Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 3837-3845

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 Special Issue-7 pp. 3837-3845
Journal homepage: http://www.ijcmas.com

Original Research Article

Influence of Different Fertilizer doses on Growth, Yield and Economics of Direct Seeded Rice in Eastern Vidharbha Zone of Maharashtra, India

Usha R. Dongarwar[1], Nitin Patke[2], L. N. Dongarwar[3] and Sumedh R. Kashiwar[4*]

[1]Krishi Vigyan Kendra (ICAR), Bhandara (Sakoli), Maharashtra - 441802, India
[2]Zonal Agricultural Research Station, Sindewahi, Maharashtra - 441222, India
[3]Dr. Panjabrao Deshmukh Krishi Vidhyapeeth, Akola, Maharashtra – 444001, India
[4]Institute of Agriculture, Visva-Bharati, Santiniketan, West Bengal - 731236, India
**Corresponding author*

A B S T R A C T

An experiment was conducted to determine, the effect of different fertilizer doses on yield and economics of direct seeded rice, during wet (*kharif*) seasons of 2013-2014, 2014-2015 and 2015-2016 at two separate locations *viz*. KVK, Bhandara and ZARS, Sindewahi. Highest no. of effective tillers length of Panicle (20.47 cm), number of grains panicles^{-1} (174.67) observed in T_5 followed by treatment T_4 and T_7. Pooled mean at ZARS, Sindewahi indicated that T_5 (4780.0 Kg ha^{-1}) was expressively higher in grain yield followed by T_4 and T_7. Conversely, T_5, T_4 & T_7 were at par with each other and significantly superior over other treatments. In pooled mean of KVK, Sakoli, T_5 (3580 Kg ha^{-1}) was significantly higher in grain yield followed by T_4 (3722.86 kg ha^{-1}) and T_7 and treatment T_4 and T_7 were at par with each other. The pooled mean of three seasons and two locations showed that T_5 was pointedly higher in grain yield (4180kg ha^{-1}) followed by Treatment T_4. The highest GMR, NMR and B: C ratio was recorded in T_5 followed by T_4 and T_7 as well as T_4 & T_7 were at par. T_5 was significantly higher in grain yield (4180 kg ha^{-1}) and B: C ratio (2.08) followed by T_4 (3861 kg ha^{-1}) with B: C ratio (2.0).

Keywords

Direct seeded, fertilizer, vidharbha, PKV HMT, Sye-2001

Introduction

Rice (*Oryza sativa* L.) is grown in regions having the necessary warmth and abundant moisture favorable to its growth, be it under lowland or upland condition. It is one of the most important and indispensable caloric cereal food crop. Beyond providing sustenance through growing, earning income, and consuming, rice plays an integral, but important cultural role in many rural communities. For instance, products of rice plant are used for a number of purposes, such as fuel, thatching, industrial starch, artwork, and festivities (Gangwar, *et al.*, 2008). No groundwater recharge in rainy (*kharif*) season, late commencement of monsoon and farm operations often delays rice (*Oryza sativa* L.) transplanting which leads to late vacation of fields, forcing farmers to plant wheat after the optimum sowing time (Singh *et al.*, 2005). Labour shortage at the time of transplanting leads to delay in transplanting and it is one of the reasons for low yields of rice. Transplanted rice in puddled field requires continuous standing water although this leads to nutrient loss through leaching. Although puddling helps in reducing water losses through percolation and controlling weed by submergence of rice fields, but besides being costly, bulky and time intense, it results in degradation of soil and other natural resources, and afterwards poses difficulties in seedbed preparation for succeeding next crop in crop rotation. Transplanting of rice mainly done by migratory labour, which has an element of seasonality and thus becoming a serious concern for timely transplanting of rice and maintaining a plant population sufficient to achieve the higher rice productivity (Gupta *et al.,* 2006, Kashiwar *et al.,* 2016). Rice production systems are undergoing various changes, one of which is a shift from transplanting to direct seeding as farmers seek alternatives to offset increasing costs. The main driving force for this changes are the rising wage rates, scarcity of labour and at the same time, the availability of option to manage weeds in direct-seeded rice (Mahajan *et al.,* 2009). In Maharashtra state of India, rice is cultivated on 15.13 lakh hectares area in nearly all four regions named Vidharbha (7.95 lakh ha.), Konkan (3.83 lakh ha.), Western Maharashtra (3.23 lakh ha.) and Marathwada (0.12 lakh ha.) with annual production of 41.71 lakh tons unmilled (brown rice) and 28.78-lakh tons milled rice. The area (7.95 lakh ha.) and production (16.81 lakh tons unmilled rice) of rice crop is more in Vidharbha region while as highest productivity was observed in Konkan region (2.75 t ha^{-1}) (AMSEWPR 2014).

