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Study on critical period of crop-weed competition on productivity and profitability of aerobic rice

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Abstract
A field experiment was carried out at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during *kharif* season of 2014. Ten treatments *viz*., T_1 -weed free up to 15 DAS, T_2 -weed free up to 30 DAS, T_3 -weed free up to 45 DAS, T_4 -weed free up to 60 DAS, T_5 -weed free up to harvest, T_6 -weedy up to 15 DAS, T_7 - weedy up to 30 DAS, T_8 -weedy up to 45 DAS, T_9 -weedy up to 60 DAS and T_{10} -weedy up to harvest, were evaluated on aerobic rice *Cv.* NAUR-1. The experiment was laid out in Randomized Block Design with three replications. Various growth parameters and yield attributing characters of aerobic rice crop *viz*., plant height, number of tillers, number of panicle/m^2, length of panicle, number of grains/panicle, grain and straw yields significantly varied due to various treatments. The results revealed that significantly the highest values of all growth parameters and yield attributing characters were recorded under the treatment T_5 -weed free up to harvest, which were at par with treatments T_4 -weed free up to 60 DAS and T_6 -weedy up to 15 DAS, Ultimately the higher grain yield (40.6 q/ha) was obtained under treatment T_5 *i.e.* weed free up to harvest being statistically at par with the treatment T_4 (36.9 q/ha) and T_6 (36.0 q/ha). The highest net realization of ₹ 28300 per ha was obtained with treatment T_4 (weed free up to 60 DAS) followed by treatment T_5. Similarly maximum BCR value of 2.03 was also recorded with treatment T_4 (weed free up to 60 DAS). It can be concluded for getting higher yield and better economic return, aerobic rice should be keep weed free up to 60 DAS from that 45 to 60 DAS is more crucial for critical crop – weed competition.

Keywords: Aerobic rice, crop-weed competition, critical period

Introduction
Rice is the most important staple food for a large part of the world's human population, especially in east and south Asia, Middle East & Latin America and West Indies.
In India, rice had been grown in 45.07 M ha with a production of 122.27 million tones and productivity of 2713 kg ha^{-1} during 2020-21 (Anon. 2022) [1]. Out of 44 M ha, upland rice holds just 7.0 M ha (Mandal *et al.* 2011) [7]. In Gujarat, rice is cultivated in 8.4 lakh hectares (55-60% lowland) with production of 19.3 lakh tonnes and productivity of 2305 kg ha^{-1}). Rice occupies 8 per cent of gross cropped area and 14 per cent of total food grain production of the state.
Direct seeding rice avoids the puddling and maintains continuous moist soil conditions and thus reduces the overall water demand for rice culture. The productivity of the direct seeded rice is often reported to be lower, mainly due to problems associated with weed management. In order to save water and labour and promote conservation agriculture with no reduces tillage, it is absolutely essential to replace puddled transplanting with direct seeding. Water shortage is becoming severe in many rice growing areas in world, so introduction of aerobic rice gain more importance. Weeds are the greatest threat under aerobic rice cultivation. Weeds were reported to reduce rice yields by 12 to 98 per cent, depending on different type of rice establishment.
The success of rice cultivation depends on effectiveness of weed control measures in direct seeded rice besides other cultural practices, even total crop loss can occur due to weed competition many times. Yield loss due to weed flora varies from 40 to 100 per cent depending upon weed flora, weed intensity and crop-weed competition time (Choubey *et al.* 2001) [3].
Determination of critical period of crop-weed competition is great importance for planning of effective weed control. Competition from weed starts is of great concern to the farmer who wants to do weeding at the proper time and thus, to avoid extravagant expenses. Time of weed removal is more important rather than removal per se.

