pH 8.4), low in available N 152 kg/ha (Alkaline permanganate method, [4], P_2O_5 19.23 kg/ha (Olsen's method) [5] and K_2O 122 kg/ha (Flame photometer method, [6]. The crop was fertilized with 120-60-40-25 kg/ha N-P_2O_5-K_2O and $ZnSO_4$. Half (50%) dose of nitrogen and total phosphorus and potash and $ZnSO_4$ (25 kg/ha) were applied as basal and remaining dose of nitrogen was applied in two equal splits (25% N at active tillering and 25% N at panicle initiation stage). The required cultural practices and plant protection measures were followed as per recommended package. The crop was harvested when 90% of the grains were golden yellow. The grains were threshed, cleaned and sun dried to record the grain yield (t/ha) on the net plot basis. Nutrient content of grains and straws were determined by using micro kjeldahl method [7] total nitrogen, spectrophotometer method [8] total phosphorus and flame photometer method [6] total potassium. Nutrient uptake was further calculated in relation to dry matter production (seed or straw) by using formula:

> Nutrient uptake (kg/ha) = (Nutrient content (%) × yield (grain or straw))/100

The data collected from the experiment were subjected to statistical analysis by using ANOVA

(p<0.05) as suggested by Gomez and Gomez [9].

3. RESULTS AND DISCUSSION

3.1 Yield of Direct Seeded Rice

Different moisture regimes and weed management treatment of direct seeded rice produced significant variation in grain and straw yield (Table. 1). Irrigation at 3 days disappearance of ponded water shows the maximum value which was significantly superior to remaining treatments and minimum value was obtained with irrigation at 7 days disappearance of ponded water during the crop period. This might be due to higher number of tillers/m^2 and dry matter production under better moisture regimes. The grain yield of a crop is the combined effect of various growth and development parameters. In the present investigation, almost all the growth and development characters seemed to be affected by increasing moisture regimes while under moisture stress condition, the photosynthesis activities were reduced owing to closure of stomata which resulted in reduced supply of CO_2 and the capacity of protoplasm to carry out photosynthesis efficiency. Reduced translocation might have hindered the further accumulation of the end products. These finding were collaborated with the results of [10,11]. Among the different weed management practices pertaining to growth and yield attributes, yields of Weedy check was recorded minimum among the several treatments whereas hand weeding was recorded maximum and was statistically at par with Pendimethalin @ 1 kg/ha *fb* Bispyribac sodium @ 30 g/ha. Similar result was obtained by Upasani et al. [12]. This might be due to lesser crop weed competition in hand weeding which led to higher crop growth, yield characters and less weed density and dry weight and thus more economic yield as compared to other treatments. Pre-emergence followed by post-emergence application of herbicide is less effective as compared to hand weeding but close to it in controlling weeds. Similar result was obtained by Kaur and Singh [13].

Highest straw yield was recorded with irrigation at 3 days disappearance of ponded water whereas lowest was with irrigation at 7 days disappearance of ponded water. Similar finding were reported by [10,11]. This difference might be due to differential production of tillers per unit area, plant height and dry matter production. Maximum straw yield was found in hand weeding which was statistically at par with pre and post herbicidal treatments and minimum yield was recorded in Weedy check. Mohapatra et al. [14], Prashanth et al. [15] reported the similar results.

Table 1. Grain yield (q/ha), straw yield (q/ha), and Harvest index (%) as affected by different treatments of direct seeded rice

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Harvest Index (%)
Moisture regimes			
I_1	36.24	52.44	40.83
I_2	32.01	46.71	40.62
I_3	26.68	39.64	40.18
SEm±	0.68	0.98	0.05
CD (P=0.05)	2.66	3.84	0.19
Weed management			
W_1	30.52	45.12	40.31
W_2	32.92	47.74	40.79
W_3	33.74	48.93	40.79
W_4	35.62	51.23	40.97
W_5	25.42	38.29	39.85
SEm±	0.84	1.24	0.06
CD (P=0.05)	2.51	3.69	0.17

I1, I2, I3 - Irrigation at 3, 5 and 7 days disappearance of ponded water. W1-Chlorimuron + Metsulfuron @ 20+4 g/ha at 15 DAS, W_2-Pendimethalin @ 1 kg/ha at 0-3 DAS fb Chlorimuron + Metsulfuron @ 20+4 g/ha at 15 DAS, W_3-Pendimethalin @ 1 kg/ha at 0-3 DAS fb Bispyribac sodium @ 30 g/ha at 20 DAS, W_4-Weed free (20, 40 and 60 DAS), W_5-Weedy check

Table 2. N, P and K content (%) in grain and straw as affected by different treatments of direct seeded rice

Treatments	N content (%)		P content (%)		K content (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
Moisture regimes						
I_1	1.161	0.580	0.302	0.160	0.247	1.416
I_2	1.143	0.571	0.297	0.157	0.241	1.394
I_3	1.116	0.558	0.287	0.151	0.233	1.361
SEm±	0.029	0.015	0.008	0.004	0.005	0.036
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Weed management						
W_1	1.124	0.562	0.295	0.155	0.237	1.371
W_2	1.149	0.575	0.298	0.158	0.241	1.401
W_3	1.153	0.577	0.299	0.159	0.244	1.407
W_4	1.158	0.579	0.300	0.159	0.246	1.413
W_5	1.114	0.557	0.285	0.150	0.233	1.359
SEm±	0.031	0.016	0.008	0.004	0.005	0.038
CD (P=0.05)	NS	NS	NS	NS	NS	NS