Materials and Methods

Study aimed to investigate, the effect of different fertilizer doses, on yield and economic traits of PKV HMT rice variety. Study conducted during three rainy (*kharif*) seasons of 2013, 2014 and 2015 at two locations Krishi Vigyan Kendra, Bhandara (Sakoli), Maharashtra, India and Zonal Agricultural Research Station, Sindewahi, Maharashtra, India. The experiment laid in Randomized Block Design having three replications and eight treatments. The experimental material comprised of well-known rice variety named PKV-HMT with eight different treatment combinations like T_1: Control (farmers practice N application at 30 DAS 1 bag acre^{-1} (i.e. 57.5 N ha^{-1}), T_2: Application of 75% RDF (75:37.5:37.5 Kg NPK ha^{-1}), T_3: Application of 100:50:50 Kg NPK ha^{-1}, T_4: Application of 125:62.5:62.5 Kg NPK ha^{-1}, T_5: Application of 150:75:75 Kg NPK ha^{-1}, T_6: Basal Application of 50:50:50 Kg NPK ha^{-1}+ Top dressing of N As per leaf colour chart, T_7: Nutrient Application as per Soil Test Basis, T_8: Basal application of 50:50:50 Kg NPK ha^{-1}+ Rice straw 2 t ha^{-1} application at 5 DAS + 3 t ha^{-1} glyricidia lopping at 30 DAS. The soil of experimental site was analyzed for initial soil nutrient status (Table 1) and date of Sowing and harvesting was strictly followed for consequent three years. (Table 2). Application of Pendimethaline @ 3.33 lit ha^{-1} within 48 hrs. after sowing and one weeding at 30 DAS and 5 t FYM ha^{-1} + Azospirilum + PSB seed treatment are common in all the treatment combinations.

Results and Discussion

Pooled mean results observed in growth traits, as influenced by various fertilizer doses, revealed that the increment of 50 % in application of NPK in T_5 (150:75:75 Kg NPK ha^{-1}), showed its positive effects (Table 3), on the plant height (91.93 cm), No. of tillers sq. m^{-1}(541.67), No. of effective tillers sq. m^{-1}(338.66), Length of panicle (20.47 cm), No. of grains panicle^{-1}(174.67) and grain yield sq. m^{-1}(490.67 g) **1** at both the locations followed by treatment T_4 and T_7 (Table 3). These results corroborate with those of Gala *et al.,* (2011) and Dongarwar *et al.,* (2015) who reported that the increasing amount of nitrogen improves considerably the vegetative growth of rice. Singh and Namdeo (2004) have also reported increased nutrient absorption by rice with increased fertilizer doses. Increase in N dose by 25 per cent over recommended dose increased the uptake of P and K conspicuously besides increase in uptake of N. Similarly increase in K dose by 25 percent resulted in marked improvement in N uptake also. Singh *et al.,* (2005) reported similar results of increase in K content and uptake due to increase in N level, increase in N content and uptake with increase in P and K levels. Application of additional doses of fertilizers enriches the available nutrient status and consequently results in higher nutrient uptake. The nitrogen rates provided decreases in the weight of 1,000 grains. May have occurred because, when the number of panicles increases, a tendency occurs for the mass of grains to decrease (Santos *et al.,* 2006 and Lacerda *et al.,* 2016). Despite this increase in plant height, no lodging was observed. Nitrogen can make plants more susceptible to lodging, as reported by Fidelis *et al.,* (2012).

