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Effect of Irrigation Schedule, Weed Management and Nitrogen Levels on Weed Growth in Rice (*Oryza sativa*) under Aerobic Conditions

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ABSTRACT

A field study was conducted at Agricultural Research Station, Kampasagar, Nalgonda district of Andhra Pradesh during the **kharif** seasons of 2008 and 2009 to find out the effect of irrigation schedules, weed management practices and nitrogen levels on weed growth, nutrient depletion and yield of aerobic rice. The major weed flora observed in the experimental plot was *Echinochloa colona* L., *Cynodon dactylon* Pers., *Dactyloctenium aegyptium* Beauv., *Cyperus rotundus* L. (Monocots), *Eclipta alba* Hassk., *Trianthema portulacastrum* L. and *Amaranthus viridis* L. (Dicots) during both the years. Irrigation scheduled at seven days interval during vegetative stage and four days interval during reproductive stage resulted in significantly higher weed density, weed dry matter production and NPK removal by weeds and higher panicle number and weight, filled spikelets per panicle grain yield and NPK uptake at harvest than that of irrigation scheduled once in two days. Pre-emergence application of pendimethalin @ 1 kg/ha fb cono weeding at 30 DAS and one HW at 45 DAS recorded significantly lower weed density, weed dry matter production and NPK uptake by weeds and significantly higher panicle number and weight, filled spikelets per panicle, NPK uptake at harvest and grain yield than that of pre-emergence application of pendimethalin @ 1 kg/ha fb 2, 4-D Na salt @ 1 kg/ha at 40 DAS and HW at 20 and 45 DAS. Among latter treatments, significantly lower values of above said weed parameters and significantly higher crop parameters were observed with pre-emergence application of pendimethalin @ 1 kg/ha fb 2, 4-D Na salt @ 1 kg/ha at 40 DAS as compared to HW at 20 and 45 DAS. Weed density, weed dry matter production and NPK removal by weeds and panicle number, length and weight, filled spikelets per panicle, grain yield and NPK uptake at harvest were significantly higher at 180 kg N/ha during both the years.

Key words : Aerobic rice, cono weeding, hand weeding, pendimethalin, nitrogen levels

INTRODUCTION

Aerobic rice (*Oryza sativa* L.) production system is gaining importance for increased productivity and reduced water requirement and is expected to occupy 10-15% of the total area in India. The irigation scheduling in aerobic rice plays major role in obtaining higher yields. It has been reported that similar yields were obtained when irrigation was scheduled 3/5 days after disappearance of 7 cm ponded water in dry rice (Prasad *et al.,* 1992). These results indicated that there was greater scope for scheduling the irrigation water for rice crop under unpuddled conditions. Further, considerable quantity of water can be saved by providing need-based irrigation by taking rainfall into consideration.

Weed infestation is the major constraint in aerobic rice. In dry seeded rice ecosystems, weeds and rice emerge simultaneously, and compete with each other for light, nutrients and moisture resulting in reduction of grain yield upto 80% (Sinha Babu *et al.,* 1992). Manual removal of weeds is highly labour intensive, expensive, tedious, back breaking and does not ensure weed removal at critical stages due to non-availability of labour. Hence, the traditional hand weeding practice needs to be substituted by herbicides to control weeds timely and economically. Weed competition in dry seeded rice is largely influenced by moisture and nutrient availability. There is a need to develop integrated weed management for effective weed control in irrigated dry seeded rice.

Nitrogen is an important nutrient in rice. Its

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efficiency may be improved by proper scheduling of water and weed management. The information on these aspects in aerobic rice is limited. Hence, the present study was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during **kharif** seasons of 2008 and 2009 at Agricultural Research Station of Acharya N. G. Ranga Agricultural University, at Kampasagar, Nalgonda and Andhra Pradesh. The soil of the experimental site was sandy clay loam with pH 8.1 and 7.7 in 2008 and 2009, respectively. The moisture at field capacity and permanent wilting point was 22.6 and 12.01% and soil bulk density was 1.56 Mg/m^3. The soil was medium in available N (281.9 to 285 kg N/ha) and available phosphorus (22.62 to 24.22 kg P_2O_5/ha) and high in available potassium (328.95 to 335.7 kg K_2O/ha).

