I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS) Rating : 3. 03

Effect of Establishment Techniques, Weed Control and Integrated Nutrient Management on Growth, Yield and Quality of Drilled Rice. (*Oryza sativa* L.)"

V.Y. Kankal[1], U.V. Mahadkar[2], P.D. Chendge[3], M.M. Burondakar[4] and H.M. Patil[5]

ABSTRACT: *A field experiment was conducted during rainy (Kharif) seasons of 2013 and 2014 at Dapoli, Ratnagiri (Maharashtra) to study the effect of establishment techniques, weed control and integrated nutrient management on growth, yield and quality of drilled rice. (Oryza sativa L.). Flat bed sprouted seed sowing crop establishment technique recorded significantly higher grain yield of 37.77, 34.77 and 36.27 q/ha during the years 2013, 2014 and in pooled analysis respectively than raised bed dry seed sowing and raised bed sprouted seed sowing establishment techniques. Significantly the highest grain yield during both years as well as in pooled mean (38.37 q/ha), straw yield (56.71 q/ha) andprotein content during the both year was recorded in the treatment weed free check which was followed by the treatment of pre-emergence application of oxadiargyl @ 0.12 kg/ha + post- emergence application of bispyribac-sodium @ 0.025 kg/ha which were at par with each other but found significantly superior over the treatment of unweeded control. Among various integrated nutrient management methods, treatment recommended dose of fertilizer + FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo gave significantly highest value of pooled grain yield (33.15 q/ha)over rest of nutrient management treatments,whereas the same treatment gave significantly higher value of pooledstraw yield (49.83 q/ha)than treatment of recommended dose of fertilizer + FYM 5 t/haand was observed at par with the treatment of application of recommended dose of fertilizer + micronutrient foliar spray of Zn, B and Mo.*

Keywords: *Establishment techniques, weed control, integrated nutrient management, yield, quality.*

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food grain crop of the world which constitutes the principle food for about 60 per cent of the world's population. In India, rice cultivation contributes to the total food grain production by 43 per cent and to the total cereal grains production by 46 per cent. The Asia-Pacific region produces and consumes more than 90 percent of the world's rice. Rice based production system provides the income and employment for more than 50 million households. Therefore rice is not only a staple food of the region but also a way of life.Rice in *Konkan* is being grown mostly as puddled transplanted crop. However, puddling and transplanting require large amount of water and labour, both of which are becoming increasingly scarce and expensive, making rice production less profitable. Also, the drudgery involved in transplanting a job largely done by women is of serious concern.

All these factors demand a major shift from puddled-transplanted rice production to direct seeding of rice in irrigated areas [1]. Direct sowing in the form of drilling is a quicker, easier and economical method which needs specific seed rate for optimum plant population taking into consideration local agro-ecological conditions. However, the weed infestation is the main problem in case of direct seeded rice. This is because weed and crop seeds germinate at the same time resulting in greater competition for space, light, nutrients and moisture from early stage of crop growth which brings down the yield drastically. Research has been shown that, in the absence of effective weed control

[1,3&5] Ph. D. Scholar, (Agronomy); 2 Director of Research, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli; 4. Associate Professor, Department of Agril. Botany, College of Agriculture, Dapoli.
[4] Associate Professor, Department of Agril. Botany, College of Agriculture, Dapoli.

options, yield losses are greater in direct seeded rice than in transplanted rice [2]. Moreover, there are heavy losses of major as well as micronutrients in puddle or direct seeded rice in heavy rainfall area like *Konkan* region. The losses of nitrogenous fertilizers reach to 70 per cent or even more. Due to application of herbicides there may be set back on crop growth. Therefore, in order to maintain sustainable soil nutrient status and good crop growth it is necessary to apply organic manure as well as major and micronutrients to rice crop for sustainable productivity. Taking in to consideration these aspects a field experiment was undertaken.

MATERIAL AND METHODS

A field experiment was conducted for two consecutive years at Agronomy Farm, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) during rainy (*Kharif)* season of 2013 and 2014 in clay loam soil which was medium in available nitrogen (282.14 kg/ha), low in available phosphorus (10.76 kg/ha) and fairly high in available potassium (235.93 kg/ ha). In respect of micronutrients the soil was deficient in available zinc, boron and molybdenum content during the both years of experimentation. The field experiment was laid out in split-split plot design comprising 36 treatment combinations replicated thrice. Ratnagiri-24 variety was used. Main plot treatment consisted of four crop establishment techniques, raised bed dry seed sowing (E_1), raised bed sprouted seed sowing (E_2), flat bed dry seed sowing (E_3) and flat bed sprouted seed sowing (E_4).