Pooled means at ZARS, Sindewahi location revealed that application of T_5- 150: 75: 75 kg NPK ha^{-1} (4780.0 Kg ha^{-1}) recorded significantly higher in grain yield followed by T_4 - 125:62.5:62.5 NPK kg ha^{-1} (4499.43 kg ha^{-1}) and T_7 (4479.39 kg ha^{-1}). However, treatments T_5 (4780.04 kg ha^{-1}), T_4 (4499.43 kg ha^{-1}) & T_7 (4479.39 kg ha^{-1}) were at par with each other and significantly superior over other treatments (Table 4).

According to Arf *et al.,* (2005), nitrogen is the nutrient that most affects plant height. The increased nutrient absorption by rice with increased fertilizer doses (Singh *et al.,* 2004 and Gala *et al.,* 2011). Application of 25% extra N dose over suggested dose, amplified the uptake of Phosphorus and Potassium also. Sanogo *et al.,* (2010) reported that combined fertilizer containing more nitrogen influences more tilling. In addition, a good number of tillers give a good number of panicles, which is a significant component of the output, which occurs during the vegetative phase, influenced by factors such as the fertilization, water stress, and other farming techniques (Lacharme, 2001).

However, increase was measurable at increase in NPK dose by 50 percent (Table 5). This might be due to higher availability of N and P in plant and in grain for more assimilation of nitrogen and protein synthesis. Nitrogen had a marked effect on the number of tillers and panicles for both genotypes. According to Larrosa *et al.,* 2001, nitrogen application increases the number of tillers and panicles. Nitrogen is essential for cell structures and functions, for all enzymatic reactions in the plant, and for part of the chlorophyll molecule (photosynthesis), among other functions.

Pooled mean of KVK, Sakoli indicated that T_5 - 150:75:75 kg NPK ha^{-1} (3580 Kg ha^{-1}) was recorded significantly highest grain yield over all other treatments followed by Treatment T_4 -125:62.5:62.5 kg NPK ha^{-1} (3222.86 kg ha^{-1}) and T_7 (3073.52 kg ha^{-1}) (Table 5). However, treatment T_4 (3222.86 kg ha^{-1}) & T_7 (3073.52 kg ha^{-1}) were at par with each other and expressively superior over other treatments (Table 5). Lacharme *et al.,* 2001; Singh *et al.,* 2004; Gala *et al.,* 2011 and Sanogo *et al.,* 2010, also report the relevant results.

Increased grain yield associated with added fertilizer levels might be due to the cumulative effect of increased translocation of photosynthates to sink resulting in enhanced level of yield components.

Table.1 Initial soil fertility status of ZARS, Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

Particulars	Locations		Method used
	ZARS Sindewahi	KVK, Sakoli	
*p*H	7.30	7.30	*p*H meter (Piper,1966)
EC (dsm^{-1})	0.22	0.18	Conductivity meter (Jackson,1967)
Organic Carbon (%)	0.48	0.49	Walkley and Black method (Jackson,1967)
Available N kg ha^{-1}	221.00	234.00	Alkaline permanganate method (Subbiah & Asija, 1956)
Available P_2O_5 kg ha^{-1}	30.2	25.6	Olsen's method (Jackson,1967)
Available K_20 kg ha^{-1}	290.00	318.00	Neutral normal ammonium acetate method (Jackson,1967)

Table.2 Dates of sowing and harvesting at ZARS, Sindewahi and KVK, Bhandara (Sakoli), Maharashtra, India

Particular	Date of sowing	
	Sindewahi	Sakoli
First Year	02/07/2013	08/07/2013
Second Year	02/07/2014	08/07/2014
Third Year	01/07/2015	08/07/2015
	Date of Harvesting :	
First Year	08/11/2013	15/11/2013
Second Year	15/11/2014	19/11/2014
Third Year	10/11/2015	20/11/2015
Previous Crop	Rice	Rice

Table.3 Average Ancillary character of Rice as influenced by different treatments

