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Influence of integrated crop management practices on lowland rice

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ABSTRACT

Field experiments were conducted during wet seasons at the Crop Research Station, Ghaghra ghat, (U.P.) to find out the most remunerative method of rice crop establishment in lowlands. Grain yield recorded in plots with transplanting in lines at 20x10 cm spacing in puddled soil + anilophos @ 0.4 kg a.i. ha^{-1} at 4 days after transplanting with recommended dose of fertilizers (RDF) @120 kg N+60P_2O_5+40 kg K_2O+25 kg ZnSO ha^{-1} was on par with seeding of sprouted seeds (80 kg ha^{-1}) by 8 - row drum seeder and application of anilophos @ 0.4 kg a.i. ha^{-1} at 4-6 days after transplanting along with RDF, and direct seeding in lines (100 kg ha^{-1}) + anilophos @ 0.4 kg a.i. ha^{-1} at 3 days after sowing followed by 2,4-D @ 0.5 kg a.i. ha^{-1} at 20 days after sowing + one hand weeding at 35 days after sowing along with RDF produced significantly higher grain yield over rest of the treatments. The highest net income of Rs. 11460 ha^{-1} was obtained with transplanting at 20x10cm spacing + anilophos @ 0.4 kg a.i. ha^{-1} at 4 DAT + 120 kg N + 60 kg P_2O_5+ 40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at panicle initiation (PI), however, benefit : cost ratio was highest (1.44) with seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder + anilophos @ 0.4 kg a.i.ha^{-1} at 4 DAS + one HW at 40 DAS + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at PI stage.

Key words: *rice, lowland, crop, establishment, weed, yield, direct seeding, benefit*

Cultivation of rice by transplanting in puddled condition is popular in North India but it is highly labour intensive and requires large quantity of water. Transplanting alone accounts for about 15% of total rice production cost and at times delayed due to shortage of labour, which causes substantial loss in yield (Mahajan *et al.,* 2006). Direct seeding of rice may ensure better plant population especially if improved equipments like seed drill or drum seeder are used (Ram *et al.,* 2006). Direct seeding eliminates the need of nursery raising and subsequent transplanting of seedling is a labour saving technique that saves water to the extent of 20 to 30 % (Tabbal *et al,* 2002). Direct seeded rice provides an option to make paddy cultivation cost effective, which saves labour expense and water use is now fast replacing traditionally transplanted rice in areas with good drainage. (Balasubramanian and Hill, 2000). Hence, many farmers are switching to direct seeding of rice that is helpful in reducing labour requirement, shorting the duration of crop by around 10 days and providing comparable yield with transplanting. Poor crop stand, abundance of weeds and inadequate nutrition are some of the problems associated with low productivity of direct seeded rice.

Considering these facts, field trials were undertaken to develop appropriate method of crop establishment, weed and nutrient management to improve grain yield of rice under lowland condition.