Material and Methods

The present study was carried out at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during *kharif* season of 2014. According to agro-climatic condition, Navsari is located in south Gujarat heavy rainfall zone-I (Agro-ecological situation- III). The climate of this zone is typically tropical, characterized by humid and warm monsoon with heavy rains, quite cold winter and fairly hot summer. The average annual rainfall of the tract is about 1500 mm. Monsoon commences by the second fortnight of June and ceases by the end of September. The soil of south Gujarat is locally known as "Deep Black Soil". The soil of Navsari campus has been placed under the great group *Ustochrepts* with Jalalpur series. The soil of the experimental site was dark grayish brown type with flat topography. The soil is characterized by medium to poor drainage and good water holding capacity. The predominant clay mineral is montmorillonite. The experimental field was infested by number of weed species comprising of monocot weeds *viz.*, *Echinochloa crusgalli* (L.), *Echinochloa colunum* (L.), *Cynodon dactylon* (L.), *Dactyloctenium agegyptium*, *Bracharia* spp., *Cenchrus biflorus*, *Eichhornia crassipes*, dicot weeds *viz.*, *Physalis minima*, *Alternanthera sassilis*, *Euphorbia hirta*, *Digera arvensis* (L.), *Cardiospermum halicacabum*, and sedges *Cyperus rotundus* (L.) predominantly during the course of experimentation. The experimental field was prepared by tractor drawn cultivator. The field was cultivated in both the direction by tractor drawn disc harrow followed by planking for leveled and prepared fine seedbed. The quantities of fertilizer were workout @ 100 -30-00 kg NPK/ha. The basal dose was uniformly applied in previously opened furrow in each plot just before sowing. Remaining 60 percent nitrogen was given in two splits, 40 per cent (40 N kg/ha) at tillering stage and 20 per cent (20 N kg/ha) at panicle initiation stage. The seeds of rice *Cv.* NAUR-1 received from the NARP, Navsari Agricultural University, Navsari were used for this experiment. The required quantity of seeds (50 kg/ha) was worked out for each treatment plot and sown by maintaining the inter row spacing of 30 cm. Seeds were covered properly with the soil and irrigation was given carefully in each plot immediately after sowing. First irrigation was given just after sowing for proper germination of crop, whereas other irrigations were applied uniformly to all the experimental plots as and when required. In order to maintain a uniform plant population, thinning was carried out in all plots at 20 days after sowing. Hand weeding was carried out as per treatment with the help of *khurpi* and hand hoe, except in the unweeded control plot. Neither serious diseases nor insect-pest were observed in the crop during the course of investigation, hence no any plant protection measures were followed. Previously five tagged plant from each net plot were harvested first and their produce was recorded separately and then added to respective net plot yield. The ring area was harvested first to eliminate the border effects, then net plots (remaining lines after moving border lines) were harvested separately and the produce was kept as such in respective plots for sun drying until constant weight was obtained. Threshing was done manually by using manually operated padal paddy thresher. Thereafter, seeds were cleaned manually and weight was recorded as per treatments. The biometric observations were recorded on five randomly selected plants from each net plot, were earlier tagged for recording growth and yield attributing parameters.

Result and Discussion

The result on growth and yield attributes are presented in Table 1. Significantly highest plant height at harvest was observed under treatment weed free up to harvest (T_5), being statistically at par with treatments T_6 (weedy up to 15 DAS), T_4 (weed free up to 60 DAS) and T_3 (weedy up to 45 DAS). This might be due to effective control of weeds under these treatments during the crop period, which improved the growth of crop and checked nutrient loss by weeds. All the treatments significantly increased number of tillers over treatment T_{10} (weedy up to harvest). Treatment weed free up to harvest (T_5) recorded maximum number of tillers, but it was statistically at par with treatments T_3, T_4 and T_6 at harvest.

Almost all the yield attributing characters *viz.*, number of panicle per m^2, panicle length (cm) and number of grain per panicle were significantly influenced by the various weed management treatments. Treatment T_5 (weed free up to harvest) recorded significantly higher number of panicle per m^2, but it remained at par with treatments T_2, T_3, T_4 and T_6. In case of the panicle length the maximum panicle length associated with treatment T_5 (weed free up to harvest) followed by treatments T_3, T_4, T_6, T_7 and T_8. The maximum number of grain per panicle noted with treatment T_5 (weed free up to harvest) which was at par with treatments T_3, T_4 and T_6. Indicating least competition offered by weeds for nutrient and moisture at crucial growth stages under this treatment ultimately improved all yield attributes. While the lowest figure for all yield attributes were found under treatment T_{10} (weedy up to harvest) may due to severe competition by weeds for resources, which made the crop plant incompetent to take up moisture and nutrients, consequently growth was adversely affected. Grain and straw yields were produced significantly higher under treatment T_5 (weed free up to harvest) and it was found at par with treatment T_4 *i.e.* weed free up to 60 DAS and T_6 *i.e.* weedy up to 15 DAS (Table 2). The higher yields under these treatments could be ascribed to better control of weeds which might have favoured higher uptake of nutrients and water, helping the plant to put optimum growth characters. Further, it might have enhanced photosynthetic activity and partitioning of assimilates, resulting in improved yield attributes by virtue of less weed count and dry weight of weeds. These growth and yield attributes evidently reflected in higher grain and straw yields under these treatments. Significantly the lower grain and straw yields were recorded under treatment T_{10} (weedy up to harvest). Deprived growth and development of crop under the weedy up to harvest treatment might have been responsible for poor yield. These findings are in agreement with those of Moorthy and Saha (2005) [9], Singh and Tripathi (2007) [12], Singh *et al.* (2007) [11], Banerjee *et al.* (2008) [2], Srinivasan *et al.* (2008) [15] and Singh *et al.* (2012) [13].