The sub plot treatment consisted, unweeded control (W_1), weed free check (hand weed at 20, 40 and 60 days after sowing) (W_2) and pre-emergence application of oxadiargyl @ 0.12 kg/ha + post-emergence application of bispyribac-sodium @ 0.025 kg/ha (W_3) (15-20 DAS) while, sub-sub plot treatment comprised of three fertilizer management methods, recommended dose of fertilizer + FYM 5 t/ha(F_1), recommended dose of fertilizer + micronutrient foliar spray of Zn, B and Mo (F_2) (at 70 DAS) and recommended dose of fertilizer + FYM5 t/ha + micronutrient foliar spray of Zn, B and Mo (F_3) (at 70 DAS). The gross and net plot size of treatment was 3.60 m × 3.00 m and 3.15 m × 2.70 m, respectively. The raised beds having 120 cm bottom width, 90 cm top width and 15 cm height were opened by keeping 30 cm wide furrow between two adjacent beds. Furrows were opened by tractor operated ridger. The flat beds were prepared by using tractor operated bund former. The sowing of seeds was carried out by using manually operated four coulter drum seeder at about 3-5 cm depth with row spacing of 22.5 cm. After sowing, the seeds were covered with soil. FYM was applied in plots as per the treatments @ 5 t/ha after preparation of experimental layout. The crop was fertilized with 100 kg N, 50 kg P_2O_5 and 50 kg K_2O per hectare.

At the time of sowing of rice seed, 40 kg N and full P_2O_5 and K_2O was applied as basal dose. For top dressing of 40 kg N was applied at 30 DAS and 20 kg at 50 DAS (at panicle initiation). Micronutrients *viz.*, zinc ($ZnSO_4 \cdot 7H_2O$, 0.5%), boron (1ppm) and molybdenum (ammonium molybdate 0.02 kg/ha) was applied in combinations at the time of flowering as per treatments in the form of zinc sulphate heptahydrate, solubor and ammonium molybdate. The spray solution was made by mixing the required quantity of nutrients and half of its quantity of calcium hydroxide to neutralize the solution. 1000 litres of water per hectare was used for spray of micronutrients. At maturity, crop from each plot was harvested and threshed separately. Grain and straw were sun dried and weight was recorded for each plot and computed on hectare basis.

RESULTS AND DISCUSSION

Effect of Crop Establishment Techniques

It is observed from Table 1 and 2 that the plant height, total number of tillers per 0.5 m length, dry matter accumulation, number of filled grains per panicle and 1000 grain weight at harvest during both the years was not significantly influenced at harvest due to various crop establishment techniques under study. However, numerically the taller plants and higher panicle length were recorded intreatment of raised bed sprouted seed sowing (E_2) while number of tillers per 0.5 m length and dry matter accumulation were found to be numerically more in flat bed sprouted seed sowing (E_4) over rest of the treatments during both years of study. Similar results in case of dry matter accumulation were also reported by Tang *et al.* [3]. Javaid *et al.* [4] also reported higher number of filled spikelets/panicle and higher 1000 grain weight by sowing on flat bed using soaked seed. This crop establishment technique recorded significantly higher grain yield of 37.77, 34.77 and 36.27 q/ha during the years 2013, 2014 and in pooled analysis (Table 3) respectively than

Table 1
Growth and yield parameters of rice as influenced by different crop establishment techniques, weed control methods and fertilizermanagement methods during Kharif 2013 and 2014.

