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Effect of dates and methods of winter rice (*Oryza sativa* L.) transplanting on relayed niger (*Guizotia abyssinica*) and soil health

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ABSTRACT

A field experiment was conducted to study the effect of dates of transplanting under different methods of cultivation on productivity of winter rice (*Oryza sativa* L.) and their effect on rice-niger (*Guizotia abyssinica*) relay system at Regional Agricultural Research Station, Shillongani Nagaon, Assam during *kharif - rabi* seasons in the year 2014-15 and 2015-16. Rice transplanted on 20 June recorded significantly higher yield attributes and grain yield of rice (59.19 q/ha) as compared to the later dates of transplanting, and it was followed by 5 July- transplanted rice. Transplanting on 20 June resulted in higher values in respect of yield attributes, yield of relayed niger, rice equivalent yield (REY) of rice- niger relay system (75.68 q/ha), NPK uptake by rice and niger as well as soil fungal and bacterial population after harvest of rice and niger. System of Rice Intensification (SRI) recorded significantly higher value of yield attributes and grain yield of rice (60.34q/ha) as compared to conventional method. In case of relayed niger, yield attributes, seed yield and REY were found higher under SRI method of rice cultivation. Under SRI method, higher uptake of NPK by rice and niger and higher soil fungal and bacterial populations after harvest of rice and niger were observed as compared to conventional method. However, conventional method of rice cultivation recorded significantly higher values of soil available N, P_2O_5 and K_2O content at the end of two year-crop cycle over that of SRI.

Key words: Date of transplanting, Method of cultivation, Niger, Rice, System of rice intensification.

INTRODUCTION

Rice is the most important staple food crop of Assam, occupying first position in respect of both area and production. Like rice, oilseeds are also important food crops for which soil and climatic conditions of Assam are very congenial. In 2016-17, the state produced about 51.27 lakh ton of total rice from an area of 24.67 lakh ha but the production of oilseeds were very low i.e 2.04 lakh ton from 3.18 lakh ha (Anonymous 2017). Assam has achieved near self-sufficiency in rice production, however, it is always deficient in oilseeds. The requirement of oilseeds for the state was 3.95 lakh ton in 2016-17 (Anonymous 2017). This shows a deficit of 1.91 lakh ton. Therefore, along with rice, production of oilseed also needs special attention to meet their requirement for the burgeoning population. In Assam, rice- lands can easily be targeted for crop intensification. To increase oilseed production, the cultivated land area cannot be increased directly. In such cases, crop intensification through multiple cropping in rice and rice based cropping systems are of prime importance (Deka *et al.*, 2013).

In Assam, wide variation of physiographic features and climatic characteristics have resulted three distinct growing seasons of rice *viz.*, *Ahu* (Feb/March-june/July), *Sali* (June/July-Nov/December) and *Boro* (Nov/Dec-May/June). Among them winter rice, locally known as S*ali* rice, is the most important one, which occupies about 75% of total rice area, covering an area of 18-19 lakh ha contributing to 65.37% of the total rice production in the state. In Assam, productivity of winter (*Sali* rice) is low (2055 kg/ha) as compared to summer (*boro*) rice (2865kg/ha). Moreover, most of the farmers are small and marginal having fragmented land holding. In this case, the winter rice productivity per unit area can be increased by adoption of SRI.

One of the major constraints of growing *rabi* crops after *Sali* rice is delayed sowing due to delayed harvesting of *Sali* rice and problem of land preparation due to excessive residual soil moisture. However, this constraint can be overcome by growing *rabi* crops as relay crops with rice. Niger is normally grown as an arable crop in major oilseed growing areas. After winter rice harvest in late November/ early December, sowing of niger gets delayed. However, possibility is there for timely sowing of niger adopting the practice of relay cropping with rice. It is evident that relay cropping of certain oilseeds with winter rice is quite feasible and profit-making. However, study on relay cropping of niger with different dates and methods of winter rice transplanting in relation to production system sustainability is not yet done. Therefore, it becomes imperative to undertake the study to

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find out the optimum date of transplanting and method of cultivation of rice for increasing the productivity of rice-niger relay cropping system.

MATERIALS AND METHODS

A field experiment was conducted at Regional Agricultural Research Station, Shillongani, Nagaon, Assam during the rainy (*kharif*) and winter (*rabi*) seasons of 2014-15 and 2015-16. The climate of this region is sub-tropical with hot humid summer and relatively dry and cold winter. The crop experienced favourable weather conditions in both the years of experimentation. Total amount of rainfall received during the crop growth period were 1220.6 mm during 2014-15 and 1286.8 mm during 2015-16. The maximum temperature rises up to 36°C in July-August and the minimum falls to 7°C in January and the relative humidity from 82 to 95 % in the morning and from 64 to 85 % in the evening. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.61), medium in organic carbon (0.84 %), medium in available N (296 kg/ha), P_2O_5 (21 kg/ha) and K_2O (195 kg/ha). All the plots were fertilized with recommended dose of fertilizers as per the crops grown in different seasons. The treatments comprised three dates of rice transplanting *viz*., 20 June, 5 July and 20 July and two methods of rice cultivation *viz*., conventional and SRI method with niger as relay crop. The experiment was laid out in a factorial randomized block design with six treatment combinations replicated four times.

