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Effect of water imponding on growth attributes of rice

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Abstract

A field experiment was conducted during the *Kharif* 2017 at S.G. College of Agriculture and Research Station, Jagdalpur on sandy loam soil with five treatments *viz.*, water imponding of 15, 30 and 45 days 10 days after transplanting, bispyribac sodium 25 g ha^{-1} as post-emergence and without water imponding (Control) in factorial randomized block design with four replications. The growth parameters *viz.*, plant height, tillers/plant, LAI, RGR and panicle length (cm), seeds/panicle, grain yield were significantly higher with 30 days water imponding 10 days after transplanting than remaining treatments. The treatment *viz*., 30 days water imponding 10 days after transplanting was found significantly higher grain yield (24.24 q ha^{-1}) than other treatments imposed except application of bispyribac-sodium 25 g ha^{-1} as post-emergence 15 days after transplanting (22.63 q ha^{-1}) being on par to 30 day water imponding. The highest net return was gained with bispyribac-sodium (Rs 9165.74 ha^{-1}) with higher B: C ratio compared to 30days water imponding 10 days after transplanting.

Keywords: Water imponding, LAI, RGR, rice, growth, yield etc.

Introduction

Rice (*Oryza sativa* L.) is one of the world's most important food crops. Currently, more than one third of the human population relies on rice for their daily sustenance. Rice is the vital food for more than two billion people in Asia and four hundred million people in Africa and Latin America (IRRI, 2006). In country scenario, rice is grown in nearly 44 million ha of land with the productivity of 2.2 t ha^{-1} which is less than the productivity of many countries. Annual population growth rate of the country is nearly 1.8% and if per capita consumption of rice is expected to be 400 gm per day then the demand for rice in 2025 will be 130 m. tonnes. In Chhattisgarh, rice occupies average of 3.6 million ha with the productivity of the state ranging between 1.2 to 1.6 t ha^{-1} depending upon the rainfall. The state is comprised with three agro-ecological zones *i.e. Chhattisgarh plain, Bastar plateau and Northern hill* region of Surguja. Various method of rice production on different land farms of farming situation. Rice is typically grown in bunded fields that are continuously flooded up to before harvesting. Continuous flooding helps ensuring sufficient water which control weeds and rice is an aquatic crop and mostly grown under submergence or variable imponding conditions.

Rice being adapted to submerged environments, the seed germination and emergence would take place even at some water depths. This would provide opportunities to suppress weeds by direct seeding rice in plots impounded with water. Imponding has the potential to eliminate weeds, and thereby avoiding rice-weed competition, and help rice farmers to avoid extra costs incurred on early weed removal. Management of water imponding in rice field is one of the most successful methods used by the rice farmers. Williams (1987) in California reported that the level of water in rice field to 5-7 cm prevented the growth of major weeds in rice, but yields were only about 70% compared to herbicide methods. He reported that flooding was the most effective cultural control method of weeds in rice, and flooding to a depth of 10cm had prevented germination of most weed seeds and killed majority of weed seedlings.

Bastar plateau is situated southernmost part of state with cultivating rice in all farming situations like *uplamd*, *midland* and *lowland*. Mostly midland and low land farming is very unique system of compartmentation, in which water ponding is very common during rainy days but stagnation of water in their compartments provide small aquatic ecosystem of the field restricted many activities and supports many practices. The imponding system creates anaerobic condition leading to grow limited number of weeds up to some extend and reduces floral composition, but it is not known exact timing even not reported by various workers, so, this has targeted under experiment by extending time of water imponding. The substitution of rice crops in low lying region becomes more difficult due to continuous rains and development of perched water table at the surface of the soil for short duration during rice growing season. The present experiment was undertaken to study the effect of different water imponding periods on rice.

Materials and Methods

The field experiment was conducted at S.G. College of Agriculture and Research Station, Jagdalpur during the rainy (*Kharif*) seasons of 2017. The normal average annual rainfall of the area is 1400 mm but its distribution is very erratic. Major amount of precipitation occurs between June and September (about 3-4 Months). The soil was sandy loam, low in organic carbon (0.53%), available N (245.24 kg/ha) and available P (7.00 kg/ha) and medium in available K (238.41 kg/ha), EC (ds m^{-1}) 0.30 with acidic (pH 5.80) in reaction. 100 kg N: 60 kg P_2O_5: 40 kg K_2O ha^{-1}. The whole quantity of P and K was applied as basal dressing, while nitrogen was applied in two equal splits at basal and active tillering stages (40 DAT). Transplanting was done on 6th July 2017 with 25 days old seedlings keeping distance of 20x10 cm in each plot of replications and harvesting of rice was done on 18th November 2017. The plot consisted of five treatments *viz.*, 15, 30 and 45 days water imponding 10 days after transplanting, bispyribac sodium 25 g ha^{-1} as post-emergence and without water imponding (Control). The water drained out from the field through drain channels opening to down side of experimental fields, for maintaining water level refilling was also done when water needed. Plant height, number of tillers/m^2, panicle length, grains/panicle, test weight, grain and straw yield and nutrient uptake were recorded from each plot at 10 randomly selected plants. Data on dry matter were recorded on five random places in each plot and plant biomass taken from these places to ensure the increase in biomass production overtime. Leaf Area Index (LAI) was recorded by using the graph method was recorded on test cultivar *Badshahbhog s*election-1. The important weed species associated with crop in the experimental field were recorded on density and dry weight of grass, sedge and broad leaved weeds at 60th days after transplanting on randomly selected spots using quadrate (1.0 m^2). These samples of weeds were kept in paper bags and dried in oven at 65 ºC till their weight become constant, after that the weight was recorded on electronic balance. Weed control efficiency was worked out on the basis of the following formula: WCE (%) = DWC-DWT/ DWC×100, Where, WCE = Weed control efficiency, DWC = Dry matter production of weeds in control plot and DWT = Dry matter production of weeds in treated plot. The cost of cultivation and returns were calculated by taking into account the prevailing cost of inputs and finger millets of output.