Treatments	Plant Height (cm)	No. of tillers sq. m^{-1}	No. of effective tillers sq. m^{-1}	Length of panicle (cm)	No. of grains $panicle^{-1}$	Grain yield sq. m^{-1} (g)	Test wt. (g)
T1	85.13	415.67	206.33	18.80	102.33	278.66	14.33
T2	86.20	460.67	285.66	19.47	143.87	378.30	14.50
T3	89.13	473.0	297.0	19.53	145.80	404.22	14.54
T4	91.13	528.33	321.33	19.87	163.20	463.33	14.47
T5	91.93	541.67	338.66	20.47	174.67	490.67	14.51
T6	90.80	486.0	318.0	19.67	155.0	443.50	14.41
T7	88.40	480.0	303.33	19.53	146.73	419.30	14.56
T8	85.80	417.0	270.66	19.40	143.80	348.10	14.49

Table.4 Pooled Mean of grain yield of Rice (Kg ha^{-1}) as influenced by various treatments at Sindewahi

Treatments	Grain yield (Kg ha^{-1})			Pooled mean (Kg ha^{-1})
	2013-14	2014-15	2015-16	
T_1:Control (farmers practice N application at 30 DAS 1 bag acre^{-1} (i.e. 57.5 N ha^{-1})	2883	4024	4218.32	3708.50
T_2: Application of 75% RDF (75:37.5:37.5 Kg NPK ha^{-1})	3345.67	4286.16	4497.38	4043.07
T_3: Application of 100:50:50 Kg NPK ha^{-1}	3561.52	4347.83	4839.66	4249.66
T_4: Application of 125:62.5:62.5 Kg NPK ha^{-1}	3885	4654.64	4958.38	4499.43
T_5:Application of 150:75:75 Kg NPK ha^{-1}	4147.40	4717.86	5474.87	4780.04
T_6: Basal Application of 50:50:50 Kg NPK ha^{-1} + Top dressing of N As per LCC	3422.76	4363.25	4762.57	4182.85
T_7: Nutrient Application as per Soil Test Basis	3823.62	4625.35	4989.21	4479.39
T_8: Basal Application of 50:50:50 Kg NPK ha^{-1} + Rice straw 2 t ha^{-1} application at 5 DAS+3 t ha^{-1} glyricidia lopping at 30 DAS	3438.18	4225.32	4279.99	3991.16
SEm±	178.89	204.89	202.03	136.62
CD at 5 %	542.61	NS	612.79	414.39
CV %	8.70	8.05	7.36	5.57

Table.5 Pooled Mean of grain yield of rice (Kg ha^{-1}) as influenced by various treatments at Sakoli

Treatments	Grain yield (Kg ha^{-1})			Pooled mean (Kg ha^{-1})
	2013-14	2014-15	2015-16	
T_1:Control (farmers practice N application at 30 DAS 1 bag acre^{-1} (i.e. 57.5 N ha^{-1})	1996.61	2215.0	2978.73	2408.77
T_2: Application of 75% RDF (75:37.5:37.5 Kg NPK ha^{-1})	2112.24	2412.67	3464.39	2663.09
T_3: Application of 100:50:50 Kg NPK ha^{-1}	2420.60	2906.67	3785.08	3037.44
T_4: Application of 125:62.5:62.5 Kg NPK ha^{-1}	2459.14	3168.43	3886.84	3222.86
T_5:Application of 150:75:75 Kg NPK ha^{-1}	2597.90	3418.13	4107.31	3580.02
T_6: Basal Application of 50:50:50 Kg NPK ha^{-1}+ Top dressing of N As per LCC	2119.95	2644.00	3606.23	2790.06
T_7: Nutrient Application as per Soil Test Basis	2489.98	2934.73	3795.87	3073.52
T_8: Basal Application of 50:50:50 Kg NPK ha^{-1} + Rice straw 2 t ha^{-1} application at 5 DAS+ 3 t ha^{-1} glyricidia lopping at 30 DAS	2173.91	2277.21	3459.76	2636.96
SEm±	103.80	170.81	170.26	97.39
CD at 5 %	314.84	518.09	516.43	295.41
CV %	7.83	10.75	8.11	5.76

Table.6 Pooled mean of grain yield (Kg ha^{-1}) as influenced by different treatments at ZARS, Sindewahi and KVK, Sakoli