The treatments (Table 1) consisting of two irrigation levels in main plot, three weed management practices in sub-plots and three nitrogen levels in sub-sub-plots were replicated thrice in a split-split plot design.

Paddy variety 'JGL 384' (Polasa Prabha) was sown in rows 25 cm apart on 10 and 25 July during 2008 and 2009, respectively. Nitrogen was applied in three equal splits 1/3 each at sowing, active tillering (50 DAS) and panicle initiation stages (80 DAS) in the form

Table 1. Weed density/m^2 and weed dry matter (g/m^2) at 45 DAS and at harvest as influenced by irrigation schedules, weed management and nitrogen levels in aerobic rice during **kharif** 2008 and 2009

Treatments	Weed density				Weed dry matter			
	2008		2009		2008		2009	
	45 DAS	At harvest	45 DAS	At harvest	45 DAS	At harvest	45 DAS	At harvest
Irrigation schedules (I)								
I_1–Irrigation once in two days	7.33 (58)	3.93 (15)	7.69 (64)	4.12 (17)	4.63 (22.7)	5.52 (30.8)	4.94 (25.7)	5.86 (34.8)
I_2–Irrigation at seven days interval during vegetative stage and four days interval during reproductive stage	7.18 (55)	4.20 (18)	7.53 (61)	4.40 (20)	4.62 (22.4)	5.90 (35.6)	5.00 (26.1)	6.26 (40.0)
S. Em±	0.09	0.01	0.09	0.03	0.09	0.10	0.07	0.10
LSD (P=0.05)	NS	0.05	NS	0.10	NS	0.30	NS	0.30
Weed management (W)								
W_1–Hand weeding at 20 and 45 DAS	7.34 (54)	4.65 (21)	7.70 (59)	4.87 (23)	4.66 (21.4)	6.54 (42.4)	4.97 (24.6)	6.92 (47.6)
W_2–Pre-emergence application of pendimethalin @ 1 kg/ha followed by 2, 4-D Na salt @ 1 kg/ha at 40 DAS	9.65 (93)	4.30 (18)	10.11 (102)	4.51 (20)	6.11 (37.0)	6.05 (36.7)	6.47 (41.6)	6.40 (41.1)
W_3–Pre-emergence application of pendimethalin @ 1 kg/ha followed by cono weeding at 30 DAS and one HW at 45 DAS	4.77 (23)	3.25 (10)	5.01 (25)	3.40 (11)	3.11 (9.3)	4.55 (20.4)	3.47 (11.7)	4.86 (23.5)
S. Em±	0.42	0.10	0.70	0.10	0.17	0.15	0.21	0.17
LSD (P=0.05)	2.00	0.30	2.00	0.30	0.50	0.45	0.60	0.50
Nitrogen levels (N) (kg/ha) (% RDN)								
120 (100)	6.77 (50)	3.75 (14)	7.10 (55)	3.94 (16)	4.26 (19.3)	5.26 (28.3)	4.60 (22.3)	5.56 (31.7)
150 (125)	7.27 (56)	4.12 (17)	7.62 (62)	4.30 (19)	4.65 (22.8)	5.78 (33.8)	5.01 (26.3)	6.14 (38.2)
180 (150)	7.73 (63)	4.34 (19)	8.10 (69)	4.53 (21)	4.97 (25.7)	6.10 (37.4)	5.30 (29.1)	6.48 (42.2)
S. Em±	0.17	0.07	0.17	0.07	0.10	0.15	0.08	0.10
LSD (P=0.05)	0.50	0.20	0.50	0.20	0.30	0.45	0.25	0.30

Figures in parentheses are original values. HW–Hand weeding, RDN–Recommended dose of nitrogen. NS–Not Significant.

of urea. Phosphorus @ 60 kg P_2O_5/ha as single super phosphate, potassium @ 40 kg K_2O/ha as muriate of potash and zinc @ 50 kg $ZnSO_4$/ha were applied to all the treatments uniformly at the time of sowing. These fertilizers were applied as bands in the seed furrow. The $ZnSO_4$ was applied one day after sowing.

