Journal of Agricultural Engineering and Food Technology
p-ISSN: 2350-0085; e-ISSN: 2350-0263; Volume 5, Issue 2; April-June, 2018, pp. 113-117

http://www.krishisanskriti.org/Publication.html

Effect of Integrated Weed and Nutrient Management Practices on Growth and Yield of Direct Seeded Upland Autumn Rice (*Oryza sativa*)

G. Goswami[1] and N.C. Deka[2]

Assam Agricultural University, Jorhat, Assam-785013

Abstract—*A field experiment was conducted during the autumn season of 2014 to evaluate the growth and yield of three different direct seeded upland rice varieties under five different integrated weed and nutrient management practices. HYV Rasi exhibited its superiority by recording higher leaf area index at 30 DAS (2.35), 60 DAS (2.72), at harvest (1.64); plant population per m at 15 DAS (12.85), number of tillers per m at 45 DAS (63.95), dry matter accumulation at 30 DAS (87.17 g/m), 60 DAS (336.47 g/m); number of panicles per m row length (55.40), panicle length (18.59 cm) and 1000-grains weight (21.61 g). Among the weed and nutrient management practices 30-15-15 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g a.i./ha+ grubber 30 DAS recorded higher plant height at 30 DAS (24.79 cm), 60 DAS (80.30 cm) and at harvest (118.22 cm), leaf area index at 60 DAS (2.93), at harvest (1.69); plant population per m at 15 DAS (14.13), number of tillers per m at 45 DAS (80.92), dry matter accumulation at 30 DAS (101.39 g/m), 60 DAS (395.20 g/m); number of panicles per m row length (72.37), panicle length (21.16 cm) and 1000-grains weight (21.25 g). The maximum values of growth and yield attributes resulted significantly higher grain yield (20.87 q/ha) and straw yield (26.31q/ha) under the weed and nutrient management practice, application of pretilachlor (750 g a.i./ha) + grubber 30 days after sowing + 30-15-15 kg/ha N-P_2O_5-K_2O. The results also revealed an increase in yields as evident by higher grain and straw yield for all the three varieties was observed with application of pretilachlor (750 g a.i./ha) + grubber 30 days after sowing + 30-15-15 kg/ha N-P_2O_5-K_2O. Further the gross returns (Rs 44,773), net returns (Rs 27726) and B:C ratio (1.63) were also highest for pre-emergence application of pretilachlor (750 g a.i./ha) + grubber 30 days after sowing + 30-15-15 kg/ha N-P_2O_5-K_2O combined with Rasi.*

Keywords*: Direct seeded rice, variety, integrated weed and nutrient management, growth, yield, economics*

1. INTRODUCTION

Introduction of high yielding dwarf rice cultivars, tailored to respond external inputs often transplanted after puddling replaced the traditional direct practice of direct seeding of rice in Indo Gangetic plains. The swift change-over was mainly due to non-availability of herbicide molecules (pre- or post-emergence) for control of weeds, a major problem of direct dry seeded rice (DSR) culture. Direct seeding offers certain advantages *i.e.* saves labour, faster and easier sowing, less drudgery, 7-10 days reduction in crop duration, less water requirements, higher net benefit over lower production cost and better soil physical conditions for succeeding crops. In general, the yield losses due to weeds in upland rice crop ranged between 66 to 92.8 percent (Maliwal and Mundra, 2011); they are a major hurdle to broad adoption of direct seeded upland rice The key to success in direct seeded autumn rice is the availability of efficient weed control techniques (Pandey and Velasco, 2002).

Proper weed management practices along with integrated nutrient management (Sarkar and Gangwar, 2001), more particularly with major nutrients, significantly influence the crop productivity in upland situations. Integrated use of chemical fertilizers with manures, compost and green manure crops is very important for sustainable rice production especially under rainfed upland conditions (Meelu, 1996). Fertilizer management can definitely alter the competitive balance between crops and weeds, but methods to incorporate it into integrated weed management are yet to be developed (Buhler, 2002). Also, it the advent of high yielding short duration upland rice varieties, which respond well to weed management and nutrient application has shown some promise in this direction under upland condition as well. Population dynamics exerts a significant influence on the growth and development of rice crop and grain yield, because of its competitive effect on both the vegetative and reproductive development and ultimately the quality. Density depended effects on yield are due to the competition between the adjacent plants for the necessary resources (Donald, 1963; Zia, 1987).Therefore, to study the efficacy of integrated weed and nutrient management practices and varieties on growth and yield of direct seeded rice, the present investigation was undertaken.