Treatments	Grain yield (Kg ha^{-1})		Pooled mean (Kg ha^{-1})
	Sindewahi	Sakoli	
T_1:Control (farmers practice N application at 30 DAS 1 bag acre^{-1} (i.e. 57.5 N ha^{-1})	3708.50	2408.77	2408.77
T_2: Application of 75% RDF (75:37.5:37.5 Kg NPK ha^{-1})	4043.07	2663.09	2663.09
T_3: Application of 100:50:50 Kg NPK ha^{-1}	4249.66	3037.44	3037.44
T_4: Application of 125:62.5:62.5 Kg NPK ha^{-1}	4499.43	3222.86	3222.86
T_5:Application of 150:75:75 Kg NPK ha^{-1}	4780.04	3580.02	3580.02
T_6: Basal Application of 50:50:50 Kg NPK ha^{-1}+ Top dressing of N As per LCC	4182.85	2790.06	2790.06
T_7: Nutrient Application as per Soil Test Basis	4479.39	3073.52	3073.52
T_8: Basal Application of 50:50:50 Kg NPK ha^{-1} + Rice straw 2 t ha^{-1} application at 5 DAS+ 3 t ha^{-1} glyricidia lopping at 30 DAS	3991.16	2663.96	2636.96
SEm±	136.62	97.39	71.23
CD at 5 %	414.39	295.41	216.04
CV %	5.57	5.76	3.44

Table.7 Cost of cultivation, Gross Monetary Return, Net Monetary Return and B:C ratio as influenced by different treatments at both locations

Treatments	Pooled Grain yield (Q ha^{-1})	COC (INR ha^{-1})	GMR (INR ha^{-1})	NMR (INR ha^{-1})	B:C Ratio
T_1:Control (farmers practice N application at 30 DAS 1 bag acre^{-1} (i.e. 57.5 N ha^{-1})	3059	30550	55978	25428	1.83
T_2: Application of 75% RDF (75: 37.5: 37.5 Kg NPK ha^{-1})	3353	32675	61383	28708	1.88
T_3: Application of 100:50:50 Kg NPK ha^{-1}	3643	34050	66752	32702	1.96
T_4: Application of 125:62.5:62.5 Kg NPK ha^{-1}	3861	35425	70785	35360	2.0
T_5:Application of 150:75:75 Kg NPK ha^{-1}	4180	36800	76717	39917	2.08
T_6: Basal Application of 50:50:50 Kg NPK ha^{-1}+ Top dressing of N As per leaf colour chart	3486	33555	63821	30266	1.90
T_7: Nutrient Application as per Soil Test Basis	3776	35085	69221	34136	1.97
T_8: Basal Application of 50:50:50 Kg NPK ha^{-1} + Rice straw 2 t ha^{-1} application at 5 DAS+3 t ha^{-1} glyricidia lopping at 30 DAS	3314	32600	60653	28053	1.86
SEm±	71	-	1303	1303	-
CD at 5 %	216	-	3952	3952	-

Grain Price: INR. 1800 Q^{-1}
Straw Price: INR. 25 Q^{-1}

The results confirm the findings of Rao *et al.,* (2004). The pooled mean of grain yield over three growing seasons of two locations revealed that T_5 -150:75:75 kg NPK ha^{-1} recorded (4180 kg ha^{-1}) significantly higher grain yield over all other treatments and it was followed by Treatment T_4 -125:62.5:62.5 kg NPK ha^{-1} (3222.86 kg ha^{-1}). T_4 – 125:62.5:62.5 Kg NPK ha^{-1} was second best treatment (322.86 kg ha^{-1}) and it was at par with treatment T_7 (3073.52 kg ha^{-1}) (Table 6). Increased levels of NPK favours greater absorption of nutrients resulting in rapid expansion of foliage, better accumulation of photosynthates and eventually resulting in increased growth structure. Balasubramanian and Palaniappan (1991) and Kumar (1986) expressed similar results and opinions. Potassium nutrition improves germination of pollen in the floret, which leads to high spikelet fertility in rice (Uexkull, 1978).