MATERIALS AND METHODS

A field experiment was conducted during wet season at the Crop Research Station, Ghaghraghat, U.P. to find out the most remunerative method for rice crop establishment in rainfed lowland. Soil of the experimental site was sandy-loam in texture with average organic carbon content of 0.43%, pH 8.1, available nitrogen ($KMnO_4$) 218 kg ha^{-1}, phosphorus 18.9 kg ha^{-1} and potassium 188 kg ha^{-1}. The field experiment with seven treatments of rice establishment techniques comprised of farmers' method of transplanting (random) with 80 kg N +40 kg P_2O_5+40 kg K_2O ha^{-1} along with one hand weeding (HW) at 30 days after transplanting (DAT), Transplanting in lines at 20x10cm spacing + anilophos @ 0.4 kg a.i. ha^{-1} at 4 days after transplanting + 120 kg N+60 kg P_2O_5+ 40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 split; ½ N at sowing + ¼ N- top dressing at tillering + ¼ N- top dressing at panicle initiation) + full dose of P_2O_5 and $ZnSO_4$and 75% K_2O as basal at sowing and the rest as top dressing at panicle initiation, farmers practice of broadcast of sprouted seeds @ 100kg ha^{-1} + 80 kg N +40 kg P_2O_5 + 40 kg K_2O ha^{-1} (1/2 N + full P_2O_5 and K_2O at sowing), and rest N in 2 equal splits-top dressing at tillering and panicle initiation + one hand weeding at 35 days after sowing; seeding of sprouted seeds (80 kg ha^{-1}) by 8-row drum seeder (Directorate of Rice Research, Hyderabad- Make) on the same day after puddling + anilophos @ 0.4 kg a.i.ha^{-1} at 4 days after seeding + one hand weeding at 40 days after sowing, and 75% K_2O as basal at sowing and the rest as top dressing at panicle initiation, transplanting at 20x10cm spacing + anilophos @ 0.4 kg a. i.ha^{-1} at 4 DAT + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at panicle initiation (PI); seeding of sprouted seeds (80 $kgha^{-1}$) by 8-row drum seeder one day after puddling + anilophos @ 0.4 kg a.i.ha^{-1} at 4-6 days after sowing+ one hand weeding at maximum tillering stage + 120 kg N + 60 kg P_2O_5 +40 kg K_2O + 25 kg $ZnSO_4$ ha^{-1} (N-3 splits i.e. 1/3 N each at 15-30 ,31-40 and 48-56 days after sowing + full P_2O_5 and 75% K_2O as basal, and rest K_2O as top dressing at panicle initiation. Seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder two days after final puddling + anilophos @ 0.4 kg a.i.ha^{-1} at 4-6 days after sowing+ one hand weeding at maximum tillering stage; seeding of sprouted seeds (80 $kgha^{-1}$) by 8-row drum seeder two day after puddling + fertilizer and weed control as per Seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder one day after puddling + anilophos @ 0.4 kg a.i.ha^{-1} at 4 DAS + one HW at maximum tillering stage + 120 kg N + 60 kg P_2O_5 +40 kg K_2O + 25 kg $ZnSO_4$ kg ha^{-1} (N- 3 splits) + full P_2O_5 and 75% K_2O as basal, and 25% K_2O at PI stage, direct seeding of rice in lines on 15th June @ 100 kg seed ha^{-1} + anilophos @ 0.4 kg a.i. ha^{-1} at 4-6 days after sowing followed by 2,4-D @ 0.5 kg ha^{-1} at 20 days after sowing + one spot hand weeding at 35 days after sowing + fertilizers as in Transplanting at 20x10cm spacing + anilophos @ 0.4 kg a. i.ha^{-1} at 4 DAT + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at panicle initiation (PI) . Rice variety Jalpriya of long duration (150 days) was used as test crop. The plot size was kept 5x4m. Sowing of direct seeding treatment was done on 15th June during both the years of experimentation. The sowing of rice in nursery was done on same day as in direct seeding, and 25 days old seedling were transplanted at 20x10 cm spacing putting 3 seedlings $hill^{-1}$. Random transplanting with 80 kg N +40 kg P_2O_5+40 kg K_2O ha^{-1} + one hand weeding (HW) at 30 days after transplanting (DAT) and Transplanting at 20x10cm spacing + anilophos @ 0.4 kg a. i.ha^{-1} at 4 DAT + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at panicle initiation (PI) In 8 row drum seeder treatments, sprouted seeds were sown at a spacing of 20cm. Application of nitrogen in the form of urea , phosphorus as single super phosphate, K as muriate of potash and Zinc as Zinc sulphate was made based on different treatments. All improved package of practices were adopted to raise the crop. The required quantity of herbicide was applied as per treatment with manually operated knapsack sprayer using spray volume of 500 litre water ha^{-1}. The samples for density and dry weight of weeds were collected from quadrates placed randomly at two spots at panicle initiation stage and at harvest of the crop. Grain and straw yield of rice were recorded for the whole plot at harvest. The cost of cultivation was calculated treatment wise based on prevailing prices. The rice received 765 mm and 901 mm rainfall in the 1st year and in the 2nd year, respectively.

