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Research Communication

Critical period of crop-weed competition in aerobic rice (*Oryza sativa*) under irrigated ecosystem

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ABSTRACT

A field experiment was conducted during rainy season of 2015 at Pantnagar, Uttarakhand, to find out the critical period of crop-weed competition in aerobic rice (*Oryza sativa* L.). Yield losses due to crop-weed competition were most pronounced during the period from 15 to 45 days after sowing (DAS) and were ranged from 4.8% to 76%. Rice yield continued to decline as the duration of weed-competition increased beyond 15 DAS, as there was drastic reduction in the number of panicles/m^2 and grains/panicle that accounted for lower rice yield. Hence the period between 15 and 45 days in aerobic rice under irrigated situation is crucial to achieve 95% of maximum possible yield (weed free) of aerobic rice.

Key words: Aerobic rice, Critical period of crop–weed competition, Weed density, Yield loss

Rice is one of the most important foodgrain crops of India, contributing to about 40% of the total foodgrain production. Estimates indicate that the burgeoning global population will need 25% more rice by 2025 than today's consumption (Maclean *et al.,* 2002). Weed infestation in direct (dry)-seeded rice (DSR) remains the single largest constraint limiting factor of DSR productivity. A DSR crop generally lacks a 'head start' over weeds due to dry tillage, absence of flooding and alternate wetting and drying conditions making it particularly vulnerable to weed competition during early part of its growth (Chauhan, 2012). Aerobic rice is a production system in which especially developed 'aerobic rice' varieties is grown in well-drained, non-puddled, and unsaturated soils. It can save as much as 50% of irrigation water (Bouman *et al*., 2002) and emit 80–85% less methane gas, a major input towards environment safety (Mishra and Singh, 2009). However, adoption of DSR technology usually leads to shift in weed flora composition towards more difficult-to-control weeds (Singh *et al.,* 2013). However, weeds may cause a yield loss to an extent of 50–100%. High weed infestation has threatened the sustainability of aerobic rice, which demands an efficient and cost-effective weed-management technique. Therefore, timely weed control at early stage is imperative for realizing desired level of productivity from aerobic rice. Anwar *et al.* (2012) from Malaysia reported that aerobic rice should be kept weed free during 21–43 days after sowing (DAS) for better yield and higher economic return. In direct-seeded irrigated rice, 95% of weed-free rice yield was obtained when weeds were controlled up to 32 DAS in wet season and 83 DAS in dry season (Johnson *et al*., 2004). Keeping this in view, an experiment was conducted to study critical period of crop-weed competition in aerobic rice under irrigated ecosystem in foothills (*tarai*) belt of Uttarakhand.

A field experiment was conducted during rainy season of 2015 at the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. The soil was calcareous, medium to moderately coarse textured, with *p*H 7.3, high in organic carbon (0.79%) and low in available nitrogen (236.6 kg/ha) and medium in available phosphorus (19.9 kg/ha) and potash (178.6 kg/ha). The experiment was laid out in a randomized block design with 3 replications. A set of 12 treatments consisting of weedy (from sowing to maturity, weedy until 15, 30, 45, 60 and 75 DAS), and weed-free (from sowing to maturity, weed free until 15, 30, 45, 60 and 75 DAS). 'Pant Dhan 18' rice variety was sown on 11 June 2015 with 45 kg/ha seed rate. A common dose of fertilizer N, P and K/ha in ratio 150 : 60 : 40 kg with urea and N, P and K mixture

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(12 : 32 : 16) was applied. Half of N and full dose of P and K were applied basal, while remaining N divided into 2 equals and applied as 25% N at active tillering and 25% at panicle-initiation stage. Weed collection was done at every 15 days interval up to 75 DAS, at 115 DAS (physiological maturity) and at harvesting stage to count the density and biomass within the area of 0.25 m^2 quadrate.