I1, I2, I3 - Irrigation at 3, 5 and 7 days disappearance of ponded water. W1-Chlorimuron + Metsulfuron @ 20+4 g/ha at 15 DAS, W_2-Pendimethalin @ 1 kg/ha at 0-3 DAS fb Chlorimuron + Metsulfuron @ 20+4 g/ha at 15 DAS, W_3-Pendimethalin @ 1 kg/ha at 0-3 DAS fb Bispyribac sodium @ 30 g/ha at 20 DAS, W_4-Weed free (20, 40 and 60 DAS), W_5-Weedy check

Harvest index is the measure of efficiency of crop production which indicates the ultimate partitioning of dry matter in grain and vegetative parts. Among the different moisture regimes, Harvest Index was recorded maximum with irrigation at 3 days disappearance of ponded water which was significantly superior to irrigation at 5 days and 7 days disappearance of ponded water. Data pertaining to Harvest Index among the different weed management practices showed significant effect due to difference in grain and straw yield. Maximum Harvest Index was recorded in hand weeding thrice and was significantly superior to all the treatments.

3.2 Nutrients Content

Different moisture regimes and weed management treatment of direct seeded rice produced non-significant variation in nutrient content (Table. 2). Increased in N, P and K content in grain and straw of direct seeded rice was noticed but the mean difference could not reach to the significant level. This was due to equal doses of N, P and K fertilizers were applied to all treatments. In moisture regimes maximum value was found with irrigation at 3 days disappearance of ponded water and minimum in 7 days disappearance of ponded water. This might be due to better translocation of these nutrients in crop plant due to more availability of water. Similar finding was also reported by Chowdhury et al. [16]. In weed management practices the maximum value was found with Weed free (20, 40 and 60 DAS) and minimum with Weedy check. This might be due to less competition offer by weed for nutrient in weed free plots.

3.3 Nutrients Uptake

Different moisture regimes and weed management treatment of direct seeded rice produced significant variation in nutrient uptake (Table. 3). Nutrient uptake is the function of total biomass production and nutrient content in the biomass. The maximum uptake was recorded with irrigation at 3 days disappearance of ponded water and decreased with decrease in number of irrigation. Greater amount of N, P and K uptake was due to higher yield and higher number of irrigation which was conducive for higher uptake of nutrient by the plants. Similar observation was found by Kaur and Mahal [17]. There is not much to explain the behavior of treatments as crop uptake is directly a function of economic and biological yield. The plots giving higher yields exhibited higher nutrient uptake. As the Weedy check offered greater opportunity to weeds to come up and grow, their weeds took up a lion's share of nutrients from the plots. Contrary to Weedy check, nutrients are not removed by Weed free (20, 40 and 60 DAS) as weeds did not get congenial conditions for their growth and

Table 3. N, P and K uptake in grain and straw as affected by different treatments of direct seeded rice

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw
Moisture regimes						
I_1	42.19	30.53	10.97	8.41	9.00	74.47
I_2	36.71	26.79	9.54	7.36	7.75	65.35
I_3	30.03	22.28	7.73	6.06	6.24	54.36
SEm±	1.55	1.12	0.40	0.31	0.28	2.74
CD (P=0.05)	6.09	4.41	1.57	1.20	1.09	10.77
Weed management						
W_1	34.49	25.49	9.06	7.02	7.28	62.18
W_2	37.97	27.68	9.84	7.61	7.99	65.53
W_3	39.10	28.20	10.14	7.75	8.29	68.80
W_4	41.37	29.75	10.72	8.18	8.80	72.58
W_5	28.62	21.54	7.32	5.81	5.97	52.54
SEm±	1.77	1.30	0.46	0.36	0.36	3.17
CD (P=0.05)	5.26	3.86	1.36	1.06	1.06	9.42

I1, I2, I3 - Irrigation at 3, 5 and 7 days disappearance of ponded water. W1-Chlorimuron + Metsulfuron @ 20+4 g/ha at 15 DAS, W_2-Pendimethalin @ 1 kg/ha at 0-3 DAS fb Chlorimuron + Metsulfuron @ 20+4 g/ha at 15 DAS, W_3-Pendimethalin @ 1 kg/ha at 0-3 DAS fb Bispyribac sodium @ 30 g/ha at 20 DAS, W_4-Weed free (20, 40 and 60 DAS), W_5-Weedy check

development. Thus more uptakes of N, P and K were observed in Weed free (20, 40 and 60 DAS) and less in Weedy check. Prashanth et al. [18] confirmed the similar result.

4. CONCLUSION

Results discussed revealed that irrigation at 3 days disappearance of ponded water and pre and post combination of herbicides found to be most congenial for yield and nutrient uptake of direct seeded rice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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