Labour saving of Direct Seeded Rice reduces 11.2% of total production cost as well as Direct Seeded Rice methods have several advantages over transplanting (Singh *et al.,* 2005; Naresh *et al.,* 2010). In addition to higher economic returns, Direct Seeded Rice crops are faster and easier to plant and less labor intensive (Jehangir *et al.,* 2005). Thus, it is necessary to change the cultivation system from transplanting to direct seeded rice (Sanjitha Rani and Jayakiran, 2010). The highest Gross Monetary Return, Net Monetary Return and B: C ratio, recorded in T_5 -150:75:75 Kg NKP ha^{-1} (76,717 INR ha^{-1}, 39,917 INR ha^{-1} and 2.03 respectively) followed by T_4 (70,785 INR ha^{-1}, 35,360 INR ha^{-1} and 2.0) and T_7 (69,221 INR ha^{-1}, 34,136 INR ha^{-1} and 1.97). Sehrawat *et al.,* (2010) also observed 13-16% labor saving in Direct Seeded Rice as compared to manual puddled transplanted rice. Kumar (2011) also recorded similar findings and found higher B: C ratio in Direct Seeded Rice as compared to transplanted rice.

The study led to the conclusion that application of 150:75:75 Kg NPK ha^{-1} recorded significantly higher in growth, grain yield, Gross Monetary Return, Net Monetary Return and B: C ratio in Direct seeded rice for Eastern Vidharbha Zone of Maharashtra, India.

References

Annual Maharashtra State Rice Workshop Progress Report, 4-5 March, 2014 pp. 12.

Arf, O., Bastos, J. C. H. A. G., Silva, M. G., Sá, M. E., Rodrigues, R. A. F., & Buzetti, S. (2005). Manejo do solo e época de aplicação de nitrogênio na produção de arroz de terras altas. Acta Scientiarum. Agronomy, 27(2), 215-223.

Balasubramanian, P. and Palaniappan, S.P. (1991). Effect of high density and fertilizer rate on growth and yield of lowland rice. Indian J. Agron., 36 (1): 10-13.

Dongarwar, U. R., Khedikar, G. R., Kashiwar S. R., and Dongarwar L., 2015, Effect of different Organic Sources Available with Farmers on Paddy (*Oryza sativa*) in Bhandara District of Maharashtra, Journal of Agricultural Engineering and Food Technology, 2 (2), 142-144.

Fidelis, R. R., Rodrigues, A. M., Silva, G. F., Barros, H. B., Pinto, L. C., & Aguiar, R. W. S. (2012). Nitrogen efficiency on upland rice genotypes. Pesquisa Agropecuária Tropical, 42(1), 124-128.

Gala B, Camara Y, Keli Z (2011). Rentabilités des engrais minéraux en riziculture pluvial de plateau cas de la zone de Gagnoa dans le centre ouest de la cote d'ivoire. J. Appl. Biosci. 46:3153-3162

Gangwar, K.S., Tomar. O.K. and Pandey D.K. 2008. Productivity and economics of transplanted and direct-seeded rice (Oryza sativa)-based cropping systems in Indo-Gangetic plains. Indian J. Agric. Sci. 78: 655-58.

Gupta R K, Ladha J K, Singh S, Singh R G, Jat M L, Saharawat Y, Singh V P, Singh S S, Singh G, Sah G, Gathala M, Sharma R K, Gill M S, Alam Murshad, Mujeeb Ur Rehman Hafiz, Singh U P, Mann, Riaz A Pathak, Chauhan H, Bhattacharya B S and Malik P R K. 2006. Production Technology for direct seeded rice. Rice- Wheat Consortium for the Indogangetic Plains, pp 16. New Delhi.

Jackson, M.L., 1973. Soil Chemical Analysis. Printice Hall Inc. Engiewood Cliffs. N. J. U.S.A.

Jehangir, W. A., Masih, I., Ahmed, S., Gill, M. A., Ahmad, M., Mann, R. A, Chaudhary, M. R., and Turral, H.2005. Sustaining crop water productivity in rice-wheat systems of South Asia: a case study from Punjab Pakistan. In: Draft Working Paper. Inter. Water Manag. Ins. Lahore, Pakistan.

