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PRODUCTION POTENTIAL AND ECONOMICS OF RICE AS INFLUENCED BY VARIETIES, NURSERY TYPE AND AGE OF SEEDLING AND SPACING IN IRRIGATED CONDITION

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ABSTRACT

A field experiment was conducted during kharif season of 2008 and 2009 at the Krishi Vigyan Kendra Farm (Bahraich) to study the effect of varieties, nursery type and age of seedlings and spacing on yield and economics of rice in irrigated condition. Rice variety NDR359 recorded higher values of growth, yield attributes and yields as compared to Pro Agro 6444. Transplanting of SRI with either 10 or 12 days old seedling was on par but both recorded significantly higher values of growth, roots and yield parameters as compared to CT with 27 days old seedling. The per cent increase in grain yield due to transplanting of SRI with either 10 or 12 days old seedling was recorded to the tune of 17.7 and 16.4, respectively over CT with 27 days old seedling. Transplanting of both, SRI with either 10 or 12 days old seedling depleted significantly higher amount of nutrientS i.e. 108.6 and 106.8 kg N ha^{-1}, 30.3 and 29.9 kg P ha^{-1} and 101.7 and 97.6 kg K ha^{-1}, respectively as compared to planting of CT with 27 days old seedling. Transplanted of rice at 25x25 cm spacing was significantly superior to planting at 30x30 cm and recorded higher grain yield (5.48 and 6.04 t ha^{-1}) in respective years. Transplanting of SRI + 10 or 12 days old seedling gave higher net income (43.77x10^{3} and `43.17x10^{3} ha^{-1} and benefit: cost ratio (1.93 and 1.90) as compared to CT with 27 days old seedlings.

Key word: Rice, varieties, age of seedling, nursery type, spacing, production, economics

INTRODUCTION

The system of rice intensification (SRI) is a new method for transplanted rice which was evolved by father Henrie Laulanie at Madagaskar in 1983.This technique is eco-friendly because the fields are not flooded but kept moist which are helpful in reducing the production of 'methane' gas and water conservation. To produce 1 kg of rice grain 2710 litres of water is needed through this novel approach in contrast to the 3720 litres through the conventional method (Kumar et al. 2009). Rice production in India had increased in the past three decades continuously beginning with the green revolution, but has stagnated since 1999 (USDA,2004). As an estimate, 115-120 million tonne of milled rice is to be produced in India with an average productivity of 4.03 t ha^{-1} to maintain the present level of self sufficiency (Mishra *et al.*, 2006). This technique primarily consists of keeping the rice field moist rather than continuously saturated, thereby minimizing anaerobic conditions, and improving root growth and diversity of aerobic soil organisms (Kumar and Shivay, 2004). Rice plants are spaced optimally to permit more growth of roots, canopy and tillering and to keep all leaves photosynthetically active. Transplanting of rice seedlings is done when young with two leaves, quickly, shallow and carefully, to avoid trauma to roots and to minimize transplant shock (Singh *et al.*, 2012). The resistance of SRI plants to lodging caused by wind and /or rain, given their larger root systems and stronger stalks, is a useful trait for extreme floods. Manipulation of planting geometry like age of nursery and spacing appears to have a promising potential for increasing the rice yield, as it is assumed to have pronounced effect on tillering interception and utilization of light which in turn influence the rice yield Alexander *et al.*, (1988). System of rice intensification (SRI) needs to be compared with conventional method of rice cultivation in order to elucidate the parameters contributing for yield determination under SRI method. Hence, an experiment was conducted to study the effect of varieties, nursery type and age of seedlings, and spacing on yield and economics of rice in irrigated conditions.