The results pertaining to yield and economic are presented in Table 2. Economics is the major consideration for the farmers while, taking a decision regarding the adoption of a new technology. Hence, the cost of cultivation, gross realization, net realization and cost benefit ratio were computed for various treatments. Among different treatments of critical period crop -weed competition, the highest net realization ₹28300 per ha was obtained with treatment T_4 (weed free up to 60 DAS) followed by treatment T_5 (weed free up to harvest) *i.e.* ₹ 28069 per ha. Similarly maximum BCR value of 2.03 was also recorded with treatment T_4 (weed free up to 60 DAS). Thus, the results show that to realize the potential

grain yield and higher monetary returns of aerobic rice, crop should be kept weed free up to 60 DAS, which is the more crucial for crop weed competition. Similar results were also reported by Mukherjee and Singh (2005) [9] and Singh *et al.* (2012) [13].

Table 1: Growth and yield attributes of aerobic rice influenced by various treatments

Treatments	Plant height (cm)		Number of tillers/m^2	Number of panicles/m^2	Length of panicle (cm)	Number of grains/ panicle
	60 DAS	At harvest				
T1: Weed free up to 15 DAS	39.86	82.17	278.0	268.00	20.80	64.00
T2: Weed free up to 30 DAS	40.00	85.37	308.7	308.67	21.21	69.00
T3: Weed free up to 45 DAS	42.42	93.63	332.0	312.00	23.00	73.67
T4: Weed free up to 60 DAS	44.34	97.77	343.7	330.33	23.87	74.00
T5: Weed free up to harvest	47.83	102.47	376.7	346.67	24.04	83.33
T6: Weedy up to 15 DAS	45.65	93.93	341.7	328.33	23.34	73.33
T7: Weedy up to 30 DAS	39.45	86.77	313.7	296.67	22.76	68.67
T8: Weedy up to 45 DAS	39.06	84.90	301.0	293.33	22.38	67.00
T9: Weedy up to 60 DAS	38.83	82.27	285.3	285.33	21.29	66.67
T10: Weedy up to harvest(Control)	33.32	77.93	268.0	258.00	19.57	54.00
S.Em. ±	2.58	4.15	15.9	14.99	0.88	4.35
C.D. at 5%	7.65	12.32	47.3	44.55	2.62	12.93
C.V. %	10.86	8.09	8.7	8.58	6.86	10.87

Table 2: Yield and economics of aerobic rice as influenced by various treatments

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Cost of cultivation (₹/ha)	Gross realization (₹/ha)			Net realization(₹/ha)	BCR
			Total	Seed	Straw	Total		
T1	26.40	40.24	21719	29040	12073	41113	19394	1.89
T2	31.10	46.84	24419	34210	14052	48262	23843	1.98
T3	34.43	46.71	26219	37877	14013	51889	25670	1.98
T4	36.97	50.69	27569	40663	15206	55869	28300	2.03
T5	40.57	54.71	32969	44623	16414	61038	28069	1.85
T6	36.07	49.81	29369	39673	14944	54617	25248	1.86
T7	32.33	45.95	26669	35567	13786	49352	22683	1.85
T8	31.37	45.15	24869	34503	13546	48050	23181	1.93
T9	22.73	37.12	23519	25007	11137	36144	12625	1.54
T10	18.93	30.02	18119	20827	9006	29833	11714	1.65
S.Em. ±	1.62	4.17	-	-	-	-	-	-
C.D. at 5%	4.82	12.38	-	-	-	-	-	-
C.V. %	9.04	16.13	-	-	-	-	-	-

Conclusion

It can be concluded for getting higher yield and better economic return, aerobic rice should be keep weed free up to 60 DAS from that 45 to 60 DAS is more crucial for critical crop – weed competition.

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