Irrigation was given as per treatments. Irrigation water was measured by the use of 3" parshall flume. Effective rainfall was measured by water balance sheet method (Gupta *et al.,* 1972). The daily balance was computed by subtracting the daily consumptive use from the sum of the previous days balance and rainfall.

The observations on weed density and weed dry matter were collected 45 days after sowing (DAS) and at harvest. The data on weed density and weed dry matter were subjected to square root transformation before statistical analysis to normalize their distribution (Panse and Sukhatme, 1978).

Weed samples collected at harvest were analyzed for N, P and K contents by following standard procedures (Singh *et al.,* 2005) and expressed in percentage. The N, P and K uptake by the crop was computed by multiplying the contents with dry matter and expressed as kg/ha.

RESULTS AND DISCUSSION

Weed Flora

The major weed flora observed in experimental plot were *Echinochloa colona* L., *Cynodon dactylon* Pers., *Dactyloctenium aegyptium* Beauv., *Cyperus rotundus* L. (Monocots), *Eclipta alba* Hassk, *Trianthema portulacastrum* L. and *Amaranthus viridis* L. (Dicots).

There were considerable differences among the treatments in relative density (RD) of weed species from initial stage to harvest of the crop. At 45 DAS, *E. colona* (31.5%), *C. rotundus* (40%), *E. alba* (13.4%), *A. viridis* (5%) and *T. portulacastrum* (9.8%) were dominant. The dominant weed flora observed at harvest were *E. colona* (35.5%), *C. rotundus* (45%), *E. alba* (8.8%), *T. portulacastrum* (8.1%) and *C. dactylon* (8.1%).

Weed Growth and NPK Removal

During both the years, irrigation scheduled at seven days interval during vegetative stage and four days interval during reproductive stage recorded significantly higher weed density and weed dry matter production at harvest than the irrigation scheduled once in two days (Table 1). The NPK removal by weed was significantly higher in irrigation scheduled at seven days interval during vegetative stage and four days interval during reproductive stage as compared to irrigation scheduled once in two days becuase of higher weed growth in irrigtion scheduled at seven days interval during vegetative stage and four days interval during reproductive stage (Table 2).

During both he years weed density, weed dry matter production at 45 DAS and at harvest and NPK removal by weeds were significantly lower with pre-emergence application of pendimethalin @ 1 kg/ha fb cono weeding at 30 DAS and one HW at 45 DAS than that of HW at 20 and 45 DAS and pre-emergence application of pendimethalin @ 1 kg/ha fb 2, 4-D Na salt @ 1 kg/ha at 40 DAS (Tables 1 and 2). Among latter treatments, pre-emergence application of pendimethalin @ 1 kg/ha fb 2, 4-D Na salt @ 1 kg/ha at 40 DAS resulted in significantly lower weed density and weed dry matter production at harvest and lower N uptake by weeds during both the years. On the other hand, the weed density and weed dry matter production at 45 DAS and P and K removal by weeds were significantly lower with HW at 20 and 45 DAS than pre-emergence application of pendimethalin @ 1 kg/ha fb 2, 4-D Na salt @ 1 kg/ha at 40 DAS.

Better control of weeds with pre-emergence application of pendimethalin @ 1 kg/ha fb cono weeding at 30 DAS and one HW at 45 DAS during active growth stage leads to reduced weed dry weight, which helps in minimizing the crop-weed competition and helps the crop to utilize the entire available nutrients to the maximum extent and leads to better crop growth. These results are in conformity with the findings of Ramamoorthy *et al.* (1998) in upland rice and Thimme Gowda *et al.* (2009) in aerobic rice.