A field experiment was carried out at Instructional Cum Research (ICR) Farm, Assam Agricultural University, Jorhat during the autumn season, 2014. The farm is situated at 26°47'N latitude, 94°12'E longitude and at the elevation of 86.6 meters above mean sea level. The soil of experimental plot was sandy loam in texture with pH 4.95, organic carbon of 0.53% and 263.87, 22.10 and 134.71 kg/ha N, P and K, respectively. The experiment was carried out in factorial randomized block design replicated thrice with 15 treatments involving 3 varieties, *viz.* Inglongkiri, Maizubiron and Rasi adopting 5 treatments of weed and nutrient management, *i.e.* 20-10-10 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS (W_1), 30-15-15 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS (W_2), 10-5-5 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS + Vermicompost @ 1 t/ha (at sowing & 30 DAS) + Sesbania (*Sesbania aculeata*) green mulch (up to 30 days) (W_3), 10-5-5 kg/ha N-P_2O_5-K_2O + pretilachlor @ 750 g/ha followed by grubber 30 DAS with intra-row spacing 15cm (W_4), and 20-10-10 kg/ha N-P_2O_5-K_2O + Weedy check (W_5). The required amounts of P_2O_5 as per treatments were applied as basal in the lines one day prior to sowing. Half dose of N and K_2O was applied 20 DAS and the remaining quantities of N and K_2O was applied 40 DAS. Vermicompost@1 t/ha was applied in rows in two equal splits *i.e.* at basal and 30 DAS. *Sesbania aculeata* as green mulch was grown and incorporated in soil at 30 days DAS. The pre-emergence herbicide, pretilachlor (Craze 50 EC) was sprayed 1 DAS and mechanical weeding was done 30 DAS by using manually operated grubber as per treatments. Observations were recorded as per the established norms. All the data were statistically analyzed to draw a valid conclusion. Economics of rice cultivation as influenced by weed and nutrient management practices were calculated by considering the prevailing market price of rice grain and straw and different inputs.

HYV Rasi at early stages while *Inglongkiri* at harvest showed significantly higher values of plant height. Saito *et al.* (2007) also reported that the local varieties had the tallest plants compared to the improved variety at harvest. Rasi showed enhanced values of the other growth attributes *viz.* LAI and plant population per meter and showed significantly higher number of tillers per meter and dry matter accumulation. Application of 30-15-15 kg/ha N-P_2O_5-K_2O along with pretilachlor @ 750g a.i./ha and grubber 30 DAS (W_2) recorded statistically higher plant height in almost all the growth stages. More or less similar trend was observed in LAI, dry matter accumulation, plant population per meter and number of tillers per meter. This might be due to better nutrition of rice owing to higher dose of major nutrients through chemical fertilizers that are readily soluble in soil solution and thereby instantaneously available to plants.

Yield attributes of rice, *viz.* number of panicles per meter row length and1000-grains weight were significantly higher in Rasi. This might be due to significantly higher number of tillers recorded in Rasi. Number of panicles per meter row length, panicle length, number of filled grains and false grains per panicle were significantly affected due to weed and nutrient management practices. In general, fertilizer dose at higher levels gave significantly higher values of yield attributes than that with lower levels of NPK. Among the different practices, maximum values of yield attributes were obtained with treatment W_2 *viz.* application of 30-15-15 kg/ha N-P_2O_5-K_2O along with pretilachlor @ 750 g a.i./ha and grubber 30 DAS. The enhanced early vegetative growth in terms of higher plant height, LAI resulted in more panicle which consequently increased the number of panicle bearing tillers significantly.