Treatment	*Plant height (cm)*			*Total tillers (per 0.5 m length)*			*Dry matter accumulation (g)*		
	2013	*2014*	*Mean*	*2013*	*2014*	*Mean*	*2013*	*2014*	*Mean*
(A) Crop establishment techniques (sowing by drum seeding)									
E_1- Raised bed dry seed sowing	72.29	70.43	71.36	33.75	32.16	32.96	58.05	55.56	56.81
E_2- Raised bed sprouted seed sowing	74.33	72.40	73.37	34.38	33.64	34.01	59.24	58.19	58.72
E_3- Flat bed dry seed sowing	70.41	68.64	69.53	33.88	34.25	34.07	60.20	59.95	60.08
E_4- Flat bed sprouted seed sowing	71.94	69.74	70.84	35.22	33.99	34.61	60.94	60.46	60.70
S.Em. ±	1.65	1.66		1.05	1.29		1.72	2.13	
C.D. at 5%	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
(B) Weed control methods									
W_1- Unweeded control	67.07	65.20	66.14	28.95	27.85	28.40	57.13	56.48	56.81
W_2- Weed free check (hand weeding (20, 40 and 60 DAS))	75.04	73.05	74.05	37.78	37.08	37.43	61.67	60.37	61.02
W_3-Pre-em. Application of oxadiargyl @ 0.12 kg/ha +post-em. application of bispyribac-sodium @ 0.025 kg/ha	74.61	72.66	73.64	36.19	35.61	35.90	60.01	58.77	59.34
S.Em. ±	1.01	0.92		0.57	0.53		0.62	0.99	
C.D. at 5%	2.87	2.63		2.87	2.63		1.77	2.83	
(C) Fertilizer management methods									
F_1- RDF (100:50:50 kg N, P_2O_5 and K_2O/ha) + FYM 5 t/ha	69.81	68.06	68.94	33.36	32.51	32.94	58.28	56.74	57.51
F_2- RDF + micronutrient foliar spray of Zn, B and Mo	72.95	70.88	71.92	34.57	33.94	34.26	60.26	59.21	59.74
F_3- RDF+FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo	73.95	71.96	72.96	34.99	34.08	34.54	60.28	59.68	59.98
S.Em. ±	1.21	0.96		0.44	0.42		0.63	0.75	
C.D. at 5%	3.43	2.74		1.24	1.19		1.80	2.13	
Interaction effect									
A × *B*	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
A × *C*	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
B × *C*	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
A × *B* × *C*	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
General mean	*72.24*	*70.30*		*34.31*	*33.51*		*59.61*	*58.54*	

DAS = Days after sowing, Pre-em. = Pre-ememergence.

raised bed dry seed sowing and raised bed sprouted seed sowing establishment techniques (Table 3). Increase in grain yield under flat bed sprouted seed sowing crop establishment technique was to the tune of 36.85, 35.24 and 36.47% over raised bed dry seed sowing technique and 26.62, 23.47 and 25.11% over raised bed sprouted seed sowing technique during the years 2013, 2014 and in pooled data, respectively. Similar trend was also observed in straw yield during both the years of experimentation and in pooled analysis. This was mainly because there were 25% more plants on flat bed. These results corroborated the findings of Choudhury and Singh [5] and Hussain *et al.* [6]. The treatment of flat bed sprouted seed sowing (E_4) recorded the numerically higher value of protein content 7.23% and 7.14% in year 2013 and 2014 respectively, (Table 3) over raised bed dry seed sowing (E_1). These results are in close confirmation with the results reported by Kumar *et al.* [7].

Effect of Weed Control Methods

Significantly the highest plant height, total number of tillers per 0.5 m length, dry matter accumulation, panicle length, number of filled grains/panicle, 1000 grain weight, grain yield and straw yield at harvest was recorded in the treatment weed free check (W_2) which was followed by the treatment of pre-emergence application of oxadiargyl @ 0.12 kg/ha + post-emergence application of bispyribac-sodium @ 0.025 kg/ha which were at par with each other but found significantly superior over the treatment of unweeded control during the both year of investigation. This might be due to effective control of weeds and

Table 2
Yield attributes of rice as influenced by different crop establishment techniques, weed control methods and fertilizer management methods during Kharif 2013 and 2014