MATERIALS AND METHODS

Field experiment was conducted during the *kharif* season of 2008 and 2009 at the Krishi Vigyan Kendra farm (Bahraich) of N.D. University of Agriculture and Technology (Uttar Pradesh). The soil of the experimental site was sandy loam in texture, having p^{H} 7.6, organic carbon 4.1 g kg^{-1}, available nitrogen 192 kg ha^{-1}, available phosphorus 22.5 kg ha^{-1} and available potassium 200 kg ha^{-1}. The experiment was laid out in split -split plot design with 3 replications with two rice varieties viz. 'NDR 359' and 'Pro Agro 6444' in main plots, three nursery type and age of seedling viz. SRI with 10 days, SRI with 12 days old seedling and CT with 27 days old seedling in sub plots, and two plant spacing (25cm x 25 cm and

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30 cm x 30 cm) in ultimate plots. Nursery of both SRI and CT was sown on 23 June in 2008 and 21 June in 2009. Under SRI, 10 and 12 days old seedlings with single seedling hill^{-1} along with seed hull and enough nursery-bed soil adhered to roots in the wet soil and in CT, 27 days old seedlings (2-3 seedlings hill^{-1}) after washing off adhered nursery-bed soil were transplanted. The seed rate used under SRI (5 kg ha^{-1}) is one-seventh compared with CT (35 kg ha^{-1}). Rice was fertilized 120 kg N, 60 kg P_20_5, 40 kg K_20 and 20 kg $ZnSO_4$ ha^{-1}. Of the total N, 60 kg N was supplied through urea, phosphorus as single superphosphate and K as muriate of potash and rest 60 kg N through farm yard manure (12 t ha^{-1}) after taking into account the P and K supplied by the farm yard manure (FYM).The half amount of N and full P, K and $ZnSO_4$ was applied at the time of transplanting. The remaining amount of N was top dressed in two splits, i.e. at tillering and panicle initiation stage. Irrigations under SRI was applied as per need but shallow submergence was maintained from panicle emergence to 15 days before maturity in all the plots. Weeds control in SRI was done by cono weeder twice, in both directions at 10 and 20 days after transplanting (DAT). In CT, butachlor granules were applied 3-5 DAT @1.5 kg a.i. ha^{-1} followed by one hand weeding at 30 DAT. All standard improved agronomic practices were followed to raise the experimental crop. Data pertaining to yield attributes were collected on 5 plants selected randomly from each treatment at harvest. The grain and straw samples collected at harvest were digested (HNO_3: $HCPO_4$) and analyzed for N, P and K content by standard procedures (Jackson, 1973). The uptake of nutrients by crop was worked out by multiplying nutrient content in grain and straw with their respective bio mass. The economics of different treatments was worked out on prevailing market prices.

RESULTS AND DISCUSSION

Varieties

Variety 'NDR 359' proved superior to Pro Agro 6444' in terms of plant height and dry matter accumulation .Variety 'Pro Agro 6444' required significantly lesser days to mature (130 days) than the 'NDR 359' (Table 1). Variety ‘NDR 359’ showed significantly higher values of yield attributes, root growth and produced grain yield at par with ‘Pro Agro 6444’ but the former gave significantly higher biological yield than the later (Table 2). This might be due to taller plants and higher dry matter accumulation with low partitioning ability of 'NDR 359'. The higher net return (Rs 41.59 x10^3 ha^{-1}) with benefit: cost ratio (1.85) was recorded with NDR 359 due to higher yields and lower cost of cultivation owing to lesser cost of seed as compared to costly seed of hybrid “Pro Agro 6444”. The uptake of NPK through grain and straw was significantly highest with NDR359 as compared to Pro Agro 6444. This was mainly due to higher availability of nutrients owing to higher root depth, surface area and volume of roots registered with NDR359 which in turn produced higher yields and more uptake of NPK.

