Indian Journal of Agronomy **66** (3): 366–369 (September 2021)

Research Communication

Influence of precision nutrient and weed management on growth and productivity of direct-seeded upland rice (*Oryza sativa*) under Eastern Plateau and Hills Region

SMRUTI RANJAN PADHAN[1], S.S. RATHORE[2], SHIV MANGAL PRASAD[3], KAPILA SHEKHAWAT[4] AND V.K. SINGH[5]

ICAR-National Rice Research Institute, Central Rainfed Upland Rice Research Station, Hazaribagh, Jharkhand 825 301

Received: August 2020; Revised accepted: August 2021

ABSTRACT

A field experiment was conducted at the Hazaribagh, Jharkhand, during the rainy season (*kharif*) of 2019, to find out the effect of nutrient and weed management on growth and yield of direct-seeded, upland rice (*Oryza sativa* L.). The field experiment was laid out in a split-plot design, comprising 3 nutrient-management practices in the main plots and 5 weed-management practices in the subplots, with 3 replications. The study revealed that, precision nutrient management like Nutrient Expert ® guided NPK and weed management through Pendimethalin followed by (*fb*) hand-weeding recorded lesser weed density (7.24 and 7.34 respectively), least weed dry weight at harvesting (10.11 and 9.94 g/m^2 respectively), maximum grain yield (3,630 and 4,090 kg/ha respectively) and higher leaf area index (LAI) at 60 days after sowing (60 DAS) as compared to weedy check. Also, there was a significantly positive correlation observed among the yield-attributing characters for obataining higher grain yield.

Key words: Weed density, Weed dry weight, Hand-weeding, Nutrient expert, Weed index, Leaf-area index

The rice grown areas spread over 158 m ha all over the world where the sharing of Asian countries is 90%. The area sharing of rice-growing ecosystem is about 44 m ha, from which the contribution of upland and lowland is 7 m ha and 17 m ha, respectively. The total production of India is 104.3 million tonnes (MT) and the national productivity is 2.4 t/ha (GoI, 2018) which is still very low as compared to that of China. The area and production of rice in Jharkhand are 1.59 million ha and 2.89 million tonnes, respectively. The productivity of rice in Jharkhand is 1,814 kg/ha which is again very low against the national rice productivity of 2,578 kg/ha. The rainfed upland ecosystem of rice is the most ignored one but it helps in feeding a substantial numbers of poor farmers of India from its limited resources (Singh *et al.,* 2011). The ecosystem spreads over an area of 7 million ha across the states in the country. But its area typically concentrates to the Eastern part in which the Eastern Plateau and Hills Region share most of the acreage. Conventionally, rice is mainly grown in puddled transplanted ecosystem including nursery growing of seedling for early establishment. But due to water intensiveness of lowland rice contrasting to looming water crisis. The direct-seeded rice (DSR) is gaining favours of the researchers as well as farmers owing to its low input demand, rapidity and easiness in planting, shorter growing season of 7–10 days fitting well into the different intensive cropping system, lower methane emission and reduction of labour share on the total cost of cultivation (Farooq *et al.,* 2011; Chauhan, 2012). The direct-seeded, upland rice-production systems, under well-drained, non-puddled, and non-saturated soils, can obtain as high as 4–6 tonnes/ha with good management practices. Under upland conditions, the farmers and the researchers are looking for alternative options to enhance rice productivity in these areas. The opportunity of achieving higher yields under upland rice is often challenged by various biotic and abiotic stresses. Among these stresses, complexity of interactions among weeds and nutrient management are the main challenges. Therefore, exact combination of crop fertilization along with weed man-

Based on a part of Ph.D. thesis of the first author submitted in ICAR-National Rice Research Institute, Hazaribagh, India

[1]**Corresponding author's Email**: sanjayrathorears@gmail.com
[1]Ph.D. Research Scholar, [2]Principal Scientist, [4]Senior Scientist, Division of Agronomy, ICAR-Indian Agricultural Research Institute, Pusa, New Delhi 110 012; [3]Senior Scientist, ICAR-National Rice Research Institute, Cuttack, Odisha 753 006; [5]Director, Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad, Telangana 500 059

agement at critical stages of growth for maintaining a proper balance between them is the key to achieve higher benefit (Cathcart *et al.,* 2004). Hence a study was carried out to improve upland rice yield, devising appropriate combination of nutrient management along with use of herbicides.