RESULTS AND DISCUSSION

Yield attributes like, panicles m^{-2}, filled grains $panicle^{-1}$, panicle length, panicle weight and 1000 grain weight were significantly better with transplanting in lines at 20x10cm spacing + anilophos @ 0.4 kg a.i. ha^{-1} at 4-6 days after transplanting + 120 kg N + 60 kg P_2O_5 +40 kg K_2O + 25 kg $ZnSO_4$ ha^{-1} (N -3 splits - ½ N at sowing +1/4 N- top dressing at tillering + ¼ N , top dressing at panicle initiation , full dose of P_2O_5 and ZnSO + 75% K_2O as basal and rest K as top dressing at panicle initiation as compared to rest of the treatments, however, being on par with seeding of sprouted seeds (80 $kgha^{-1}$) by 8-row drum seeder on same day after puddling + along with specified schedule of weed control and fertilizer application. The higher values of yield attributes with the above treatments was because of better establishment of rice plants due to balanced fertilization and lower initial weed population, competition as compared to poor control of weeds in rest of the treatments. Similar higher values of yield attributes with transplanted rice or direct seeded by drum seeder has been reported by Ravi Sankar *et al.* (2008). The lowest values for all the yield attributes studied were recorded in the plots with farmers practice of broadcast of sprouted seeds @ 100kgha^{-1} fertilized with 80N+ 40P_2O_5+ 40K_2O kg ha^{-1} - 1/2 N + full P and K at sowing, and rest N top dressed in 2 splits + one hand weeding at 35 days after seeding which could be due to poor control of weeds (one hand weeding only) and use of inadequate quantity of fertilizers. Among the 8- row drum seeder treatments, seeding of sprouted seeds (80 kg ha^{-1}) by 8-row drum seeder two day after puddling, with specified schedule of weed control and fertilizer resulted significantly lower values of all yield attributes. This was due to the fact that disappearance of water from field due to light texture soil in one or two days after puddling caused dry surface of soil resulting in poor germination as compare to adequate availability of soil moisture with other treatments. Direct seeding of rice in lines on 15th June @100 kg ha^{-1} + anilophos @ 0.4 kg a.i. ha^{-1} 4 days after seeding followed by 2,4-D @0.5 kg ha^{-1} at 20 days after sowing + one spot hand weeding at 35 days after sowing and specified fertilizer application resulted in higher values of all yield attributes as compared to rest of the treatment except transplanting at 20x10cm spacing + anilophos @ 0.4 kg a. i.ha^{-1} at 4 DAT + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at panicle initiation (PI) and seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder + anilophos @ 0.4 kg a.i. ha^{-1} at 4 DAS + one HW at 40 DAS and fertilizer application owing to better initial establishment mainly because of efficient control of weed and use of optimum balanced fertilizers.