A perusal of the findings revealed that there was no significant difference in grain yield amongst the three varieties tested while Inglonkiri showed significantly higher straw yield. It might be due to significantly higher plant height at harvest in Inglongkiri. Regarding the factor, weed and nutrient management, application of 30-15-15 kg/ha N-P_2O_5-K_2O along with pretilachlor @ 750 g a.i./ha and use of grubber 30 DAS (W_2) showed significantly higher grain yield and straw yield. The higher grain yield might be due to better nutrition of rice crop owing to application of higher dose of major nutrients as well as reduction in crop weed competition due to combined methods of weed control *i.e.* chemical and mechanical, that resulted in statistically superior growth characters (LAI, number of tillers and dry matter accumulation) and yield attributing characters (number of panicles, panicle length and number of filled grains). Kavitha *et al.*, (2010) reported that application of pretilachlor suppressed the weed in the early growth stages of *autumn* rice leading to higher yield. The higher straw yield might be due to higher amount of dry matter production at 30 and 60 DAS in W_2. The improved cultivars produced higher yields than traditional cultivars in both high and low fertility conditions (Saito *et al.*, 2006).

The grain and straw yield were affected significantly by the interaction effect of varieties and weed and nutrient management practices (Table 5). The results revealed that higher grain yield was given by Rasi, when combined with application of 30-15-15 kg/ha N-P_2O_5-K_2O along with pretilachlor @ 750 g a.i./ha and use of grubber 30 DAS (W_2) while Inglongkiri showed significantly higher straw yield when combined with W_2.

The growing of variety Rasi (V_3) along with application of 30-15-15 kg/ha N-P_2O_5-K_2O, pretilachlor @ 750g a.i./ha and grubber 30 DAS (W_2) recorded higher benefit-cost ratio (1.63) and higher net return (Rs 27726.00 per ha). This may be ascribed to significantly highest grain yield (21.86 q/ha) as well as highest gross return (Rs. 44773.00 per ha) obtained in V_3W_2. The treatment combination (V_3W_2) recorded highest net return and benefit cost ratio as because the incremental gain in gross income (Rs 3969.00) was higher as compared to additional cost of cultivation (Rs 604.00) owing to application of higher level of nutrients along with proper weed management. This was followed by treatment combination of variety Inglongkiri (V_1) along with application of 30-15-15 kg/ha N-P_2O_5-K_2O, pretilachlor @ 750 g a.i./ha and use of grubber at 30 DAS which recorded benefit-cost ratio of 1.53 and net return of Rs. 26059.00 per ha.

Table 1: Effect of variety, weed and nutrient management practices on plant height and leaf area index at different periods (DAS) and harvest of autumn rice

Treatment	Plant height (cm)			Leaf Area Index		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
Variety						
V_1: Inglongkiri	21.50	2.27	2.65	1.58	73.86	122.99
V_2: Maizubiron	21.18	2.30	2.57	1.50	73.41	114.07
V_3: Rasi	22.53	2.35	2.72	1.64	66.94	87.07
S.Em +	0.24	0.07	0.11	0.05	1.09	1.03
CD (P = 0.05)	0.70	NS	NS	NS	3.15	2.99
Weed and nutrient management						
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	22.75	2.23	2.85	1.67	77.09	116.94
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	24.79	2.33	2.93	1.69	80.30	118.22
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t ha^{-1} + sesbania green mulch + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	23.30	2.23	2.65	1.58	78.05	117.49
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	22.48	2.29	2.52	1.52	78.03	115.26
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	15.37	2.45	2.28	1.42	43.54	72.12
S.Em +	0.31	0.09	0.14	0.07	1.41	1.33
CD (P = 0.05)	0.90	NS	0.40	0.19	4.07	3.86

Table 2: Effect of variety, weed and nutrient management practices on plant population, number of tillers and dry matter accumulation at different periods (DAS) of autumn rice

Treatment	Plant population (Numbers per m) (15 DAS)	Number of tillers per m (45 DAS)	Dry matter accumulation ($g\ m^{-1}$)	
			30 DAS	60 DAS
Variety				
V_1: Inglongkiri	12.22	62.38	85.09	328.95
V_2: Maizubiron	12.22	61.15	82.83	317.68
V_3: Rasi	12.85	63.95	87.17	336.47
S.Em +	0.32	0.69	1.23	3.12
CD (P = 0.05)	NS	2.00	NS	9.03
Weed and nutrient management				
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	13.51	72.29	94.32	356.78
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	14.13	80.92	101.39	395.20
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t ha^{-1} + sesbania green mulch + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	13.93	66.29	85.00	342.12
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	10.47	60.18	82.22	310.57
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	10.13	32.78	62.22	233.83
S.Em +	0.42	0.89	1.59	4.02
CD (P = 0.05)	1.21	2.58	4.60	11.65

