Original Research Article

Studies on nutrient and weed dynamics on growth and yield attributes of direct seeded rice

ABSTRACT

Field experiment was carried out during *kharif* 2020 and 2021 at wetland farm of S. V. agricultural College, ~~Tirupati,~~ Andhra Pradesh. The experiment was laid out in a split plot design with three replications. The treatments consisted of three main plots *viz*., 100 % RDF (N_1), 125 % RDF (N_2) and 150 % RDF (N_3) and five sub plots *viz*., Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS (W_1), Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS (W_2), Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS (W_3), hand weeding twice at 20 and 40 DAS (W_4) and unweeded check (W_5). Nutrient levels and weed management practices significantly influenced the growth parameters *viz*., plant height, number of tillers m^{-2} and dry matter production and yield attributes *viz*., number of panicles m^{-2}, total number of grains $panicle^{-1}$ and number of filled grains $panicle^{-1}$ of direct seeded rice during both the years of investigation as well as in pooled mean. ~~Interaction effect due to nutrient levels and weed management practices on growth parameters and yield attributes was found to be significant during both the years of study and in the pooled mean.~~ On growth parameters and yield attributes, an interaction effect caused by nutrient levels and weed management techniques was shown to be significant over the course of the study's years and in the pooled mean.

Keywords: Direct seeded rice, growth parameters, yield attributes

1. INTRODUCTION

Rice has been traditionally cultivated by transplanting seedlings into puddled soils and submerging the area. Standing water in the field causes macropore clogging, soil aggregate breakup in puddled soils, and the creation of hard pans beneath the subsurface layers of soils, as

Comment [s1]: No need

Comment [s2]: Of soil,

well as effective weed control. But, the sustainability of transplanted rice system is under jeopardy due to several production-related constraints, *viz*., water, labour and energy scarcity, during peak period of demand and growing environmental concerns.

~~Transplanting of rice can be delayed due to late start of monsoon rainfall and the discharge of water into canals, as well as drudgery of puddling and physical transplanting.~~ Under traditional system of rice cultivation, it takes around 5000 litres of water in order to produce 1 kg of rice (IRRI, 2001). As a result, rice production techniques that are not only able to cope with existing limits but also inexpensive, economically feasible, ~~and capable of fulfilling future food demand must be investigated.~~ In this context, direct seeded rice (DSR) is being assessed as viable alternative resource conservation method to address the problems interrelated with traditional rice farming in the face of looming agricultural resource shortages (Pandey and Velasco, 2002).

Direct seeded rice is subjected to greater weed competition than transplanted rice because both weed and crop seeds emerge at the same time and compete with each other right from its germination time resulting huge loss in grain yield (Rao *et al*., 2007). Diverse and intensified weed flora can be controlled by pre emergence herbicides in combination with post emergence herbicides. In addition to weed management problems in DSR, the nutrient management is also very difficult. ~~Various researches under direct seeded rice have been conducted on nutrient and weed management practices in alone.~~ Numerous studies on nutrient and weed management techniques have been done specifically for straight seeded rice. The combined effect of nutrient levels and weed management practices may have different impacts than their individual effects considering better plant growth under effective weed management practices thus the nutritional requirement of the crop may change.

2. MATERIAL AND METHODS

The experiment was conducted during *kharif*, 2020 & 2021 at wetland farm of S. V. Agricultural College, Tirupati, Andhra Pradesh geographically situated at 13.5°N latitude and 79.5°E longitude and at an altitude of 182.9 m above the mean sea level in the Southern Agro-Climatic Zone of Andhra Pradesh. ~~The experimental soil was sandy clay loam in texture, slightly alkaline in reaction, low in organic carbon and available nitrogen and medium in available~~