The present field experiment was conducted during the rainy season of 2019 at the ICAR-National Rice Research Institute, Central Rainfed Upland Rice Research Station, Hazaribagh, Jharkhand, in the upland condition of Eastern plateau and hills region, to find out the effect of precision nutrient and weed management on the weed dynamics, growth, yield-attributing characters of direct-seeded upland rice. The experimental site was 23°57'41" N and 85°21'48" E at 615 m above mean sea-level. With a warm and humid climate, mean maximum and minimum temperature of the district as per the long term data analysis is about 31.4°C and 13.7°C, respectively, with an average temperature of 23.7 °C. The maximum and minimum relative humidity is about 67.4 and 36.3%, respectively, with a normal annual rainfall of 1,274 mm 79% of the total and rainfall is poured in the monsoon during June–September. The soil (upper 15 cm) was clay-loam, having a good water-holding capacity, with a *p*H of 6.6 in soil-water suspension (1 : 2.5). As per the chemical analysis of soil, just before the sowing, the soil was found to be medium in organic carbon (0.59%), low in available N (158 kg/ha), medium in available P (10.82 kg/ha) and high in available K (368 kg/ha).

The field experiment was laid out in a split-plot design, comprising 3 nutrient-management practices in the main plots and 5 weed-management practices in the subplots, making 15 treatment combinations, with 3 replications. Separate randomization was executed for both main plots and subplots. Main plot consisted of recommended dose of fertilizer (RDF, N_1), Nutrient Expert ® guided NPK (N_2) and leaf colour chart (LCC) guided N + full P and K (N_3), while subplots comprised weed management, as weedy check (W_1), pre-emergence application of pendimethalin @ 1.0 kg/ha + post-emergence application of bispyribac-Na @ 25 g/ha at 25 DAS (W_2), pre-emergence application of pendimethalin @ 1.0 kg/ha + 1 hand-weeding at 25 DAS (W_3), brown manuring of *dhanicha* [*Sesbania bispinosa* (Jacq.) W. Wight; Syn. *S. aculeate* (Willd.) Pers.] at 25 DAS with bispyribac-Na @ 25 g/ha sown with a seed rate of 20 kg/ha (W4) and weed free (W5).

Different precision nutrient and weed-management options significantly influenced the weed density in upland rice. Under precision nutrient management, Nutrient Expert ® guided NPK recorded significantly lesser weed density (7.24) and weed dry weight (10.11 g/m^2) at harvesting stage than weedy check or other treatments (Table 1). While under RDF, the maximum weed density and weed dry weight were observed. With respect to weed-management practices, pendimethalin followed by (*fb*) hand-weeding resulted in lesser weed density (7.34) and weed dry weight (9.94 g/m^2) at harvesting. The next best weed-management practice was pendimethalin *fb* bispyribac-Na, being better than brown manuring in terms of weed density and weed dry weight. The establishment of aerobic weeds vis-à-vis small-seeded broad-leaf weeds can be effectively controlled by the application of pendimethalin (Shekhawat

Table 1. Weed density, weed dry weight, weedindex and grain yield of upland rice as influenced by precision nutrient and weed-management practices

Treatment	Weed density at harvesting	Weed dry weight at harvest (g/m^2)	Weed index	Grain yield) kg/ha)
Nutrient-management practice				
Recommended dose of fertilizer (RDF)	9.09(107)	13.94(258.4)	26.47	3030
Nutrient Expert®-guided NPK	7.24(72)	10.11(152.5)	25.02	3630
Leaf colour chart (LCC)-guided N + full P and K	8.62(96)	12.71(220.6)	19.11	3410
SEm±	0.19	0.29	-	110
CD (P=0.05)	0.51	0.81	-	290
Weed-management practices				
Weedy check	15.17(230)	24.00(577.0)	76.74	1,030
Pendimethalin *fb* hand-weeding	7.34(54)	9.94(100.8)	6.58	4,090
Pendimethalin *fb* bispyribac-Na	8.73(78)	12.23(156.9)	13.67	3,790
Brown manuring	9.63(95)	14.40(217.7)	20.68	3,480
Weed-free	0.71(0)	0.71(0.0)	0.00	4,390
SEm±	0.24	0.36	-	120
CD (P=0.05)	0.49	0.75	-	240