Kashiwar, S. R., Kumar, D., Dongarwar, U. R., Mondal, B., and Nath, T. 2016. Experiences, challenges and Opportunities of Direct Seeded Rice in Bhandara District of Maharashtra. Journal of Energy Research and Environmental Technology (3) 2: 141-145

Kumar, V. and Ladha, J. K. 2011. Direct seeding of rice: Recent developments and future research needs. Adva. Agro. 111: 297-413.

Kumar, V. K. (1986). Agro meteorological parameters and hydro-nutritional management practices in rice cultivation. Ph.D thesis TNAU, Coimbatore.

Lacerda, M. C. and Nascente, A. S. 2016. Effects of row spacing and nitrogen topdressing fertilization on the yield of upland rice in a no-tillage system. Acta Scientiarum. Agronomy, 38(4), 493-502, Doi: 10.4025/actasciagron.v38i4.30855

Lacharme M (2001). «Fascicule2» le plant de riz: données morphologiques et cycle de la plante. Memento technique de riziculture: 22 p.

Larrosa, M., Felipe, R., Marchezan, E., Aita, C., and Coradini, J. Z. (2001). Efficiency of nitrogen application on rice tillering under water management systems. Ciência Rural, 31(5), 745-749.

Mahajan G, Chauhan B S and Johnson D E. 2009. Weed management in northwestern Indo-Gangetic Plains. Journal of Crop Improvement 23: 366–82.

Naresh R.K.; Gupta Raj K.; Singh B.; Kumar Ashok; Shahi U.P.; Pal Gajendra;Singh,Adesh; Yadav Ashok Kumar;and Tomar S.S.2010. Assessment of No-Tillage and Direct Seeding Technologies in rice-wheat rotation for Saving of Water and Labor in Western IGP. Progr. Agri. Int. J. 10 (2): 205- 218.

Piper C. S., 1966. Soil and plant analysis. Hans publishers, Bombay. 368.

Rao, K.V. Surekha, K., Kundu, D. K. and Prasad, A. S.R. (2004). Nutrient management to sustain productivity targets of irrigated rice. International symposium on rice. Hyderabad.pp 416-417.

Sanjitha Rani T. and Jayakiran K.2010.Evaluation of different planting techniques for economic feasibility in Rice. Elec. J. Envir. Agri.

Food Chem. 9 (1):150-153.

Sanogo S, Camara M, Zouzou M, Keli Z, Messoum F, Sekou A (2010). Effets de la fertilisation minérale sur des variétés améliorées de riz en condition irriguée à Gagnoa, Côte d'Ivoire. J. Appl. Biosci. 35:2235-2243.

Santos, A. B., Stone, L. F., & Vieira, N. R. A. (2006). Rice crop in Brazil, (2a ed.). Santo Antônio de Goiás, GO: Embrapa Arroz e Feijão.

Seharawat, Y.S., Bhagat Singh, Malik, R.K., Ladha, J. K., Gathala, M., Jat, M.L. and Kumar, V. 2010. Evaluation of alternative tillage and crop establishment methods in a rice–wheat rotation in North Western IGP. Field Crops Res., 116: 260- 267.

Singh RK and Namdeo KM 2004. Effect of fertility levels and herbicides on growth, yield and nutrient uptake of direct seeded rice. Indian journal of Agronomy 49(1): 34-36.

Singh S. Sharma R K, Govindra Singh, Singh S S, Singh U P, Gill M A, Jat M L, Sharma S K, Malik R K, Josan A S and Gupta R K. 2005. Direct Seeded Rice: A Promising Resource Conserving Technology. Rice-Wheat Consortium for the Indo- Gangetic Plains, New Delhi.

Singh Y, Singh G, Johnson D. and Mortimer M. 2005. Changing from transplanted rice to direct seeding in the rice-wheat cropping system in India. In: Rice is Life: Scientific Perspectives for the 21st Century, Tsukuba, Japan: Proceeding of the Word Rice Research Conference, 4-7 November 2004; pp. 198- 201.

Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for the estimation of available nitrogen in soil.Curr. Sci. 25: 259.

Uexkull, H.R.V. (1978). Potash and rice production in Asia. Potash Review, Cereal Crops, 41, pp 1-18.