During bot the years, weed density at harvest and weed dry matter production at 45 DAS and at harvest increased significantly upto 180 kg N/ha. Weed density at 45 DAS during both the years after application of 180 kg N/ha significantly increased the weed density over that of 120 kg N/ha. The weed density at 150 and 180 kg N/ha was comparable with each other (Table 1).

During both the years, the NPK removal by weeds was significantly increased with increase in nitrogen level from 120 to 150 and 180 kg N/ha (Table 2).

The increase in NPK removal by weeds was mainly due to increase in the number and dry weight of

Table 2. NPK uptake by weed and crop (kg/ha) at harvest as influenced by irrigation schedules, weed management and nitrogen levels in aerobic rice during **kharif** 2008 and 2009

Treatments	Weed N uptake		Weed P uptake		Weed K uptake		Crop N uptake		Crop P uptake		Crop K uptake	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Irrigation schedules (I)												
I_1–Irrigation once in two days	4.0	4.3	1.4	1.4	6.3	6.8	103.7	94.7	34.8	33.0	172.7	167.0
I_2–Irrigation at seven days interval during vegetative stage and four days interval during reproductive stage	4.7	5.0	1.6	1.6	7.8	8.3	118.9	108.6	33.9	35.3	180.3	173.9
S. Em±	0.17	0.17	0.07	0.07	0.10	0.10	2.0	1.6	2.0	0.2	1.9	1.3
LSD (P=0.05)	0.50	0.2	0.2	0.2	0.30	0.20	4.1	3.3	NS	0.4	3.7	2.6
Weed management (W)												
W_1–Hand weeding at 20 and 45 DAS	5.2	5.6	1.5	1.4	7.4	7.8	92.2	84.7	29.7	26.9	142.9	138.1
W_2–Pre-emergence application of pendimethalin @ 1 kg/ha followed by 2, 4-D Na salt @ 1 kg/ha at 40 DAS	4.9	5.1	1.9	1.8	8.2	8.7	106.2	95.5	34.8	37.1	186.0	179.1
W_3–Pre-emergence application of pendimethalin @ 1 kg/ha followed by cono weeding at 30 DAS and one HW at 45 DAS	3.1	3.3	1.2	1.3	5.6	6.2	135.5	124.7	38.5	38.5	200.6	194.2
S. Em±	0.10	0.14	0.10	0.03	0.17	0.16	5.2	3.7	3.9	1.4	5.7	5.9
LSD (P=0.05)	0.30	0.40	0.30	0.10	0.50	0.50	10.3	7.2	NS	2.7	11.2	11.5
Nitrogen levels (N) (kg/ha) (% RDN)												
120 (100)	3.5	3.7	1.2	1.1	5.5	5.9	101.5	92.2	33.7	28.4	161.8	156.4
150 (125)	4.4	4.7	1.5	1.5	7.2	7.7	105.6	96.9	31.2	33.8	174.1	167.8
180 (150)	5.2	5.6	1.9	1.9	8.5	9.2	126.9	115.9	38.2	40.3	193.5	187.2
S. Em±	0.21	0.21	0.07	0.10	0.14	0.17	3.1	2.9	3.7	0.7	2.8	2.8
LSD (P=0.05)	0.50	0.6	0.2	0.3	0.40	0.50	6.1	5.8	NS	1.3	5.6	5.6

NS–Not Significant.