(Weed density and weed dry-weight data were subjected to square-root transformation ($\sqrt{x+0.5}$).
*Figures in the parentheses indicates original values

et al., 2020). One-hand weeding at 25 days after sowing (DAS) remove all the weeds from the field and at the later stage as there was rapid increase in the growth and vigour of crop plant due to application of second splits of nitrogen as top-dressing where the newly emerging weed found to be less competitive. But in case of bispyribac-Na treated plots there were some weeds which were not fully controlled and they showed their growth again after the nitrogen application. Bispyribac-Na is a potent herbicide to knock down typical rice weeds like *Echinochloa* sp., but not like *Dactyloctenium aegyptium* (Chauhan, 2012) in DSR. As there was no application of any pre-emergence herbicides in brown-manuring treatment, the early flush of weed infestation was uncontrolled making the treatment high in weed density as well as weed dry weight as compared to the treatments where pendimethalin was applied as pre-emergence. In case of weedy check, the weeds grew luxuriously without any management measures leading to poor result in all the stages. The least weed index (WI) was obtained in LCC (19.11) followed by Nutrient Expert (25.02) and RDF (26.47) and in the weed-management aspect, apart from weed-free treatment, the least control was recorded in pendimethalin *fb* hand-weeding (6.58) followed by pendimethalin *fb* Bispyribac-Na (13.67) subsequently by brown manuring (20.68) and weedy check (76.74). The weed index (WI) displays relative reduction of grain yield, so the lower WI is associated with better weed management aspect (Sharma *et al*., 2007). Among the nutrient-management practices, Nutrient Expert ® guided NPK resulted in significantly maximum grain yield (3,630 kg/ha), followed by LCC-guided N + full P and K (3410 kg/ha), which was significantly higher over RDF. Among the weed-management aspects, pendimethalin *fb* hand-weeding, pendimethalin *fb* bispyribac-Na resulted in significantly higher grain yield (4,090 and 3,790 kg/ha) over the brown-manuring (3,480 kg/ha) and weedy check (1,030 kg/ha). These trends may be owing to the superior yield-attributing characters and yield-attributing characters directly influenced the grain, straw as well as the biological yield. Generally, weeds are found to be more competitive in nature and occupy all the factors at a very faster rate required for crop growth and development (Das *et al*., 2012; Shekhawat *et al*., 2017).

Precision nutrient management did not influence on leaf-area index (LAI) at 30 DAS (Fig. 1); however at 60 DAS, higher LAI was recorded under Nutrient Expert ®-guided NPK (4.0) and in LCC-guided N + full P and K (3.8) over RDF (3.59). The weed-management practices exerted significant influence on LAI at 30 and 60 DAS. The maximum LAI at 60 DAS (4.37) was found in weed-free plot and after that pendimethalin *fb* hand-weeding and pendimethalin *fb* bispyribac-Na resulted in significant increase in LAI of upland rice. This might be attributed to the weed-competitive ability for absorbing nutrient and accquring other resources making it unavailable for crop plant (Gopinath *et al*., 2012) reducing their yield attributing characters along with LAI. There is an inverse relation between nutrient uptake by crops and nutrient uptake by weeds. Das *et al*. (2012) reported a removal of 30–40 kg, 10–15 kg, 20–40 kg of N, P_2O_5, and K_2Om respectively, from soil by weed flora.

Among different yield attributes and grain yield of the upland rice, asignificant positive correlation was observed hence it explained that improvement in different yield attributes resulted in higher grain yield (Table 2).