Treatment	*Panicle length (cm)*			*No. of filled grains/panicle*			*1000 grain weight (g)*		
	2013	*2014*	*Mean*	*2013*	*2014*	*Mean*	*2013*	*2014*	*Mean*
(A) Crop establishment techniques (sowing by drum seeding)									
E_1- Raised bed dry seed sowing	19.91	18.25	19.08	110.16	96.64	103.40	15.20	14.95	15.08
E_2- Raised bed sprouted seed sowing	20.69	19.09	19.89	115.02	101.08	108.05	15.36	15.09	15.23
E_3- Flat bed dry seed sowing	20.56	18.96	19.76	112.40	99.87	106.14	15.60	15.54	15.57
E_4- Flat bed sprouted seed sowing	20.23	19.00	19.62	120.97	103.59	112.28	15.70	15.57	15.64
S.Em. ±	0.32	0.23		4.40	2.81		0.12	0.18	
C.D. at 5%	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
(B) Weed control methods									
W_1-Unweeded control	19.63	18.05	18.84	86.34	93.73	90.04	14.94	14.88	14.91
W_2-Weed free check (hand weeding (20, 40 and 60 DAS)	20.97	19.46	20.22	130.09	105.09	117.59	15.79	15.58	15.69
W_3-Pre-em. Application of oxadiargyl @ 0.12 kg/ha + post-em. application of bispyribac-sodium @ 0.025 kg/ha	20.45	18.97	19.71	127.48	102.06	114.77	15.66	15.41	15.54
S.Em. ±	0.23	0.19		4.08	2.55		0.07	0.07	
C.D. at 5%	0.65	0.54		11.60	7.26		0.21	0.21	
(C) Fertilizer management methods									
F_1- RDF (100:50:50 kg N, P_2O_5 and K_2O/ha) + FYM 5 t/ha	19.78	18.27	19.03	106.44	96.18	101.31	15.30	15.03	15.17
F_2- RDF + micronutrient foliar spray of Zn, B and Mo	20.45	18.87	19.66	117.83	101.96	109.90	15.49	15.32	15.41
F_3- RDF+FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo	20.81	19.35	20.08	119.64	102.75	111.20	15.60	15.51	15.56
S.Em. ±	0.22	0.19		3.32	1.75		0.06	0.09	
C.D. at 5%	0.64	0.55		9.44	4.97		0.16	0.25	
Interaction effect									
A × *B*	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
A × *C*	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
B × *C*	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
A × *B* × *C*	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
General mean	*20.35*	*18.83*		*114.64*	*100.29*		*15.46*	*15.29*	

DAS = Days after sowing, Pre-em. = Pre-ememergence.

thereby reduced crop weed competition and better crop growth which might have helped in the synchronization of yield attributes.

These results are in agreement with the results with respect to growth and yield attributes reported by Ganie *et al.* [8] and with respect to yield as reported by Walia *et al.* [9]. From different weed control methods treatment weed free check produced higher protein content in grain *i.e.* 7.47% and 7.44% in year 2013 and 2014 respectively, followed by the pre-emergence application of oxadiargyl @ 0.12 kg/ha + post-emergence application of bispyribac-sodium @ 0.025 kg/ha which was statistically at par each other but found significantly superior over unweeded control during both years of experiment. These results are in close concurrence with the findings of Singh and Namdeo [10].

Effect of Fertilizer Management Methods

Significantly more plant height, total number of tillers per 0.5 m lengthand dry matter accumulation at harvest was recorded in treatment of recommended dose of fertilizer + FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo (F_3) than treatment of recommended dose of fertilizer + FYM 5 t/ha(F_1) and was observed to at par with the treatment of application of recommended dose of fertilizer + micronutrient foliar spray of Zn, B and Mo (F_2) at harvest during both the years of study. The higher number of tillers and dry matter accumulation in treatment of recommended dose of fertilizer + FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo (F_3) might have ultimately resulted into more transformations in the sink resulting into significantly higher yield attributes *viz.*, higher number of filled

Table 3
Mean yield, pooled mean yield and protein content ofrice as influenced by different crop establishment techniques, weed control methods and fertilizer management methods during Kharif 2013 and 2014