Table 1: Effect of varieties, nursery type and age of seedling and spacing on growth and yield attributes of rice (mean data of 2 years)

Treatment	Plant height (cm) at harvest	LAI at anthesis	Root depth (cm) at 90 DAS	Surface Area (cm^2) at 90 DAS	Volume (Cm^2) at 90 DAS	Dry matter accumulation at harvest (t ha^{-1})	Days to maturity	Panicles (m^{-2})	Panicle length (cm)	Filled grain panicle^{-1}	Test weight (g)
Varieties											
NDR 359	101.23	5.16	10.90	679	12.8	15.25	135	285	27.8	116	23.39
PA 6444	99.96	5.15	10.68	624	10.6	14.76	130	283	27.6	114	21.70
CD (P=0.05)	0.85	NS	NS	43	1.7	0.32	3.7	NS	NS	NS	0.93
Nursery type and age of seedling											
SRI and 10 Days	100.57	5.25	10.98	682	12.7	15.53	130	300	28.18	122	22.80
SRI and 12 Days	100.62	5.19	10.87	675	12.3	15.42	131	296	28.06	119	22.69
CT and 27 Days	100.59	5.02	10.52	569	10.8	14.06	138	256	26.86	105	22.14
CD (P=0.05)	NS	0.12	----	53	1.3	1.27	5.1	0.73	0.95	9.8	0.60
Spacing (cm)											
25 x 25	100.70	5.14	10.89	680	12.9	15.60	132	293	27.44	114	22.48
30 x 30	100.49	5.17	10.69	674	12.8	14.41	133	275	27.96	116	22.61
CD (P=0.05)	NS	NS	NS	NS	NS	1.04	NS	0.08	0.75	NS	NS

Nursery type and age of seedling

Transplanting of SRI with either 10 or 12 days old seedling resulted higher growth in terms of plant height, more tillers, root depth, flag leaf area and hastened maturity (6-7 days) than CT with 27 days old seedlings. Vijayakumar *et al.*, (2004) also reported taller plants with younger seedlings (14 days old) as compared to conventional transplanting. The younger seedlings in SRI when carefully transplanted by keeping the roots straight (assuring that the roots do not assume 'J' shape) might have encouraged vigorous and deeper root system which in turn resulted into more vigorous and taller plants. Besides, the control of weeds due to use of cono weeder might have been associated to improved aeration which resulted in increased crop vigour. Transplanting of younger seedlings reduces transplanting shock to the seedlings and hence advances the tillering process (LinHua *et al.*, 2006). This advantage is carried over by the crop and thereby encouraging its early maturity. In the present investigation, days taken by the crop to come into maturity were significantly reduced and these were on an average less in SRI with 10 to 12 days old seedling by 6 and 7 days. Krishna *et al.*, (2008) reported that SRI produced 153% higher number of productive tillers over Conventional. Transplanting of SRI with either 10 or 12 days old seedling influenced the performance of rice favorably despite reduction in plant population (hills) per unit area to almost half which produced significantly higher grain yield during both the years. On an average, SRI with 10 days old seedling yielded (5.88 t ha^{-1}) and 12 days old seedling (5.82 t ha^{-1}) being 17.1% and 15.9 % higher, respectively as compared to CT with 27 days old seedling (5.02 t ha^{-1}). Higher yield in both SRI methods attributed to planting of young single seedling and criss-cross cono-weeding twice at 10 and 20 days after transplant which in turn led to more number of productive tillers per unit area with larger and heavier panicles. Shekhar *et al.*, (2009) also stated that SRI method out performed the conventional (CT). Krishna *et al.*, (2008) reported that SRI produced 153% higher number of productive tillers and yielded 0.60 t ha^{-1} higher grain as compared to CT + 27 days old seedling (2.28 t ha^{-1}). Lu *et al.* (2006) reported higher yield with SRI due to increased root activity and delayed root and leaf senescence during later growth stages resulting from efficient control of weed by cono weeder in SRI method. Significantly highest biological yield was recorded with SRI+10 or 12 days old seedling as compared to conventional + 27 days old seedlings during both years. This could be attributed to higher leaf area index, dry matter accumulation and taller plants recorded with SRI+10 or 12 days old seedlings. The uptake of nutrients (NPK) was significantly higher with both SRI treatment as compared to CT mainly due to higher root growth i.e. root depth, surface area and volume of roots which improved availability of nutrients to crop and produced higher dry matter and more uptake of NPK by rice crop. Shekhawat *et al.*, (2009) reported significantly higher uptake of NPK and grain yield of rice with SRI method as compared to CTR. Transplanting of SRI with either 10 or 12 days old seedlings was on par but gave significantly higher net returns (43.77 ha^{-1}) and (43.17 ha^{-1}) and B:C ratio (1.93) and (1.90) as compared to CT with 27 days old seedlings. This higher net returns and benefit: cost ratio was might be due to higher yields and lesser cost of cultivation as compared to CT with 27 days old seedling.