Table 3. Yield attributes and grain yield as influenced by irrigation schedules, weed management and nitrogen levels in aerobic rice during **kharif** 2008 and 2009

Treatments	Panicles/m^2		Panicle length (cm)		Panicle weight (g)		Filled spikelets/ panicle		Unfilled spikelets/ panicle		Grain yield (kg/ha)	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Irrigation schedules (I)												
I_1–Irrigation once in two days	273	255	22.07	20.97	1.74	1.57	139.6	255	22.07	20.97	43.48	4106
I_2–Irrigation at seven days interval during vegetative stage and four days interval during reproductive stage	286	267	21.46	20.39	1.96	1.77	152.0	267	21.46	20.39	4537	4286
LSD (P=0.05)	8	6	NS	0.53	0.06	0.06	4.7	4.0	7.5	6.8	93	89
Weed management (W)												
W_1–Hand weeding at 20 and 45 DAS	202	182	22.00	20.89	1.74	1.57	120.9	182	22.00	20.89	3506	3306
W_2–Pre-emergence application of pendimethalin @ 1 kg/ha followed by 2, 4-D Na salt @ 1 kg/ha at 40 DAS	300	282	21.78	20.71	1.83	1.65	147.2	282	21.78	20.71	4690	4431
W_3–Pre-emergence application of pendimethalin @ 1 kg/ha followed by cono weeding at 30 DAS and one HW at 45 DAS	335	319	21.51	20.45	1.98	1.76	169.4	319	21.51	20.45	5132	4851
LSD (P=0.05)	24	27	NS	NS	0.05	0.04	5.7	5.0	NS	NS	316	301
Nitrogen levels (N) (kg/ha) (% RDN)												
120 (100)	256	239	20.81	19.77	1.79	1.61	135.0	239	20.81	19.77	4216	3981
150 (125)	277	259	21.81	20.72	1.85	1.67	144.7	259	21.81	20.72	4398	4153
180 (150)	304	284	22.68	21.56	1.92	1.73	157.7	284	22.68	21.56	4715	4454
LSD (P=0.05)	14	14	0.49	0.46	0.03	0.03	7.3	6.6	NS	NS	154	146

NS–Not Significant.

weeds with increase in the dose of nitrogen. Shad and De Datta (1988) and Roy and Mishra (1999) under upland conditions also reported similar results.

Yield Attributes, Yield and NPK Uptake

Panicle number, weight and filled spikelets per panicle, total N and K uptake at harvst and grain yield of rice crop during both the years and total P uptake at harvest during 2009 were significantly higher with irrigation scheduled at seven days interval during vegetative stage and at four days interval during reproductive stage as compared to irrigation scheduled once in two days (Tables 2 and 3).

There was greater uptake of nitrogen in irrigation scheduled at seven days interval during vegetative stage and four days interval during reproductive stage. The higher NPK uptake helped in significant increase in panicle number, panicle weight and filled spikelets per panicle. It indicated that greater uptake ultimately helped in higher yield with irrigation scheduled at seven days interval during vegetative stage and four days interval during reproductive stage. The grain yield recorded with irrigation once in two days was significantly lower. It may be due to high frequency of irrigation which resulted in alternate wetting and drying process and ultimately in the nutrient leaching. It has been reproted that grain yield was higher in irrigation interval once in five days when compared to irrigation once in 24 h in summer paddy at Davangere due to more number of tillers, panicles and filled spikelets.

The uptake of N, P and K by rice crop, panicle number and weight, filled spikelets per panicle and grain yield were significantly higher with pre-emergence application of pendimethalin @ 1 kg/ha fb cono weeding at 30 DAS and one HW at 45 DAS than that of pre-emergence application of pendimethalin @ 1 kg/ha fb 2, 4-D Na salt @ 1 kg/ha at 40 DAS and HW at 20 and 45 DAS (Tables 2 and 3). Further, the grain yield was significantly higher with pre-emergence application of pendimethalin @ 1 kg/ha fb 2, 4-D Na salt @ 1 kg/ha at 40 DAS among latter two treatments.

Kathiresan and Manoharan (2002) reported that integrated weed control with pre-emergence herbicides coupled with one hand weeding proved better than two hand weedings. Controlling the weeds through pre-emergence application of pendimethalin @ 1.25 kg/ha fb post-emergence application of 2, 4-D @ 1.0 kg/ha resulted in higher grain yield in semi-dry rice (Ramaiah and Muthukrishnan, 1992). The results obtained in the present study corroborate the above findings.