Treatment	*Grain yield (q/ha)*			*Straw yield (q/ha)*			*Protein content in grain (%)*		
	2013	*2014*	*Pooled Mean*	*2013*	*2014*	*Pooled Mean*	*2013*	*2014*	*Mean*
(A) Crop establishment techniques (sowing by drum seeding)									
E_1- Raised bed dry seed sowing	27.60	25.71	26.65	41.95	39.83	40.89	7.04	6.85	6.95
E_2- Raised bed sprouted seed sowing	29.83	28.16	28.99	45.46	43.10	44.28	7.01	7.07	7.04
E_3- Flat bed dry seed sowing	34.49	32.44	33.47	52.01	49.19	50.60	7.32	7.16	7.24
E_4- Flat bed sprouted seed sowing	37.77	34.77	36.27	55.78	51.64	53.71	7.23	7.14	7.19
S.Em. ±	1.16	1.10	0.80	1.78	1.72	1.24	0.19	0.23	
C.D. at 5%	4.00	3.81	2.46	6.17	5.95	3.82	N.S.	N.S.	
(B) Weed control methods									
W_1- Unweeded control	19.29	17.58	18.44	31.65	29.30	30.47	6.59	6.53	6.56
W_2- Weed free check (hand weeding (20,40and 60 DAS))	39.58	37.16	38.37	58.34	55.14	56.71	7.47	7.44	7.46
W_3-Pre-em. Application of oxadiargyl @ 0.12 kg/ha +post-em. application of bispyribac-sodium @ 0.025 kg/ha	38.40	36.07	37.23	56.40	53.38	54.89	7.40	7.19	7.30
S.Em. ±	0.62	0.62	0.44	0.93	0.99	0.68	0.18	0.19	
C.D. at 5%	1.76	1.78	1.27	2.64	2.81	1.95	0.50	0.54	
(C) Fertilizer management methods									
F_1- RDF (100:50:50 kg N, P_2O_5 and K_2O/ha) + FYM 5 t/ha	29.81	27.61	28.71	44.93	42.10	43.52	7.03	6.94	6.99
F_2- RDF + micronutrient foliar spray of Zn, B and Mo	33.20	31.17	32.18	50.01	47.52	48.77	7.17	7.07	7.12
F_3- RDF + FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo	34.26	32.03	33.15	51.45	48.20	49.83	7.25	7.15	7.20
S.Em. ±	0.41	0.38	0.28	0.66	0.71	0.48	0.14	0.16	
C.D. at 5%	1.16	1.09	0.78	1.87	2.02	1.36	N.S.	N.S.	
Interaction effect									
A × B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	
A × C	N.S.	N.S.	SIG	N.S.	N.S.	SIG	N.S.	N.S.	
B × C	N.S.	N.S.	SIG	N.S.	N.S.	SIG	N.S.	N.S.	
A × B × C	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	
General mean	*32.42*	*30.27*	*31.35*	*48.80*	*45.94*	*47.37*	7.15	7.05	

DAS = Days after sowing, Pre-em. = Pre-ememergence.

grains/panicle and higher 1000 grain weight during both the years of experiment.

Table 4
Grain yield (q/ha) of rice as influenced by interaction effects between crop establishment techniques × fertilizer management methods.

Treatment	*Pooled data*		
	F_1	F_2	F_3
E_1	24.29	27.44	28.23
E_2	27.77	29.39	29.83
E_3	29.64	34.31	36.44
E_4	33.14	37.59	38.09
S.Em. ±		0.56	
C.D. at 5%		1.57	

The panicle length, number of filled grains/ panicle, 1000 grain weight, grain yield and straw yield also followed the similar trend during both the years of study. But from the pooled data, (Table 3) among various integrated nutrient management treatment of recommended dose of fertilizer + FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo (F_3) gave significantly highest grain yield (33.15 q/ha) over rest nutrient management treatments. These results corroborated the findings Singaravel *et al.* [11]. In respect of quality parameters, protein content of grain were found to be numerically higher in treatment of recommended dose of fertilizer + FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo (F_3) during both the years of study and recorded 7.25% and 7.15% protein content in year 2013 and 2014 respectively. Singh and Namdeo [10] observed increase in seed protein significantly with increasing fertility levels.

Table 5
Grain yield (q/ha) of rice as influenced by interaction effects between weed control × fertilizer management methods.

Treatment	*Pooled data*		
	F_1	F_2	F_3
W_1	14.69	19.93	20.70
W_2	36.27	38.69	40.14
W_3	35.18	37.93	38.60
S.Em. ±		0.48	
C.D. at 5%		1.36	

Interaction effects of crop establishment techniques, weed control methods and fertilizer management methods

The interaction effects with respect to crop establishment techniques × fertilizer management methods were found to be significant in pooled analysis of two years (Table 4). The treatment combination of sprouted seed rice sown on flat bed when applied with RDF + FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo (E_4F_3) recorded significantly the highest grain yield (38.09 q/ha) over all other combinations, except treatment combination of sprouted seed rice sown on flat bed when applied with RDF + micronutrient foliar spray of Zn, B and Mo (E_4F_2). The combination of sprouted seed rice sown on flat bed when applied with RDF + FYM5 t/ha + micronutrient foliar spray of Zn, B and Mo (E_4F_3) also recorded significantly the highest straw yield (Table 6) over all other combinations, but it was found to be statistically at par with treatment combination of E_4F_2 and E_3F_3.