~~phosphorus and available potassium.~~ The experimental soil had a sandy clay loam texture, a reaction that was somewhat alkaline, low levels of organic material carbon and nitrogen, and medium levels of available phosphorus and potassium. The treatments in main plot consisted of three nutrient levels *viz*., 100 % RDF (N_1), 125 % RDF (N_2) and 150 % RDF (N_3) under main plots and five weed management practices comprised to sub plots *viz*., ., Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS (W_1), Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS (W_2), Pre emergence (PE) application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS (W_3), hand weeding twice at 20 and 40 DAS (W_4) and unweeded check (W_5). Pre emergence herbicide was applied immediately after sowing of rice crop and post emergence herbicides were imposed at 20 DAS. The rice variety chosen for the experiment was NLR-34449 and adopted a spacing of 20 cm x 10 cm. Nutrients *viz*., nitrogen, phosphorus and potassium in the form of urea, single super phosphate and muriate of potash, respectively were applied as per the treatments . Nitrogen was applied in three splits at 15 DAS, tillering and at panicle initiation stages. Entire quantity of phosphorus was applied at the time of sowing and potassium was applied in two splits, ½ at the time of sowing and the remaining ½ at panicle initiation stage~~. Observations on growth and yield attributes of direct seeded rice was recorded at the time of harvest and the data~~ At the time of harvest, observations on the growth and yield characteristics of direct-seeded rice were collected, and the data was statistically analyzed by following the analysis of variance for split plot design as suggested by the Panse and Sukhatme (1985). Statistical significance was tested with F test at 5 per cent level of probability and compared the treatmental means with critical difference.

3. RESULTS AND DISCUSSION

A. Effect of nutrient levels on growth and yield attributes of direct seeded rice

Growth parameters like plant height, number of tillers m^{-2} and dry matter production and yield attributes *viz*., number of panicles m^{-2}, total number of grains $panicle^{-1}$ and number of filled grains $panicle^{-1}$ at harvest followed similar trend. Significantly higher values of above parameters viz., plant height, number of tillers m^{-2}, dry matter production number of panicles m^{-2}, total number of grains $panicle^{-1}$ and number of filled grains $panicle^{-1}$ were obtained with 150 % RDF (N_3) than rest of the nutrient levels during both the years of study and in the pooled mean.

Adequate supply of nutrients at different growth stages of crop might have enhanced the greater uptake of nutrients by the crop that lead to better crop growth. Similar results were reported by Kumar *et al*. (2022). The next best nutrient level in obtaining higher values was 125 % RDF (N_2) which was significantly superior to 100 % RDF (N_1) during both the years of study and in the pooled mean.

B. Effect of weed management practices on growth and yield attributes of direct seeded rice

Among the different weed management practices, higher values of plant height, number of tillers m^{-2} and dry matter production and yield attributes *viz*., number of panicles m^{-2}, total number of grains $panicle^{-1}$ and number of filled grains $panicle^{-1}$ at harvest were obtained with hand weeding twice at 20 and 40 DAS (W_4) which was statistically comparable with PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS (W_2) during both the years of study and in the pooled mean. This might be due to reduced weed infestation as evident from lower weed density and biomass that facilitated for better utilization of growth resources which enhanced the vegetative and reproductive potential of the crop. The results are in accordance with those of Yadav *et al*. (2018). The next best weed management practice was PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS (W_1) followed by PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS (W_3) with significant disparity among them. The lowest values of plant height, number of tillers m^{-2} and dry matter production and yield attributes *viz*., number of panicles m^{-2}, total number of grains $panicle^{-1}$ and number of filled grains $panicle^{-1}$ at harvest were registered with unweeded check (W_5) during both the years of study and in the pooled mean. This was obviously due to severe competition offered by the weeds for growth resources right from the seedling emergence leading to poor crop growth and ~~inefficient translocation of photosynthates from source to sink which lead to diminished yield attributes of rice~~ ineffective photosynthetic transport from source to sink caused rice yield characteristics to deteriorate.

Among the various combinations of nutrient levels and weed management practices, significantly higher plant height, number of tillers m^{-2} and dry matter production and yield attributes *viz*., number of panicles m^{-2}, total number of grains $panicle^{-1}$ and number of filled

Table 1. Growth parameters of direct seeded rice as influenced by nutrient levels and weed management practices at harvest