The major weed flora in the experimental field among grassy weeds: *Echinochloa crus-galli* (12.7%), *Ecinochloa colona* (28.3%), *Leptochloa chinensis* (7.4%), while among non-grassy weeds, sedges were dominant weed species, viz. *Cyperus iria* (11.2%), *Cyperus rotundus* (21.6%) and *Cyperus difformis* (10.4%), while among broad-leaf weeds *Trianthema monogyna* (dominant up to 15 days), *Alternanthera sessilis, Ammania baccifera, Caesulia axillaris* also found and density of broad-leaf weeds was recorded only 8.2%. Weed density in weed-free plots up to 30, 45 and 60 DAS was significantly lower compared with the weedy from sowing to maturity and weed free until 15 days (Table 1). Rao *et al.* (2007) reported that the grasses persist in all of principal crops and have greatest weed pressure and crop-weed competition in aerobic rice. The highest total weed dry biomass was observed in season-long weedy plot which was statistically at par with weedy until 60 and 75 DAS and weed-free until 15 DAS (Table 1). Grassy weeds were more competitive with irrigated aerobic rice and accumulated highest weed biomass as compared to sedges and broad-leaf weeds. The rice grain and straw yields were reduced significantly with increased weed competition period, i.e. drastic reduction in yield-contributing characters like panicles/m^2, grains/panicle (Table 1). Weed competition beyond 15 DAS caused drastic reduction in rice grain as well as straw yield, while weed-free until 45 DAS resulted in the yield which was statistically at par with weedy until 15 DAS and weed-free 60, 75 days and up to harvesting stage (Table 1). It might be due to the less growth of weeds because of less availability of sunlight, early coverage of ground by rice plants and their more opportunity for tillering. When aerobic rice field kept weed-free only for 15 days then yield reduction was 76% over season-long weed-free plot which was 35% and 4.8% in weed-free until 30 and 45 DAS respectively. The rice yield obtained with 45 days weed-free and onward was statistically at par with season-long weed-free plot. A 100% loss of rice crop was observed in weedy situation. The rice yield in treatments, viz. weedy until 15 DAS (5.5 t/ha), weed-free until 75 DAS (5.6 t/ha), weed-free until 45 DAS (5.3 t/ha) and afterwards of the crop-growth period was comparable (Table 1). Thus, under *tarai* conditions aerobic rice in irrigated situation field should be kept weed free during 15–45 DAS to achieve rice grain yield comparable to weed free condition (Fig. 1). This may be achieved either by early post-emergence application of herbicides or by weeding between 10 and 15 DAS followed by a post-emergence application or weeding between 30 and 45 DAS. Any reduction in weed pressure can be expected to promote yield, as it lessens the strength of the competition for resources between the crop and the weeds (Phoung *et al*., 2005). However, weed management beyond the critical period may avoid weed seed rain and prevents buildup of the weed seed bank, which helps long-term

Table 1. Effect of weed treatments on weeds and weed density, weed biomass at 60 days after sowing and yield and yield contributing characters of aerobic rice

Treatment	Total grasses (no./m^2)*	Total sedges (no./m^2)*	Total BLWs (no./m^2)*	Total weed density (no./m^2)*	Total weed biomass (g/m^2)*	Panicles/ m^2	Grains/ panicle	Grain yield (t/ha)	Straw yield (t/ha)
Weedy from sowing to maturity	9.3 (86.7)	8.8 (77.3)	3.8 (14.6)	13.3 (178.7)	19.9 (399.2)	0.0	0.0	0.0	0.0
Weedy until 15 DAS	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	266.7	117.7	5.6	7.8
Weedy until 30 DAS	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	220.8	110.0	3.8	5.7
Weedy until 45 DAS	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	191.0	92.3	2.8	4.9
Weedy until 60 DAS	8.7 (73.3)	8.4 (69.3)	3.4 (10.7)	12.4 (154.6)	19.0 (362.9)	115.8	85.6	1.4	2.6
Weedy until 75 DAS	9.2 (85.3)	8.4 (69.3)	3.9 (14.7)	12.9 (169.3)	19.3 (372.9)	101.6	84.4	1.3	2.2
Weed-free from sowing to maturity	1.0 (0.0)	1.0 (0.0)	1.0 (0)	1.0 (0.0)	1.0 (0.0)	274.2	122.4	5.6	7.9
Weed-free until 15 DAS	8.6 (74.6)	8.1 (65.3)	3.9 (14.6)	12.5 (154.7)	19.1 (365.6)	135.8	75.6	1.4	2.2
Weed-free until 30 DAS	4.9 (24.0)	6.4 (40.0)	3.4 (10.6)	8.6 (74.66)	15.7 (247.5)	192.5	106.5	3.7	5.3
Weed-free until 45 DAS	2.7 (14.7)	2.9 (8.0)	1.5 (1.3)	4.1 (16.0)	4.8 (23.1)	257.1	111.2	5.4	7.4
Weed-free until 60 DAS	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	260.0	118.0	5.5	7.8
Weed-free until 75 DAS	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	260.0	121.0	5.6	7.9
SEm±	0.5	0.4	0.3	0.6	0.5	15.2	3.9	0.2	0.4
CD (P=0.05)	1.4	1.2	0.8	1.7	1.4	44.5	11.6	0.7	1.1

*Square root transformation ($\sqrt{x+1}$); original data are given in parentheses. DAS, days after sowing

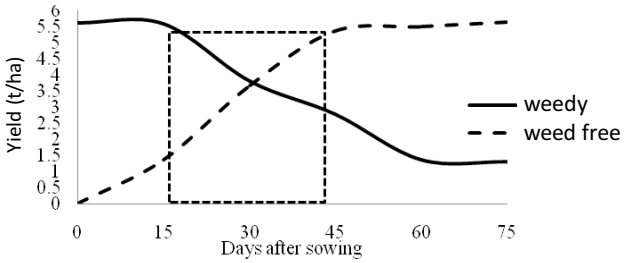

Fig. 1. Critical period of crop–weed competition in aerobic rice

sustainability of weed management.

It can be concluded that the critical period of crop–weed competition in aerobic rice under irrigated situation occurred during 15–45 days after seeding, and weed control should be done within this period.

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