Table 6
Straw yield (q/ha) of rice as influenced by interaction effects between crop establishment techniques × fertilizer management methods.

Treatment	*Pooled data*		
	F_1	F_2	F_3
E_1	37.38	42.16	43.13
E_2	42.53	45.09	45.21
E_3	44.86	52.30	54.64
E_4	49.29	55.52	56.33
S.Em. ±		0.97	
C.D. at 5%		2.71	

The interaction between weed control methods × fertilizer management methods was significant when pooled over two years (Table 5 and 7). The treatment combination of weed free check (hand weeding 20,40 and 60 DAS) with RDF + FYM 5 t/ha + micronutrient foliar spray of Zn, B and Mo (W_2F_3) gave significantly the highest grain yield (40.14 q/ha) over rest of treatment combinations whereas, same treatment combination was found to be significantly superior over rest of treatment combinations, except treatment combination of W_2F_2 and W_3F_3 with respect to straw yield.

Table 7
Straw yield (q/ha) of rice as influenced by interaction effects between weed control × fertilizer management methods.

Treatment	*Pooled data*		
	F_1	F_2	F_3
W_1	24.41	33.07	33.95
W_2	53.88	57.43	58.92
W_3	52.26	55.81	56.61
S.Em. ±		0.84	
C.D. at 5%		2.35	

REFERENCES

Virender Kumar and Jaggdish K. Ladha (2011), Direct seeding of rice : recent developments and future research needs. *Advances in Agron*. **111:** 297-301.

Rao, A.N.; Johnson, D.E.; Sivaprasad, B.; Ladha, J.K. and Mortimer, A.M. (2007), Weed management in direct-seeded rice. *Adv. Agron*. **93**:153–255.

Tang, Y., Huang, G., Dend, X. and Zheng, J. (2006), Preliminary study on raised-bed planting for common wheat after rice in Sichuan basin. *Southwest China J. Agric. Sci*. **19**(6): 1049-1053.

Javaid, T., Awan, I.U., Baloch, M.S., Shah, I.H., Nadim, M.A., Khan, E.A., Khakwani., A.A. and Abuzar, M.R. (2012), Effect of planting methods on the growth and yield of coarse rice. *J. Anim. Plant Sci*. **22**(2): 358-362.

Choudhury, B.U. and Singh, A.K. (2007), Performance of rice (Oryza sativa) planted on raised-bed under different soil-moisture tensions. *Indian J. Agron*. **52**(4): 305-310.

Hussain, S., Ramzan, M., Rana, M. A., Mann, R. A. and Akhter, M. (2013), Effect of various planting techniques on yield and yield components of rice *J. Anim. Plant Sci*. **23**(2): 672-674.

Kumar, A., Shivay, Y. S. and Pandey, J. (2007), Effect of crop establishment methods and weed control practices on weed dynamics, productivity, nutrient removal by weeds vis-a-vis crop and quality of aromatic rice (*Oryza sativa*). *Indian J. Agric. Sci*. **77**(3): 179-183.

Gaine, Z.A., Singh, S., and Singh, S. (2013), Effect of seed rate and weed control methods on yield of direct-seeded rice (*Oryza sativa*). *Indian J. Agron*. **58**(1): 125-126.

Walia, U.S., Walia, S.S., Sidhu, A.S. and Nayyar, S. (2012), Efficacy of pre- and post-emergence herbicides in direct-seeded rice in Central Punjab. *Indian J. of Weed Sci.* **44**(1): 30-33.

Singh, R. K. and Namdeo, K. N. (2004), Effect of fertility levels and herbicides on growth, yield and nutrient uptake of direct-seeded rice (*Oryza sativa*). *Indian J. Agron*. **49**(1): 34-36.

Singaravel, R., Elayaraja, D. and Radhika, K. (2007), Study on the multi micronutrients foliar nutrition on the growth and physiology of rice. *Plant Archives*. **7**(2): 677-678.