Treatments	Plant height (cm)			Number of tillers m^{-2} (No. m^{-2})			Dry matter production (kg ha^{-1})		
	2020	**2021**	**Pooled**	**2020**	**2021**	**Pooled**	**2020**	**2021**	**Pooled**
Nutrient levels									
N_1 : 100 % RDF	57.3	53.1	55.2	181	152	166	5468	4811	5139
N_2 : 125 % RDF	68.4	63.3	65.8	220	190	205	6769	5937	6353
N_3 : 150 % RDF	74.6	69.0	71.8	240	211	225	7454	6560	7007
SEm ±	**1.45**	**1.34**	**1.40**	**4.5**	**4.9**	**4.2**	**159.2**	**146.5**	**161.3**
CD (P=0.05)	**5.7**	**5.3**	**5.5**	**18**	**19**	**16**	**625**	**575**	**633**
Weed management practices									
W_1 : PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS	63.9	59.1	61.5	201	169	185	6395	5628	6011
W_2 : PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyle + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS	83.0	76.8	79.9	283	253	268	8572	7510	8041
W_3 : PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS	57.2	53.0	55.1	165	133	149	5522	4860	5191
W_4 : Hand weeding twice at 20 and 40 DAS	86.6	80.2	83.4	299	269	284	8917	7847	8382
W_5 : Unweeded check	43.0	39.9	41.5	120	97	108	3411	3002	3207
SEm ±	**1.41**	**1.31**	**1.36**	**6.5**	**6.0**	**6.9**	**147.8**	**130.2**	**131.8**
CD (P=0.05)	**4.1**	**3.8**	**4.0**	**20**	**18**	**21**	**431**	**380**	**385**
Interaction									
N at W									
SEm ±	**3.39**	**3.13**	**3.26**	**12.9**	**13.7**	**13.0**	**360.1**	**321.8**	**335.9**
CD (P=0.05)	**10.9**	**10.1**	**10.5**	**41**	**43**	**41**	**1169**	**1051**	**1110**
W at N									
SEm ±	**2.44**	**2.26**	**2.35**	**9.5**	**10.5**	**9.8**	**256.0**	**225.5**	**228.3**
CD (P=0.05)	**7.1**	**6.6**	**6.9**	**28**	**30**	**29**	**747**	**658**	**666**

Table 2. Interaction effect of nutrient levels and weed management practices on plant height (cm) of direct seeded rice at harvest

Treatments	2020-21				2021-22				Pooled			
	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)
W_1	52.3	66.7	72.6	**63.9**	48.4	61.7	67.2	**59.1**	50.4	64.2	69.9	**61.5**
W_2	72.0	85.4	91.6	**83.0**	66.7	79.1	84.8	**76.8**	69.4	82.2	88.2	**79.9**
W_3	53.2	56.5	62.0	**57.2**	49.2	52.3	57.5	**53.0**	51.2	54.4	59.7	**55.1**
W_4	72.5	92.2	95.2	**86.6**	67.1	85.3	88.1	**80.2**	69.8	88.8	91.7	**83.4**
W_5	36.6	41.1	51.4	**43.0**	33.9	38.1	47.6	**39.9**	35.3	39.6	49.5	**41.5**
Mean (N)	**57.3**	**68.4**	**74.6**		**53.1**	**63.3**	**69.0**		**55.2**	**65.8**	**71.8**	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
N	**1.45**	**5.7**	**1.34**	**5.3**	**1.40**	**5.5**
W	**1.41**	**4.1**	**1.31**	**3.8**	**1.36**	**4.0**
N at W	**3.39**	**10.9**	**3.13**	**10.1**	**3.26**	**10.5**
W at N	**2.44**	**7.1**	**2.26**	**6.6**	**2.35**	**6.9**

Table 3. Interaction effect of nutrient levels and weed management practices on number of tillers (No. m^{-2}) of direct seeded rice at harvest

Treatments	2020-21				2021-22				Pooled			
	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)
W_1	146	211	245	**201**	114	179	213	**169**	130	195	229	**185**
W_2	249	292	309	**283**	218	263	277	**253**	234	278	293	**268**
W_3	141	163	191	**165**	109	131	159	**133**	125	147	175	**149**
W_4	259	311	326	**299**	229	280	299	**269**	244	295	313	**284**
W_5	110	121	127	**120**	90	96	104	**97**	100	109	115	**108**
Mean (N)	**181**	**220**	**240**		**152**	**190**	**211**		**166**	**205**	**225**	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
N	**4.5**	**18**	**4.9**	**19**	**4.2**	**16**
W	**6.5**	**20**	**6.0**	**18**	**6.9**	**21**
N at W	**12.9**	**41**	**13.7**	**43**	**13.0**	**41**
W at N	**9.5**	**28**	**10.5**	**30**	**9.8**	**29**

Table 4. Interaction effect of nutrient levels and weed management practices on dry matter production (kg ha^{-1}) of direct seeded rice at harvest