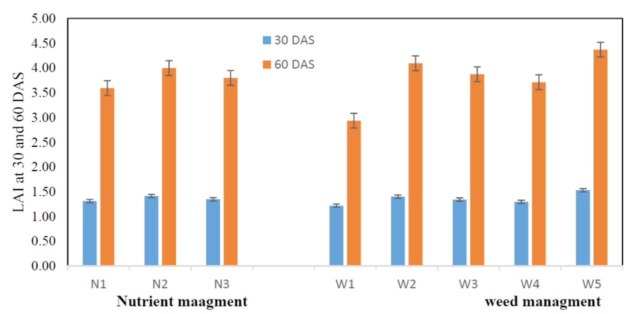

Fig. 1. Leaf-area index of upland rice under different nutrient and weed-management options

Table 2. Correlation between yields attributes and seed yield of upland rice

Characters	Tillers/m²	Panicles/m²	Length of panicle	Filled grains/ panicle	Unfilled grains/ panicle	Grains/panicle	1,000-grain weight
Tillers/m²	1						
Panicles/ m²	0.99						
Length of panicle	0.97	0.94					
Filled grains/panicle	1.00	0.99	0.97				
Unfilled grains/panicle	0.72	0.64	0.86	0.73			
Grains/panicle	0.97	0.94	1.00	0.98	0.86		
1,000-grain weight	0.95	0.91	1.00	0.96	0.90	1.00	
Seed yield	0.92	0.94	0.83	0.92	0.44	0.82	0.79

trient through precision nutrient management tools like Nutrient Expert and leaf-color chart could be a better option for lowering the weed density, weed dry weight, increasing leaf-area index and obtaining a higher yield. And among the weed-management options, pendimethalin *fb* hand-weeding was found to be more viable option where labour scarcity is not a bottleneck and if so, other options like pendimethalin *fb* bispyribac-Na could be a better option for weed management in direct-seeded upland rice.

REFERENCES

Cathcart, R.J., Chandler, K. and Swanton, C.J. 2004. Fertilizer N rate and the response of weeds to herbicide. *Weed Science* **52**: 291–296.

Chauhan B.S. 2012. Weed ecology and weed management strategies for dry-seeded rice in Asia. *Weed Technology* **26**(1): 1–13.

Das, T.K., Tuti, M.D., Sharma, R., Paul, T. and Mirja, P.R. 2012. Weed management research in India: An overview. *Indian Journal of Agronomy* **57** (3rd IAC Special Issue): 148–156.

Farooq, M., Siddique, K.H.M., Rehman, H., Aziz, T., Lee, D. and Wahid, A. 2011. Rice direct seeding: Experiences, challenges and opportunities. *Soil and Tillage Research* **111**: 87–98.

GoI. 2018. *Agricultural Statistics at a Glance*. Ministry of Agriculture, Department of Agriculture and Cooperation, Directorate of Economics and Statistics, Government of India, New Delhi.

Gopinath, K.A., Mina, B., Singh, K. and Nataraja, K.C. 2012. Integrated weed management in direct-seeded rainfed rice (*Oryza sativa*). *Indian Journal of Agronomy* **57**: 245–249.

Sharma, R.P., Pathak, S.K and Singh, R.C. 2007. Effect of nitrogen and weed management in direct-seeded rice under upland conditions. *Indian Journal of Agronomy* **52**(2): 114-119.

Shekhawat, K., Rathore, S.S. and Chauhan, B.S. 2020. Weed management in dry direct-seeded rice: A review on challenges and opportunities for sustainable rice production. *Agronomy* **10**: 1–12.

Shekhawat, K., Rathore, S.S., Dass, A., Das, T.K., Mahajan, G. and Chauhan, B.S. 2017. Weed menace and management strategies for enhancing oilseed brassicas production in the Indian sub-continent: A review. *Crop Protection* **96**: 245–257.

Singh, R.K., Mandal, N.P., Singh, C.V. and Anantha, M.S. 2011. *Upland Rice in India*. Scientific Publishers (India), Jodhpur, Rajasthan.