Table 3. Effect of variety, weed and nutrient management practices on number of panicles, panicle length, 1000-grains weight and number of filled grains per panicle of autumn rice

Treatment	**Number of panicles per m row length**	**Panicle length (cm)**	**1000-grains weight (g)**	**Number of filled grains per panicle**
Variety				
V_1: Inglongkiri	52.69	18.17	20.13	110.25
V_2: Maizubiron	52.27	18.01	19.55	110.61
V_3: Rasi	55.40	18.59	21.61	111.39
S.Em +	0.29	0.16	0.32	0.59
CD (P = 0.05)	0.84	NS	0.92	NS
Weed and nutrient management				
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	61.56	19.26	20.75	121.80
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	72.37	21.16	21.25	125.70
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t ha^{-1} + sesbania green mulch + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	58.81	18.08	20.54	119.48
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	53.32	17.70	19.66	117.88
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	21.22	15.10	19.95	68.89
S.Em +	0.37	0.21	0.41	0.76
CD (P = 0.05)	1.08	0.61	NS	2.21

Table 4: Effect of variety, weed and nutrient management practices on grain yield, straw yield and harvest index of autumn rice

Treatment	**Grain yield ($q\ ha^{-1}$)**	**Straw yield ($q\ ha^{-1}$)**	**Harvest Index (%)**
Variety			
V_1: Inglongkiri	15.96	21.05	43.26
V_2: Maizubiron	15.50	21.03	42.82
V_3: Rasi	16.05	20.17	44.21
S.Em +	0.20	0.11	-
CD (P = 0.05)	NS	0.31	-
Weed and nutrient management			
W_1: 20-10-10 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	18.77	25.33	42.55
W_2: 30-15-15 kg/haN-P_2O_5-K_2O + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	20.87	26.31	44.21
W_3: 10-5-5 kg/haN-P_2O_5-K_2O + vermicompost @ 1t ha^{-1} + sesbania green mulch + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	16.79	22.56	42.67
W_4: 10-5-5 kg/haN-P_2O_5-K_2O + intra-row spacing 15 cm + pretilachlor @ 750g a.i./ha+ grubber 30 DAS	15.73	20.92	42.93
W_5: 20-10-10 kg/haN-P_2O_5-K_2O + weedy check	7.03	8.63	44.78
S.Em +	0.26	0.14	-
CD (P = 0.05)	0.75	0.40	-

Table 5: Economic analysis of different treatment combinations

Treatment	**Cost of cultivation (Rs. per ha)**	**Gross Return (Rs. per ha)**	**Net Return (Rs. per ha)**	**B:C ratio**
$V_1 W_1$	16443.00	40295.00	23852.00	1.45
$V_1 W_2$	17047.00	43106.00	26059.00	1.53
$V_1 W_3$	23849.00	35671.00	11822.00	0.50
$V_1 W_4$	15839.00	33443.00	17604.00	1.11

$V_1 W_5$	13723.00	15843.00	2120.00	0.15
$V_2 W_1$	16443.00	38549.00	22106.00	1.34
$V_2 W_2$	17047.00	42363.00	25316.00	1.49
$V_2 W_3$	23849.00	34799.00	10950.00	0.46
$V_2 W_4$	15839.00	33128.00	17289.00	1.09
$V_2 W_5$	13723.00	16092.00	2369.00	0.17
$V_3 W_1$	16443.00	40804.00	24361.00	1.48
$V_3 W_2$	17047.00	44773.00	27726.00	1.63
$V_3 W_3$	23849.00	36399.00	12550.00	0.53
$V_3 W_4$	15839.00	33248.00	17409.00	1.10
$V_3 W_5$	13723.00	11591.00	-2132.00	-0.16

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