Treatments	2020-21				2021-22				Pooled			
	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)
W_1	4890	6903	7392	**6395**	4303	6074	6505	**5628**	4597	6488	6949	**6011**
W_2	7443	8803	9469	**8572**	6550	7647	8332	**7510**	6997	8225	8901	**8041**
W_3	4748	5607	6213	**5522**	4178	4934	5467	**4860**	4463	5270	5840	**5191**
W_4	7492	9500	9761	**8917**	6593	8360	8590	**7847**	7042	8930	9175	**8382**
W_5	2765	3034	4435	**3411**	2433	2670	3903	**3002**	2599	2852	4169	**3207**
Mean (N)	**5468**	**6769**	**7454**		**4811**	**5937**	**6560**		**5139**	**6353**	**7007**	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
N	**159.2**	**625**	**146.5**	**575**	**161.3**	**633**
W	**147.8**	**431**	**130.2**	**380**	**131.8**	**385**
N at W	**360.1**	**1169**	**321.8**	**1051**	**335.9**	**1110**
W at N	**256.0**	**747**	**225.5**	**658**	**228.3**	**666**

Table 5. Yield attributes of direct seeded rice as influenced by nutrient levels and weed management practices

Treatments	Number of panicles (No. m^{-2})			Total number of grains $panicle^{-1}$			Number of filled grains $panicle^{-1}$		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
Nutrient levels									
N_1 : 100 % RDF	131	110	121	102	99	100	88	85	87
N_2 : 125 % RDF	159	138	149	116	113	115	100	98	99
N_3 : 150 % RDF	174	153	163	128	125	126	110	108	109
SEm ±	**3.0**	**3.5**	**3.2**	**2.5**	**2.7**	**2.6**	**2.1**	**2.2**	**2.0**
CD (P=0.05)	**12**	**14**	**13**	**10**	**11**	**10**	**8**	**9**	**8**
Weed management practices									
W_1 : PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* penoxsulam + cyhalofop-p-butyl 125 g ha^{-1} at 20 DAS	146	123	134	111	107	109	95	93	94
W_2 : PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyle + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS	206	183	195	141	138	139	121	119	120
W_3 : PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* bispyribac-sodium 20 g ha^{-1} at 20 DAS	120	97	108	99	96	98	86	83	84
W_4 : Hand weeding twice at 20 and 40 DAS	217	195	206	148	144	146	127	125	126
W_5 : Unweeded check	87	70	78	79	76	77	68	65	67
SEm ±	**3.7**	**4.4**	**4.0**	**2.3**	**2.1**	**2.3**	**2.0**	**1.9**	**2.0**
CD (P=0.05)	**11**	**13**	**12**	**7**	**6**	**7**	**6**	**6**	**6**
Interaction									
N at W									
SEm ±	**8.3**	**9.9**	**9.1**	**5.6**	**5.4**	**5.4**	**4.8**	**4.8**	**4.7**
CD (P=0.05)	**26**	**31**	**28**	**18**	**18**	**18**	**16**	**16**	**15**
W at N									
SEm ±	**6.4**	**7.6**	**7.0**	**4.0**	**3.6**	**3.7**	**3.4**	**3.3**	**3.4**
CD (P=0.05)	**19**	**22**	**20**	**12**	**10**	**11**	**10**	**10**	**10**

Table 6. Interaction effect of nutrient levels and weed management practices on number of panicles (No. m^{-2}) of direct seeded rice

Treatments	2020-21				2021-22				Pooled			
	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)
W_1	106	153	178	**146**	83	130	155	**123**	95	142	166	**134**
W_2	181	212	224	**206**	158	191	201	**183**	170	202	213	**195**
W_3	102	118	139	**120**	79	95	116	**97**	91	107	127	**108**
W_4	188	226	237	**217**	166	203	217	**195**	177	215	227	**206**
W_5	80	88	92	**87**	65	70	75	**70**	73	79	84	**78**
Mean (N)	**131**	**159**	**174**		**110**	**138**	**153**		**121**	**149**	**163**	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
N	**3.0**	**12**	**3.5**	**14**	**3.2**	**13**
W	**3.7**	**11**	**4.4**	**13**	**4.0**	**12**
N at W	**8.3**	**26**	**9.9**	**31**	**9.1**	**28**
W at N	**6.4**	**19**	**7.6**	**22**	**7.0**	**20**

Table 7. Interaction effect of nutrient levels and weed management practices on total number of grains panicle^{-1}of direct seeded rice

Treatments	2020-21				2021-22				Pooled			
	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)
W_1	91	114	127	**111**	88	111	123	**107**	90	112	125	**109**
W_2	127	141	154	**141**	124	139	151	**138**	125	140	153	**139**
W_3	91	95	112	**99**	88	92	109	**96**	89	94	110	**98**
W_4	128	156	160	**148**	125	153	156	**144**	126	154	158	**146**
W_5	74	75	88	**79**	70	72	85	**76**	72	73	87	**77**
Mean (N)	**102**	**116**	**128**		**99**	**113**	**125**		**100**	**115**	**126**	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
N	**2.5**	**10**	**2.7**	**11**	**2.6**	**10**
W	**2.3**	**7**	**2.1**	**6**	**2.3**	**7**
N at W	**5.6**	**18**	**5.4**	**18**	**5.4**	**18**
W at N	**4.0**	**12**	**3.6**	**10**	**3.7**	**11**