Results and Discussion

Plant population

The data in respect to plant population recorded at 15, 30, 45, 60, 75 and 90 DAT are in Table 4.1. Plant population increased with the time up to 45 DAT and decreased later at 90 DAT. At 15 and 60 DAT, plant population was significantly increased with 30 days water imponding 10 days after transplanting. (201.75, 330.25 and 380.25 m^{-2} at 15, 30, and 45 DAT), later plant population was decreased at 60, 75 and 90 DAT. However, 30 days water imponding had higher plant population throughout observation and found significant value of 201.75, 374.75, 380.25, 330.25, 316.50 and 295.75 m^{-2} at 15, 30, 45, 60, 75 and 90 DAT, respectively being on par to that of herbicide application (Bispyribac sodium @ 25 g ha^{-1} post emergence) followed by 45 days water imponding 10 days after transplanting at all stages of observation recorded. The availability of growth resource in beginning by suppression of weed flora might be increased plant population (Yao *et al*., 1990 and Rajput *et al*., 2017) [10, 6].

Table 1: Effect of water imponding period on plant population of rice

Treatment		Plant Population (m^{-2})					
		15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
T_1	15 Days water imponding 10 days after transplanting	171.25	350.25	358.50	326.50	298.00	284.75
T_2	30 Days water imponding 10 days after transplanting	201.75	374.75	380.25	330.25	316.50	295.75
T_3	45 Days water imponding 10 days after transplanting	180.75	351.50	347.25	321.25	295.25	281.50
T_4	Bispyribac sodium @ 25g ha^{-1} Post Emergence at 15 DAT	200.00	362.50	362.25	328.75	309.25	285.25
T_5	Without water imponding (Control).	156.50	312.50	314.00	312.75	282.00	265.50
S.Em±		6.89	4.06	5.62	0.51	6.98	4.61
CD (P=0.05)		21.56	13.26	18.00	2.52	21.25	14.25

Plant height

The data recorded on plant height of rice are presented in Table 4.2. The plant height was significantly increased from 15 DAT to 90 DAT. But the increment was more in initial phase of growth till 45 DAT, later increased with slow growth. The maximum plant height was noted with 30 days water imponding 10 days after transplanting (T_2) having plant height of 78.43, 94.80, 107.29, 131.65 and 140.10 cm at 30, 45, 60, 75 and 90 DAT, which was significantly higher than remaining treatments except 45 day water imponding 10 days after transplanting at 15 DAT. Application of bispyribac-sodium @ 25 g ha^{-1} as post emergence at all stage of observation till 90 DAT, was found on par to plant height of 30 days water imponding 10 days after transplanting. The lowest plant height was recorded under without water imponding (T_5). Inundation naturally affect to non aquatic plant in anaerobic ecosystem which highly support to aquatic like rice crop, this behavior of rice has potential to grow well under semi water logged condition later stage, whereas other plant hardly survives. This finding is in close conformity with findings of Juraimi *et al*. (2009) [5].

Table 2: Effect of water imponding period on plant height of rice

Treatment		Plant height (cm)					
		15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
T_1	15 Days water imponding 10 days after transplanting	44.58	75.09	92.33	103.05	120.35	138.90
T_2	30 Days water imponding 10 days after transplanting	47.85	78.43	94.80	107.29	131.65	140.10
T_3	45 Days water imponding 10 days after transplanting	45.19	76.91	91.60	102.55	120.80	137.80
T_4	Bispyribac sodium @ 25g ha-1 Post Emergence at 15 DAT	46.00	76.42	92.74	103.60	123.06	139.58
T_5	Without water imponding (Control).	44.06	74.57	89.85	102.28	119.50	129.41
S.Em±		1.32	1.63	1.80	1.32	2.57	0.22
CD (P=0.05)		NS	2.38	2.08	3.70	8.61	0.56

Number of tillers per plant

The tillers per plant was recorded at 15, 30, 45, 60, 75 and 90 DAT (Table 4.3) which was significant in producing tillers per plant at all growth stages of rice. 30 days water imponding 10 days after transplanting (5.15) attained higher number of tillers per plant being on par with bispyribac sodium @ 25 g ha^{-1} applied as post-emergence (4.75) and the lowest number of tillers per plant was recorded with no water imponding (3.95) at 15 DAT, the similar trend of tillers per plant was followed at later growth stage of rice *viz.*, 30, 45, 60, 75 and 90 DAT. The 30 days imponding of water naturally affected crop growth positively rather than imponding of water for 15 (short period) or 45 (long period) DAT 10 days after transplanting and due to initial suppression of weeds by imponding in plots restricted to utilize growth resources available in field by weeds, which ultimately availed to rice plants (Chaudhary and Dixit, 2018) [4].