Methods of establishment of rice crop significantly influenced the grain and straw yield (Table 2). The highest grain yield (30.55 ha^{-1}) was recorded with seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder + anilophos @ 0.4 kg a.i. ha^{-1} at 4 DAS + one HW at 40 DAS and fertilizer with specifed schedule followed by seeding of sprouted seed by drum seeder, direct dry seeding in lines and seeding of sprouted seed by drum seeder 2 days after puddling. Transplanting at 20x10cm spacing + anilophos @ 0.4 kg a. i.ha^{-1} at 4 DAT + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at panicle initiation (PI) recorded 46.87% and 54.68% higher grain yield over Random transplanting with 80 kg N +40 kg P_2O_5+40 kg K_2O ha^{-1} + one hand weeding (HW) at 30 days after transplanting (DAT) and Broadcasting of sprouted seeds @ 100kg ha^{-1} + 80 kg N +40 kg P_2O_5 + 40 kg K_2O kg ha^{-1} (1/2 N + full P_2O_5 and K_2O at sowing)and rest N in 2 splits + one hand weeding at 35 DAS, respectively. The higher grain yield in the treatment involving transplanting at 20x10cm spacing + anilophos @ 0.4 kg a. i.ha^{-1} at 4 DAT + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder + anilophos @ 0.4 kg a.i. ha^{-1} at 4 DAS + one HW at 40 DAS and anilophos @ 0.4 kg a.i.ha^{-1} at 4-6 days after sowing+ one hand weeding at maximum tillering stage and direct seeding of rice in lines on 15th June @ 100 kg ha^{-1} + anilophos @ 0.4 kg a.i. ha^{-1} at 4-6 DAS + 2,4-D @0.5 kg ha^{-1} at 20 DAS + one hand weeding at 35 DAS + anilophos @ 0.4 kg a.i.ha^{-1} at 4-6 days after sowing+ one hand weeding at maximum tillering stage was mainly attributed to higher values of yield attributing characters (Table 1). Similar results were reported by Gill *et al.* (2006), Halder and Patra (2007). Seeding of sprouted seeds with 8- row drum seeder in seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder + anilophos @ 0.4 kg a.i.ha^{-1} at 4 DAS + one HW at 40 DAS and +, 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at panicle initiation (PI) seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder one day after puddling + anilophos @ 0.4 kg a.i.ha^{-1} at 4 DAS + one HW at maximum tillering stage + 120 kg N + 60 kg P_2O_5 +40 kg K_2O + 25 kg $ZnSO_4$ kg ha^{-1} (N- 3 splits) + full P_2O_5 and 75% K_2O as basal, and 25% K_2O at PI stage and Seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder two days after final puddling + fertilizer and weed control anilophos @ 0.4 kg a.i.ha^{-1} at 4 DAS + one HW at maximum tillering stage recorded significantly higher grain yield over both farmers practices of treatments (random transplanting with 80 kg N +40 kg P_2O_5+40 kg K_2O ha^{-1} + one hand weeding (HW) at 30 days after

Table 1. Yield attributes of rice as influenced by different cultural practices

Treatment	Panicles/m^{-2}		Filled grain panicle $^{-1}$		Panicle length (cm)		Panicle weight (g)		1000-grain weight(g)	
	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year
T1	198	200	47.3	55.4	22.9	23.0	2.78	2.73	23.8	23.3
T2	361	321	55.6	60.5	25.5	26.8	3.35	3.31	26.7	26.5
T3	185	190	45.5	53.7	22.6	23.6	2.68	2.70	24.2	23.9
T4	347	325	50.9	59.3	25.1	26.5	3.26	3.19	26.3	25.8
T5	297	289	48.1	57.3	24.5	25.6	3.06	3.03	25.7	25.5
T6	268	262	47.7	57.0	24.2	25.3	2.95	2.91	25.4	24.8
T7	318	302	48.4	58.8	24.9	26.4	3.21	3.19	26.4	25.7
CD(P=0.05)	22.3	28.2	4.9	5.5	0.8	0.7	0.07	0.08	1.0	0.9

Table 2. Yields and economics of rice as influenced by different cultural practices (pooled data)

Treatment	Grain yield(t ha^{-1})	Straw yield(t ha^{-1})	Net return(Rsha^{-1})	Benefit :cost ratio	Cost (Rsha^{-1})
T1	2.08	3.00	7223	1.18	6099
T2	3.05	4.57	11460	1.40	8166
T3	1.97	2.96	7265	1.34	5425
T4	3.00	4.48	11391	1.44	7878
T5	2.84	2.72	9530	1.16	8209
T6	2.67	3.99	8892	1.07	8258
T7	2.95	4.52	10386	1.22	8532
CD (P= 0.05)	2.55	3.1			

Price of rice grain Rs 5800 t^{-1} Straw: Rs 400 t^{-1}

T1-Random transplanting with 80 kg N +40 kg P_2O_5+40 kg K_2O ha^{-1} + one hand weeding (HW) at 30 days after transplanting (DAT)

T2- Transplanting at 20x10cm spacing + anilophos @ 0.4 kg a. i.ha^{-1} at 4 DAT + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at panicle initiation (PI)