Spacing

Growth and yield attributes were significantly higher with transplanting at 25x25 cm spacing as compared to at 30 x 30 cm spacing except days to maturity. The higher value of growth at 25x25cm spacing was mainly due to optimum space available for rice plant resulted in least competition for light, nutrients and space. Significantly higher grain (5.76 t ha^{-1}) and biological yield (13.8 t ha^{-1}) was recorded with planting at 25x25 cm as compared to 30x30 cm

Table 2: Grain and biological yield, nutrient uptake and economics of rice as effected by varieties, nursery type and age of seedling and spacing

Treatment	Grain yield (t ha^{-1})		Biological yield (t ha^{-1})		Total Nutrient uptake (kg ha^{-1})			Cost of cultivation (X 10^3 ha^{-1})	Net return* (x10^3 ha^{-1})	B: C ratio
	2008	2009	2008	2009	N	P	K			
Varieties										
NDR 359	5.33	5.87	13.18	14.23	102.3	29.1	95.2	22.45	41.59	1.85
PA 6444	5.30	5.82	12.22	13.77	102.1	28.4	94.5	23.26	39.74	1.71
CD (P=0.05)	NS	NS	0.62	0.44	NS	NS	NS		NS	NS
Nursery type and age of seedling										
SRI + 10 Days	5.59	6.18	13.05	14.61	108.1	30.3	101.7	22.72	43.77	1.93
SRI + 12 Days	5.54	6.11	13.22	14.23	106.8	29.9	97.6	22.72	43.17	1.90
CT + 27 Days	4.80	5.25	11.86	13.15	91.7	26.0	85.2	23.14	34.84	1.51
CD (P=0.05)	0.31	0.30	0.98	1.17	10.2	3.12	9.85		6.40	0.36
Spacing (cm)										
25 x 25	5.48	6.04	13.12	14.48	105.6	29.4	97.9	22.92	42.58	1.86
30 x 30	5.15	5.65	12.31	13.51	98.8	28.1	91.8	22.79	38.57	1.69
CD (P=0.05)	0.07	0.16	0.54	0.62	4.8	NS	5.72		3.06	0.11

spacing which was mainly due to higher dry matter accumulation and more number of panicles m^2 and grains $panicle^{-1}$. These findings are in close conformity with those of Bommayasamy *et al.*, (2010). The per cent increase in grain yield of rice by transplanting at 25 x 25cm spacing was 6.7% over planting at 30 x 30 cm spacing. Rice transplanted at 25 x 25cm spacing removed significantly higher amount of nutrient i.e. 105.6 N +29.46 P + 97.97 K kg ha^{-1}) as compared to planting at 30 x 30 cm spacing. Better roots growth with 25 x 25cm spacing improved availability of nutrients to crop which in turn improved crop growth (plant height, LAI, dry matter accumulation) and uptake of NPK by crop. The net income and benefit: cost ratio were higher ($42.58x10^3$ ha^{-1}) and (1.86), respectively with transplant 25 x 25 cm followed by 30 x 30 cm spacing. This was because lower cost incurred with higher net income due to higher yields. Ravisankar *et al.* (2005) also reported higher economic returns and B: C ratio at closer spacing because increased grain and straw yield. Results of field experiment revealed that rice variety NDR 359 produced higher grain yield over Pro Agro 6444. Transplanted of SRI with 10 or 12 days old seedlings was on par but yielded 17.7 and 16.4 % higher over CT with 27 days old seedling. These treatments also gave significantly higher net income and benefit: cost ratio over CT with 27 days old seedlings. Rice seedling transplanted at 25x25 cm recorded significantly higher grain yield and uptake of nutrients as compared to planting at 30x30cm spacing. Transplanting of SRI with 10 or 12 days old seedlings depleted significantly higher amount of N, P and K as compared to CT with 27days old seedlings.