Table 3: Effect of water imponding period on number of tillers of rice

Treatment		Number of tiller (Plant^{-1})					
		15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
T_1	15 Days water imponding 10 days after transplanting	4.05	7.65	8.50	8.05	10.35	10.70
T_2	30 Days water imponding 10 days after transplanting	5.15	8.65	9.40	10.20	11.70	12.60
T_3	45 Days water imponding 10 days after transplanting	4.65	8.00	7.60	8.90	10.00	10.95
T_4	Bispyribac sodium @ 25g ha^{-1} Post Emergence at 15 DAT	4.75	8.50	8.80	9.85	11.55	11.95
T_5	Without water imponding (Control).	3.95	7.15	7.33	8.05	8.95	9.35
S.Em±		0.12	0.05	0.18	0.12	0.05	0.58
CD (P=0.05)		0.42	0.17	0.68	0.42	0.17	0.97

Number of panicle hill^{-1}

The number of panicles hill^{-1} of rice was recorded significant with weed management (Table 4.23). The number of panicles hill^{-1} was increased with magnitude of weed management treatments. The higher number of panicles hill^{-1} of rice was recorded with 30 days water imponding 10 days after transplanting (3.08) being on par to bispyribac-sodium 25 g ha^{-1} as post-emergence (2.95) in enhanceing of number of panicle hill^{-1} followed by imponding of water for 15 days 10 days after transplanting (2.80). The lowest number of panicles hill^{-1} (2.55) was noted with no water imponding (Ahmed *et al*., 2014; Ali *et al.*, 2004 and Bhurer *et al*., 2010) [1, 2]

Panicle length (cm)

The panicle length of rice was differed significantly with weed management treatments (Table 4.23). The lowest panicle length (17.29 cm) was noted with no water imponding, which was increased with imposing treatments and higher panicle length of rice was recorded with 30 days water imponding 10 days after transplanting (21.36 cm) being at par to application of bispyribac-sodium 25 g ha^{-1} as post-emergence (22.62 cm) at 15 days after transplanting. The imponding of water for 45 days in rice (19.53 cm) was equally effective as 15 days water imponding 10 days after transplanting (20.02 cm). This enhancement of panicle length with application of bispyribac-sodium 25 g ha^{-1} as post-emergence was associated with higher degree of weed suppression triggered sound vegetative growth led to enhance length of panicle (Ranawake and Amara singhe, 2014) [7].

Seeds per panicle

The seeds per panicle of rice were differed significantly with weed management (Table 4.23). The seeds per panicle were increased with imposing treatments and higher seeds panicle^{-1} of rice was recorded with 30 days water imponding 10 days after transplanting (137.87) which was comparable to that of bispyribac-sodium 25 g ha^{-1} as post-emergence (134.43). Water imponding of 15 (131.65) and 45 (129.36) 10 days after transplanting were equally effective in enhancing seeds panicle^{-1}. The lowest seeds panicle^{-1} length (124.28) were noted with no water imponding. As panicle length and panicle increased the seeds were increased in number with plus characters. Juraimi *et al.* 2009 [5] and Yan *et al.* (2010)

Grain yield

The grain yield is main agronomical parameter to assess the treatment potentiality, which is a combined effect of weed management, growth and yield attributes on crop yields. The treatment *viz*., 30 days water imponding 10 days after transplanting was found significantly higher grain yield (24.24 q ha^{-1}) than other treatments except application of bispyribac-sodium 25 g ha^{-1} as post-emergence 15 days after transplanting (22.63 q ha^{-1}) which was being on par to 30 day water imponding 10 days after transplanting. However, imponding water for 15 days 10 days after transplanting (21.50 q ha^{-1}) was comparable with that of bispyribac-sodium 25 g ha^{-1} as post-emergence 15 days after transplanting. The results are in line with the findings of Sarkar *et al*. (2017) [8] and Sen *et al.* (2002) [9] who have obtained higher grain yield consequently recording higher yield attributing characters with water imponding on transplanted rice and was found significantly higher grain yield (24.24 q ha^{-1}) in rice due to better weed control efficiencies. The lowest grain yield was recorded with no water imponding (18.43 q ha^{-1}). Unchecked weed growth resulted in more dominant weed densities with higher weed biomass, which reduced the seed yield of transplanted rice drastically.

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