

Effect of Weed Management Practices on Yield and Economics of Semidry Rice

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A field experiment was conducted during *khari f*, 2014 in sandy loam soils of Agricultural College Farm, Naira, to find out the effect of weed management practices on yield attributes, yield and economics of semidry rice. The experiment was laid out in randomized block design with ten treatments, each replicated thrice. It was found that superior performance of rice in terms of yield attributes and yield was observed with pre-emergence application of pendimethalin @ 0.75 kg a.i ha⁻¹ at 3-5 DAS *fb* post-emergence application of metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha⁻¹ at 20-25 DAS (T₁₀) which was comparable with weed free check (T₂). Maximum grain yield, net returns and B: C ratio were also associated with pre-emergence application of pendimethalin @ 0.75 kg a.i ha⁻¹ at 3-5 DAS *fb* post-emergence application of metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha⁻¹ at 20-25 DAS (T₁₀).

Keywords: Economics, herbicides, semidry rice, weeds, yield.

Transplanted rice has deleterious effects on soil environment and nearly 30 % of the total water used in rice culture is consumed mainly during puddling and transplanting operations. Puddling requires lots of scarce water at a time when there is little water in the reservoirs, destroys soil structure and adversely affects soil productivity. Therefore, a key concern is how the water requirement of rice culture can be reduced and how farmers can avoid puddling and transplanting operations without yield penalty.

Direct seeded semidry rice which eliminates puddling and drudgery of transplanting the young rice seedlings provide an option to

resolve the adaphic conflict and enhance the sustainability of rice and subsequent cropping system. Direct seeded rice overcomes the problem of seasonality in labour requirement for rice nursery raising and transplanting operations. Direct seeded rice facilitates timely establishment of rice and succeeding crops.

Semidry system of rice cultivation is a unique technique and extensively adopted in more than 20 per cent of rice growing area of our country. In this system, the early growth of rice, up to 30-40 days is in dry soil environment and thereafter comes under submergence with the release of canal water after stabilization of south-west monsoon. Absence of stagnant water during the initial 4-6 weeks causes serious problems in dry sown low land rice with regard to weed management, affecting its productivity adversely. Adoption of direct-seeded rice has resulted in a change in the

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relative abundance of weed species in rice crop. The outcome of competition would depend not only on the competing species but also on their density, duration and the level of fertility. Weeds pose a serious problem in semidry rice production system due to the prevalence of congenial atmosphere for its growth during monsoon season and uncontrolled weed growth reported to reduce yield up to 30.2% (Singh *et al.*, 2005). The shift from transplanted to direct-seeded rice results in more aggressive weed flora and increased reliance on herbicides, owing to increasing labour problems and time consuming, cumbersome and less effective nature of cultural and mechanical methods of weed control.

MATERIAL AND METHODS

A field experiment was conducted during *kharif*, 2014 at the Agricultural College,

Naira, Andhra Pradesh to study the effect of weed management practices on yield and economics of semidry rice. The soil was sandy loam in texture with a pH of 6.5 and EC of 0.15 dSm⁻¹, low in organic carbon (0.33%) and available nitrogen (174 kg ha⁻¹), medium in available phosphorus (38 kg ha⁻¹) and potassium (264 kg ha⁻¹). Rice variety 'Vijetha' was sown by using line markers at 20 cm row spacing in solid rows with a seed rate of 75 kg ha⁻¹ on 26th July, 2014. During the crop growing period, 723.9 mm rainfall was received in 36 rainy days. The plot size was 6 m × 4 m. The experiment was laid out in randomized block design with three replications. The treatments consisted of ten different weed management practices viz., T₁: Weedy check, T₂: Hand weeding twice at 20 and 40 DAS (weed free check), T₃: Pendimethalin @ 0.75 kg a.i ha⁻¹ as pre-emergence application at 3-5 DAS, T₄: Orthosulfamuron @

Table 1. Weed density, weed dry weight, weed control efficiency and weed management index of semidry rice as influenced by different weed control treatments