T3- Broadcasting of sprouted seeds @ 100kg ha^{-1} + 80 kg N +40 kg P_2O_5 + 40 kg K_2O kg ha^{-1} (1/2 N + full P_2O_5 and K_2O at sowing)and rest N in 2 splits + one hand weeding at 35 DAS

T4- Seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder + anilophos @ 0.4 kg a.i.ha^{-1} at 4 DAS + one HW at 40 DAS and fertilizer as in T2

T5- Seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder one day after puddling + anilophos @ 0.4 kg a.i.ha^{-1} at 4 DAS + one HW at maximum tillering stage + 120 kg N + 60 kg P_2O_5 +40 kg K_2O + 25 kg $ZnSO_4$ kg ha^{-1} (N- 3 splits) + full P_2O_5 and 75% K_2O as basal, and 25% K_2O at PI stage

T6- Seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder two days after final puddling + fertilizer and weed control as inT5

T7- Direct seeding of rice in lines on 15th June @ 100 kg ha^{-1} + anilophos @ 0.4 kg a.i. ha^{-1} at 4-6 DAS + 2,4-D @0.5 kg ha^{-1} at 20 DAS + one hand weeding at 35 DAS + fertilizer as in T2

Table 3. Weed density and dry weight as influenced by different cultural practices (pooled data)

Treatment	Weed density/m^{-2}		Weed dry weight(t ha^{-1})	
	At PI stage	At harvest	At PI stage	At harvest
T1	82.45	74.60	3.12	2.73
T2	61.95	46.85	2.33	1.94
T3	92.55	85.00	5.77	5.29
T4	66.10	60.50	2.56	2.15
T5	85.70	78.00	3.51	3.09
T6	92.30	83.70	5.41	4.90
T7	67.60	60.60	2.65	2.23
CD (P=0.05)	3.98	3.08	3.40	3.32

transplanting (DAT) and broadcasting of sprouted seeds @ 100kg ha^{-1} + 80 kg N +40 kg P_2O_5 + 40 kg K_2O kg ha^{-1} (1/2 N + full P_2O_5 and K_2O at sowing) and rest N in 2 splits + one hand weeding at 35 DAS). This was because of higher values of all yield attributes owing to better establishment of rice crop, efficient control of weeds and use of balanced fertilizers. The straw yield also exhibited similar trend as in case of grain yield (Table 2).

Weed population and its dry weight both at PI stage and harvest were significantly affected due to different seeding methods (Table 3). The lowest weed population (61.95 and 46.85 m^{-2}) and dry weight (2.33 and 1.94 q ha^{-1}) at PI stage and harvest, respectively were recorded in plots with transplanting in lines. Yadav and Singh (2006) and Haldar and Patra (2007) also reported similar lower density and dry weight of weeds with drum seeding and transplanting method of crop establishment.

Thus, it can be concluded that transplanting in lines and direct seedling by drum seeder on the same day after puddling gave higher yield and net income over farmers' method of transplanting or broadcasting of seed under puddled condition. The highest net income of Rs. 11460 ha^{-1} was obtained with transplanting at 20x10cm spacing + anilophos @ 0.4 kg a. i.ha^{-1} at 4 DAT + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at however, benefit : cost ratio was highest (1.44) with seeding of sprouted seeds (80 kg ha^{-1}) by drum seeder + anilophos @ 0.4 kg a.i.ha^{-1} at 4 DAS + one HW at 40 DAS + 120 kg N+60 kg P_2O_5+40 kg K_2O+25 kg $ZnSO_4$ ha^{-1} (N -3 splits) + P_2O_5 and $ZnSO_4$ and 75% K_2O as basal and 25% K_2O at PI stage. Farmers' method of transplanting recorded the lowest net income due to lower grain yield (Table 2). Similar higher net income was reported with transplanting and drums seeder method of crop establishment by (Ravi Sankar, *et al.* (2008) and Yadav and Singh (2006).

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