Table 8. Interaction effect of nutrient levels and weed management practices on number of filled grains panicle^{-1} of direct seeded rice

Treatments	2020-21				2021-22				Pooled			
	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)	N_1	N_2	N_3	Mean (W)
W_1	79	98	109	**95**	76	96	106	**93**	77	97	108	**94**
W_2	109	122	133	**121**	107	119	130	**119**	108	120	132	**120**
W_3	78	82	96	**86**	76	80	94	**83**	77	81	95	**84**
W_4	110	134	138	**127**	108	132	134	**125**	109	133	136	**126**
W_5	64	65	76	**68**	60	62	73	**65**	62	63	75	**67**
Mean (N)	**88**	**100**	**110**		**85**	**98**	**108**		**87**	**99**	**109**	

	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)	SEm±	CD (P=0.05)
N	**2.1**	**8**	**2.2**	**9**	**2.0**	**8**
W	**2.0**	**6**	**1.9**	**6**	**2.0**	**6**
N at W	**4.8**	**16**	**4.8**	**16**	**4.7**	**15**
W at N	**3.4**	**10**	**3.3**	**10**	**3.4**	**10**

grains panicle^{-1} at harvest were observed with 150 % RDF coupled with hand weeding twice at 20 and 40 DAS (N_3W_4) which was statistically comparable with 125 % RDF coupled with hand weeding twice at 20 and 40 DAS (N_2W_4) and 150 % RDF coupled with PE application of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS (N_3W_2). The lowest value of plant height, number of tillers m^{-2} and dry matter production and yield attributes *viz*., number of panicles m^{-2}, total number of grains panicle^{-1} and number of filled grains panicle^{-1} at harvest were noticed with 100 % RDF in combination with ~~unweeded check (N_1W_5) during both the years of study and in the pooled mean.~~ unweeded check (N1W5) during the course of the study's years as well as in the pooled mean.

4. CONCLUSION

From the present investigation it was concluded that among nutrient levels, 150 % RDF was found to be significant superior to other nutrient levels. ~~Among various weed management practices, hand weeding twice at 20 and 40 DAS (W_4) which was statistically comparable with PE application~~ Hand weeding twice at 20 and 40 DAS (W4), which was statistically equivalent with PE application, of pyrazosulfuron-ethyl 25 g ha^{-1} *fb* florpyrauxifenbenzyl + cyhalofop-p-butyl 150 g ha^{-1} at 20 DAS (W_2).

REFERENCES

IRRI (International Rice Research Institute). 2001. Annual Report 2000-01. Rice research: the way forward. Los Banos. International Rice Research Institute, Phillippines.

Kumar R., Singh DK, Singh VK, Bhatnagar A, Pareek N, Nanda, G Rawat A. 2022. Influence of different establishment methods and nutrient management practices on growth attributes of rice (*Oryza sativa* L.). *Indian Journal of Agricultural Research.* ~~2022;~~10: 1-7.

Pandey S, Velasco L. 2002 Economics of direct seeding in Asia: patterns of adoption and research priorities. In: Direct Seeding: Research Strategies and Opportunities. (eds.Pandey S, Mortimer M, Wade L, Tuong TP, Lopes K, Hardy B) International Rice Research Institute, Los Banos Philippines. ~~2002~~.

Panse, VG, Sukhatme PV.1985 Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi.~~1985~~;100-174.

Rao AN, Johnson DE, Sivaprasad B, Ladha JK, Mortimer AM. 2007 Weed management in direct-seeded rice. *Advances in Agronomy*. ~~2007;~~93: 153–155.

Yadav V, Tiwari RK, Tiwari P, Tiwari J. 2018. Integrated weed management in aerobic rice (*Oryza sativa* L.). *International Journal of Current Microbiology and Applied Sciences.* ~~2018;~~ 7(1): 3099-3104.

~~Rao AN, Johnson DE, Sivaprasad B, Ladha JK and Mortimer AM. 2007. Weed management in direct-seeded rice. *Advances in Agronomy* 93: 153–155.~~

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