Treatments	Weed density (No. m ⁻²)		Weed dry weight (g m ⁻²)		Weed control efficiency (%)	Weed management index
	60 DAS	Harvest	60 DAS	Harvest		
T ₁ : Weedy check	16.1(259.9)	14.3(203.8)	16.9(283.4)	16.2(261.9)	-	0.71(0)
T ₂ : Hand weeding twice at 20 and 40 DAS (weed free check)	6.0(35.7)	5.5(29.7)	5.2(26.7)	6.4(40.0)	72.1(90.6)	1.12(0.75)
T ₃ : Pendimethalin @ 0.75 kg a.i ha ⁻¹ as pre-emergence at 3-5 DAS	12.8(163.2)	11.6(135.1)	10.9(119.0)	11.0(121.3)	49.6(58.0)	1.07(0.64)
T ₄ : Orthosulfamuron @ 100 g a.i. ha ⁻¹ as pre-emergence at 3-5 DAS	7.0(48.9)	6.8(46.4)	6.9(47.7)	7.1(49.7)	65.7(83.1)	1.11(0.74)
T ₅ : Orthosulfamuron @ 100 g a.i. ha ⁻¹ as post-emergence at 20-25 DAS	12.7(160.4)	11.8(139.6)	9.4(87.6)	9.3(86.6)	56.2(69.1)	1.07(0.64)
T ₆ : Ethoxysulfuron @ 20 g a.i ha ⁻¹ post-emergence at 20-25 DAS	12.2(149.6)	11.3(126.7)	9.0(80.9)	8.8(77.3)	57.7(71.4)	1.10(0.71)
T ₇ : Metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha ⁻¹ as post-emergence at 20-25 DAS	11.7(136.6)	10.8(116.1)	8.0(63.9)	8.4(69.4)	61.7(77.4)	1.10(0.71)
T ₈ : T ₃ followed by T ₅	7.5(55.2)	7.5(55.4)	6.9(48.2)	7.4(54.9)	65.6(82.9)	1.11(0.74)
T ₉ : T ₃ followed by T ₆	8.1(65.2)	7.6(57.6)	7.7(59.5)	7.5(56.0)	62.7(78.9)	1.11(0.74)
T ₁₀ : T ₃ followed by T ₇	6.1(37.5)	5.9(34.1)	5.4(29.1)	6.5(41.3)	71.3(89.7)	1.12(0.75)
S.Em +	0.7	0.6	0.3	0.1	1.5	0.08
CD (P=0.05)	2.2	1.8	0.9	0.4	4.5	0.02
CV (%)	12.9	11.2	6.2	2.8	4.6	1.3

Data were subjected to square root transformation "x + 0.5 except for WCE which was subjected to arc sine transformation. Figures in parentheses are original values.

100 g a.i ha⁻¹ as pre-emergence application at 3-5 DAS, T₅: Orthosulfamuron @ 100 g a.i ha⁻¹ as post-emergence application at 20-25 DAS, T₆: Ethoxysulfuron @ 20 g a.i ha⁻¹ post-emergence application at 20-25 DAS, T₇: Metsulfuron methyl + Chlorimuron ethyl @ 4 g a.i ha⁻¹ as post-emergence application at 20-25 DAS, T₈: T₃ followed by T₅, T₉: T₃ followed by T₆, T₁₀: T₃ followed by T₇. The herbicides were applied with knapsack sprayer; using a spray volume of 500 l ha⁻¹. The crop was harvested on 2nd December, 2014.

The density and dry weight of weeds were taken at 30, 60 DAS and at harvest in each plot using a quadrat of 0.25m². Weed species in each quadrat were separated and dried in shade initially and later oven dried till the constant weight was recorded. The data on density and dry weight of weeds were subjected to square-root transformation and statistically analysed following standard procedure.

RESULTS AND DISCUSSION

Weed flora

All together there were 11 species of weed flora that belong to seven different families were recorded in the experimental field. Among them, *Echinochloa colona*, *Echinochloa crusgalli* and *Cynodon dactylon* were grasses, *Cyperus rotundus*, *Cyperus difformis*, *Fimbristylis miliaceae* were sedges while, *Eclipta alba*, *Ludwigia parviflora*, *Ammania baccifera*, *Euphorbia hirta*, *Trianthema portulacastrum* were broad leaved weed. However, *Echinochloa colona* and *Echinochloa crusgalli* among grasses, *Cyperus rotundus* among sedges and *Eclipta alba* and *Ludwigia parviflora* among broad leaved weed were dominant throughout the crop growth period.

Effect on weeds

Statistically detectable disparities were noticed with respect to total weed density (Table 1) due to various weed control practices. The lowest total weed density among the herbicide treatments

Table 2. Yield attributes and yield of semidry rice as influenced by different weed control treatments

Treatments	Filled grains panicle ⁻¹	Panicle length (cm)	Test weight (g)	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)
T ₁ : Weedy check	95	19.9	20.9	1971	3049
T ₂ : Hand weeding twice at 20 and 40 DAS (weed free check)	151	23.8	22.4	5402	6967
T ₃ : Pendimethalin @ 0.75 kg a.i ha ⁻¹ as pre- emergence at 3-5 DAS	110	20.8	20.4	3018	4701
T ₄ : Orthosulfamuron @ 100 g a.i. ha ⁻¹ as pre-emergence at 3-5 DAS	140	23.6	22.0	4936	6458
T ₅ : Orthosulfamuron @ 100 g a.i. ha ⁻¹ as post- emergence at 20-25 DAS	113	21.7	21.0	3496	5024
T ₆ : Ethoxysulfuron @ 20 g a.i ha ⁻¹ as post- emergence at 20- 25 DAS	116	21.9	21.2	3996	5694
T ₇ : Metsulfuron methyl + chlorimuron ethyl@ 4 g a.i ha ⁻¹ as post-emergence at 20-25 DAS	119	22.2	21.5	4230	5707
T ₈ : T ₃ followed by T ₅	133	23.0	21.9	4711	6238
T ₉ : T ₃ followed by T ₆	125	22.6	21.7	4680	6283
T ₁₀ : T ₃ followed by T ₇	149	23.7	22.2	5396	6966
S.Em ±	3.8	0.2	0.4	116.0	186.9
CD (P=0.05)	11.4	0.5	NS	344.8	555.5
CV (%)	5.3	1.4	3.6	4.8	5.7