Panicle number, length and weight and filled spikelets per panicle were significantly higher at 180 kg N/ha as compared to 150 and 120 kg N/ha in both the years (Table 3). The grain yield and uptake of NPK at harvest increased significantly at each successive increment of N from 120 to 150 and 180 kg N/ha during both the years (Tables 2 and 3).

Efficient utilization of applied nitrogen as well as other major nutrients (P and K) resulted in more number of effective tillers at higher levels of nitrogen. There was 11.8 and 7.2% increase in grain yield at 180 kg N/ha over 120 and 150 kg N/ha, respectively, as against 4.3% observed with 150 kg N/ha over 120 kg N/ha. Significant increase in grain yield at 150 and 180 kg/ha could be attributed to improved uptake of N, P and K by the crop and thereby photosynthetic activity, resulting in higher growth and yield attributes. The improvement of all these led to higher yield. These results are in agreement with the findings of Sathiya *et al.* (2008) who recorded significantly higher grain yield with 175 kg N/ha over 100 and 125 kg N/ha under aerobic condition.

From these studies, it can be concluded that for obtaining higher grain yield of aerobic rice, irrigation should be scheduled at seven days interval during vegetative stage and four days interval during reproductive stage along with pre-emergence application of pendimethalin @ 1 kg/ha fb cono weeding at 30 DAS and one HW at 45 DAS and application of 180 kg N/ha.

REFERENCES

Babu, S. D. P., B. T. S. Moorthy, S. Rajamani and G. B. Manna. 1992. Integrated weed management benefits of direct seeded upland rice. *Ind. Fmg.* **42** : 7-8.

Gupta, S. K., K. G. Tejwani and Rambabu. 1972. Effective rainfall of Dehradun under irrigated conditions. *Symp. Soil and Water Manage.,* ICAR, held at Hisar, 11-13 March, 1969. pp. 62-70.

Kathiresan, G. and M. L. Manoharan. 2002. Effect of seed rate and methods of weed control on weed growth and yield of direct seeded rice *(Oryza sativa). Ind. J. Agron.* **47** : 212-215.

Panse, V. G. and P. V. Sukhatme. 1978. *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi. 361 pp.

Prasad, U. K., T. N. Prasad and A. Kumar. 1992. Response of direct seeded rice (*Oryza sativa*) to levels of nitrogen in calcareous soil. *Ind. J. Agron.* **37** : 686-689.

Ramaiah, S. and P. Muthukrishnan. 1992. Effect of weed control on weed growth and grain yield of semi-dry rice (*Oryza sativa*). *Ind. J. Agron.* **37** : 317-319.

Ramamoorthy, K., A. Arokiaraj and A. Balasubramanian. 1998. Effect of irrigation and chemical weed control on crop yields and nutrient uptake by upland rice and associated weeds under rice-blackgram intercropping system. *Oryza* **33** : 264-268.

Roy, D. K. and S. S. Mishra. 1999. Effect of weed management in direct seeded, upland rice (*Oryza sativa*) at varying nitrogen levels. *Ind. J. Agron.* **44** : 105.

Sathiya, K., K. Sathyamoorthi and G. J. Martin. 2008. Effect of nitrogen levels and split doses on the productivity of aeobic rice. *Res. on Crops* **9** : 527-530.

Shad, R. A. and S. K. De Datta. 1988. Fertilizer nitrogen use efficiency in direct seeded wet land rice under different water management systems. *Pak. J. Agric. Res.* **9** : 440-447.

Singh, D., P. K. Chhonkar and B. S. Dwivedi. 2005. *Manual on Soil, Plant and Water Analysis*. Published by Mrinal Goel, West Ville Publishing House, 47, B-5, Paschim Vihar, New Delhi.

Thimme Gowda, P., C. Shankaraiah, A. C. Jnanesh, M. Govindappa and K. N. Kalyana Murthy. 2009. Studies on chemical weed control in aerobic rice (*Oryza sativa* L.) . *J. Crop and Weed* **5** : 321-324.