REFERENCES

Alexander, D., Padananadan, N and Karunakaran, K (1988) Azolla growth under different planting method in kerella.*Intenational Rice reaearch Note* 13:24-25 indin.

Bommayasamy, N., Ravishankar, N and Subramani, T. (2010) Influence of non-monetary inputs on growth and yield of rice under system of rice intensification (SRI). *Indian Journal of Agronomy* 55:95-99.

Jackson, M.L. (1973) Soil chemical analysis. Prentise Hall of India Private Limited, New Delhi

Krishna, A., Biradarpatil, N.K., Channappagoudar, B.B. (2008) Influence of system of rice intensification (SRI) cultivation on seed yield and quality. *Karnataka Journal of Agricultural Science* 21:369-72.

Kumar, D and Shivay, Y.S. (2004) System of rice intensification. *Indian Farming* 58(8):18-21

Kumar, R.M, Surekha, K., Padmavati, C., Subba Rao, L.V. and Latha, P.C. (2009) Research experiences on system of rice intensification and future directions. *Journal of Rice Research* 2: 61-71.

Lin Hua, Wu. ChunZan, Chen Aliliu., Ding, Yu Yun and Liao Chuashuang. (2006) Yield increasing mechanism of system of rice intensification (SRI) and its key techniques. *Hybrid Rice* 21:42-43.

Lu, X.M., Huang, Q., Liu, H.Z. (2006) Research of some physiological characteristics under the system of rice intensification. *Journal of South China Agricultural University*. 25:5-8.

Mishra D., Ispal asmed, M., Rao, K.V, and Bentor, J.S. (2006) Rice Research in India: Green revolution to gene revolution. *Journal of Rice Research* 1:38-51.

Ravisankar, N., Zamir Ahmed., Din M. and Rai, R.B. (2005) Rice intensification system in the Andaman and Nicobar Islands. *SAIC News letter* 15:10-11.

Shekhar, J., Mankotia, B.S. and Dev, S P (2009) Productivity and economics of rice *(Oryza sativa)* in system of rice intensification in North-Wetern Himalayas. *Indian Journal of Agronomy* 54:423-427.

Shekhawat, J; Mankotia, B.S. and Dev, S.P. (2009) productivity and economics of rice (Oryza sativa) in system of rice intensification in Noth-Western Himalayas. *Indian Journal of Agronomy* 54; 423-427

Singh, K.N., Singh, Parmeet, Singh, Lal, Kanth, Raihana, H. and Aga, Farooq, A. (2012) Influence of nursery raising methods, age of seedling and planting dates on rice (Oryza sativa) under temperate Kashmir. *Indian Journal of Agronomy* 57: 373-377

USDA (United state department of agriculture) (2004) Producer, supply and distribution online database. Washington, D.C., USDA. http.//www.tas.usda.gov.

Vijayakumar, M., Singh, S.D.S., Prabhakaram, N.K. and Thiyagarajan, T.M. (2004) Effect of SRI (System of rice Intensification) practices on the yield attribute yield and water productivity of rice *(Oryza sativa* L.) *Acta Agronomica Hungarica* 52:399-403.