was registered with T₄ (pre-emergence application of orthosulfamuron @ 100 g a.i ha⁻¹), T₈ (pre-emergence application of pendimethalin @ 0.75 kg a.i ha⁻¹ fb orthosulfamuron @ 100 g a.i ha⁻¹) and T₁₀ (pre-emergence application of pendimethalin @ 0.75 kg a.i ha⁻¹ fb post-emergence application metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha⁻¹) which were on par with each other as well as with weed free check (T₂) and significantly superior to rest of the herbicide treatments and weedy check (T₁). Better performance exhibited by T₄ and T₁₀ in reducing the total weed density might be due to the reason that it was able to control both grassy as well as broad leaved weeds effectively at 60 DAS and at harvest. Better performance of orthosulfamuron, pendimethalin and metsulfuron methyl + chlorimuron ethyl in reducing total weed density has also been reported by Ramana *et al.* (2007).

Significantly lower total dry weight of weeds at 30 DAS, 60 DAS and harvest was noticed with weed free check (T₂) which was however, comparable with T₄ (pre-emergence application of orthosulfamuron @ 100 g a.i ha⁻¹) at 30 DAS and

T₁₀ (pre-emergence application of pendimethalin @ 0.75 kg a.i ha⁻¹ fb post-emergence application metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha⁻¹) at 60 DAS and harvest. Although pre-emergence application of orthosulfamuron @ 100 g a.i ha⁻¹ at 3-5 DAS (T₄) exerted significant influence in reducing total dry weight of weeds during the early part of lifecycle (30 DAS) of semidry rice, the gains could not be sustained subsequently (at 60 DAS and at harvest) due to gradual increase in the total dry weight of weeds. Superior performance of herbicides in reducing the weed dry weight due to sequential application compared to alone application has also been reported by Narolia *et al.* (2014).

Pre-emergence application of pendimethalin fb post-emergence application of metsulfuron methyl + chlorimuron ethyl (T₁₀) registered the highest weed control efficiency (89.7%) which was comparable with weed free check (90.6%). The highest weed control efficiency associated with T₁₀ might be due to the fact that the successive application of two herbicides at an interval of 20 days created an adverse environment

Table 3. Gross and net returns (Rs ha⁻¹) and returns per rupee investment of semidry rice as influenced by weed control treatments

Treatments	Gross returns	Net returns	Returns per rupee investment
T ₁ : Weedy check	28325	4754	0.2
T ₂ : Hand weeding twice at 20 and 40 DAS (weed free check)	76946	43175	1.3
T ₃ : Pendimethalin @ 0.75 kg a.i ha ⁻¹ as pre-emergence at 3-5 DAS	43400	18639	0.8
T ₄ : Orthosulfamuron @ 100 g a.i. ha ⁻¹ as pre-emergence at 3-5 DAS	70358	45454	1.8
T ₅ : Orthosulfamuron @ 100 g a.i. ha ⁻¹ as post-emergence at 20-25 DAS	50058	25154	1.0
T ₆ : Ethoxysulfuron @ 20 g a.i ha ⁻¹ 57188 post-emergence at 20-25 DAS	32879	1.4	
T ₇ : Metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha ⁻¹ as post-emergence at 20-25 DAS	60377	36338	1.5
T ₈ : T ₃ followed by T ₅	67189	41095	1.6
T ₉ : T ₃ followed by T ₆	66785	41286	1.6
T ₁₀ : T ₃ followed by T ₇	76868	51639	2.1
S.Em +	1387.3	1387.3	0.1
CD (P=0.05)	4121.4	4121.4	0.2
CV (%)	4.0	7.0	7.2

to weeds, resulting in reduction in total weed dry matter which was comparable with weed free check (T_2).

Among the weed control treatments, except T_3 (pre-emergence application of pendimethalin) and T_5 (post-emergence application of orthosulfamuron), all other herbicide treatments recorded significantly higher values for weed management index which were comparable with each other as well as with weed free check (T_2). Comparable performance of the herbicide applied treatments except T_3 and T_5 with that of the weed free check (T_2) could be attributed to enhanced weed control efficiency of the herbicides.

Effect on yield attributes and yield

Weed management practices were found to influence the yield attributing characters markedly. The highest number of filled grains panicle⁻¹ and panicle length were noticed with pendimethalin *fb* metsulfuron methyl + chlorimuron ethyl (T_{10}), pendimethalin *fb* orthosulfamuron (T_8) and pre-emergence application of orthosulfamuron (T_4) which were comparable with weed free check (T_2). Thousand grain weight did not alter significantly due to weed management practices. Effective suppression of weed growth throughout the critical period of crop-weed competition might have enabled semidry rice to bear promising architecture for yield attributes, both in T_4 and T_{10} among herbicide treatments as well as in weed free check (T_2).

Maximum grain and straw yield (Table 2) was obtained with the application of pendimethalin *fb* metsulfuron methyl + chlorimuron ethyl (T_{10}), which was comparable with weed free check (T_2). Harvest index did not vary to a statistically perceptible magnitude. The increase in grain and straw yield might be due to the reason that the sequential application of two herbicides having distinct modes of action created a rather weed free environment by effectively suppressing a broad-spectrum of weed population and consequently weed dry matter. Prevalence of weed free crop growing environment might have enabled congenial conditions for production of higher growth stature and better yield structure which might have eventually resulted in higher yields in T_{10} (pre-emergence application of pendimethalin @ 0.75 kg a.i ha⁻¹ *fb* metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha⁻¹ as post-emergence), on par with weed

free check (T_2). Similar views were also expressed by Narolia *et al.* (2014).

Effect on economics

The highest gross returns were recorded with pre-emergence application of pendimethalin @ 0.75 kg a.i ha⁻¹ *fb* post-emergence application of metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha⁻¹ (T_{10}) which was comparable with weed free check (T_2). As regards net returns, it was maximum with the application of pendimethalin @ 0.75 kg a.i ha⁻¹ as pre-emergence *fb* metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha⁻¹ as post-emergence (T_{10}). While, significantly lower values for gross and net returns were observed in weedy check (T_1). The highest returns per rupee invested (2.05) was observed with pendimethalin @ 0.75 kg a.i ha⁻¹ as pre-emergence application *fb* metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha⁻¹ as post-emergence application (T_{10}). The return per rupee invested (0.20) was lowest with weedy check (T_1). The highest gross returns, net returns as well as returns per rupee (B: C ratio) invested with T_{10} might be due to higher grain yield, barring labour costs and effective working of pendimethalin *fb* metsulfuron methyl + chlorimuron ethyl compared to other treatments. Though hand weeding resulted in higher grain yield and gross returns than all other treatments, the B: C ratio remained was only 1.28. The lower returns per rupee invested with weedy check might due to higher labour cost involved in hand weeding and the higher cost involved in manual weeding was not compensated by the additional grain yield obtained in weed free check (T_2) resulting in lower benefit cost ratio (BCR). Similar results were reported by Narolia *et al.* (2014) and Jayadeva *et al.* (2011).

Thus, it could be concluded that, sequential application of pendimethalin @ 0.75 kg a.i ha⁻¹ at 3-5 DAS *fb* metsulfuron methyl + chlorimuron ethyl @ 4 g a.i ha⁻¹ at 20-25DAS (T_{10}) was found to be the most effective weed management practice to achieve broad spectrum weed control and to realize higher yield attributes, grain yield as well as economic returns from *khari*f sown semidry rice in North Coastal Zone of Andhra Pradesh.

REFERENCES

1. Jayadeva, H.M., Bhairappanavar, S.T., Hugar, A.Y., Rangaswamy, B.R., Mallikarjun, G.B.,

1. Malleshappa, C and Channa Naik, D. Integrated weed management in aerobic rice (*Oryza sativa* L.). *Agriculture Science Digest*. 2011; **31**(1): 58-61.
2. Narolia, R.S., Pratap Singh, Chandra Prakash and Harpool Meena. Effect of irrigation schedule and weed management practices on productivity and profitability of direct-seeded rice (*Oryza sativa*) in South-eastern Rajasthan. *Indian Journal of Agronomy*. 2014; **59**(3): 398-403.
3. Ramana, A.V., Naidu, G.J and Ramana Murthy, K.V. Integrated weed management in rainfed upland rice (*Oryza sativa*). *Indian Journal of Agronomy*. 2007; **52**(4): 311-314.
4. Singh, V.P., Singh, G., Singh, R.K., Singh, S.P., Kumar, A., Dhyani, V.C., Kumar, M and Sharma, G. Effect of herbicides alone and in combination on direct seeded rice. *Indian Journal of Weed Science Science*. 2005; **37** (3&4): 197-201.