Winter rice variety 'Ranjit' and niger variety 'NG-1' were used for study. Niger seeds were broadcast @ 16 kg/ha in the standing rice crop at optimum soil moisture saturation prior to rice harvest of 10-30 days as per variation of dates of transplanting. Based on proper soil moisture content, niger was sown on 1 November in 2014 and 26 October in 2015. Rice was harvested from net plot while niger was harvested from gross plot. Soil samples were collected before sowing and at the end of second year to analyse for chemical properties following standard procedures. The plant samples (both seed and stover) of rice and niger were collected separately after threshing and dried in oven at 65°C for 72 hrs. The oven-dried samples were finely ground and chemically analysed for N, P and K content. The uptake of nutrients was calculated by multiplying the dry matter yield with respective percentage of nutrients.

For counting of soil microbial population *viz*., fungal and bacterial, soil samples from 0-15 cm depth from 3 spots of each plot were collected before transplanting of rice and at harvest of each crop and then fungal and bacterial populations in soil were enumerated by following the standard serial dilution technique and pour-plate method using different media (Pramer and Schmidt, 1965). The bacterial population was counted on third day and that of fungal population on fifth day of incubation using the following formula.

Total viable count = Average number of colonies X size of aliquot X Dilution factor

The REY of relay niger and rice-niger relay system were calculated by using the following formula.

$$\text{REY of niger} = \frac{\text{Yield of niger (q/ha)} \times \text{price of niger (Rs/q)}}{\text{Price of rice (Rs./q)}}$$

REY of rice-niger relay system =

Rice yield + REY of niger

Gross return of rice –niger relay system =

REY of rice- niger relay system (q/ha) × price of rice (Rs./q)

The data pertaining to each of the characters of the experimental crops were tabulated and finally analyzed statistically as per the procedure prescribed for Factorial RBD as well as Split Plot Design described by Panse and Sukhatme (1985). The significance or non-significance of the variances due to treatment effects was tested by 'F' test. Critical difference was calculated wherever 'F' test was significant.

RESULTS AND DISCUSSION

Yield attributes and grain yield of rice: Date of transplanting had no significant effect on panicle length in both the years (Table 1). The highest panicle weight of 6.08 g/panicle and 5.96 g/panicle were recorded in rice planted on 20 June which was at par with 5 July transplanting and was significantly higher than 20 July transplanting. This was due to production of higher number of filled grains/panicle in the former treatment.

Rice grown under SRI recorded significantly longer panicle (28.17 cm in 2014 and 27.89 cm in 2015) as compared to conventional method (Table 1). These results are in agreement with the findings of Singh *et al*. (2013) and Uzzaman *et al*. (2015). The methods of rice cultivation also exerted significant effect on panicle weight. The highest value (6.32 and 6.30 g/panicle during 2014 and 2015) was noted under SRI which was significantly higher than those under conventional method. Higher panicle weight was owing to higher number of filled grains/panicle under SRI. SRI accrued in significantly higher 1000-grain weight (20.50 and 20.43g in 2014 and 2015, respectively) than conventional method. Similar results were reported by Uzzaman *et al*. (2015) and Ranjitha and Reddy (2014). Higher 1000-grain weight in SRI might be due to better translocation of photosynthetates and dry-matter partitioning to the grains as compared to conventional method.

Different dates of transplanting had significant effect in grain yield (Table 1). The highest grain yield (59.61, 58.79 and 59.19 q/ha in 2014, 2015 and pooled, respectively) was recorded under 20 June which were at par with that of 5 July transplanting and were significantly higher than that of 20 July. Higher grain yield under early planting might be attributed to relatively early crop establishment, better

Table 1: Yield attributes and grain yield of rice as influenced by date of transplanting and method of cultivation of rice.

Treatment	Panicle length (cm)		Panicle weight (g/panicle)		1000-grain weight(g)		Grain yield (q/ha)		
	2014	2015	2014	2015	2014	2015	2014	2015	Pooled
Date of rice transplanting									
20 June	27.20	26.79	6.08	5.96	20.12	20.03	59.61	58.79	59.19
5 July	27.08	26.56	5.78	5.84	19.97	19.91	58.44	57.73	58.09
20 July	26.85	26.43	5.33	5.26	19.95	19.94	55.92	55.16	55.55
S. Em (±)	0.85	0.66	0.18	0.20	0.12	0.11	1.11	1.02	0.99
C.D. (P=0.05)	NS	NS	0.56	0.63	NS	NS	3.49	3.21	3.12
Method of cultivation									
Conventional	25.92	25.30	5.15	5.08	19.54	19.49	55.21	54.54	54.99
SRI	28.17	27.89	6.32	6.30	20.50	20.43	60.77	59.91	60.34
S. Em (±)	0.69	0.54	0.14	0.17	0.10	0.09	1.04	0.96	0.88
C.D. (P = 0.05)	2.19	1.71	0.44	0.53	0.32	0.30	3.28	3.05	2.77
Interaction									
S. Em (±)	1.20	0.94	0.27	0.39	0.17	0.16	1.98	1.87	1.79
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Total NPK-uptake by rice at harvest as influenced by date of transplanting and method of cultivation of rice.

Treatment	Total uptake (kg/ha)					
	Total N-uptake		Total P-uptake		Total K-uptake	
	2014	2015	2014	2015	2014	2015
Date of transplanting						
20 June	68.49	66.08	22.08	20.56	62.69	60.96
5 July	67.05	64.68	21.03	19.77	61.34	60.21
20 July	62.99	64.43	19.26	18.19	58.40	56.42
S. Em (±)	2.21	1.63	0.55	0.35	1.62	1.63
CD (P=0.05)	NS	NS	1.75	1.09	NS	NS
Method of cultivation						
Conventional	63.26	60.69	19.71	18.47	58.49	56.43
SRI	69.10	69.43	21.88	20.54	63.13	61.97
S. Em (±)	1.79	1.33	0.45	0.28	1.32	1.33
CD (P = 0.05)	5.66	4.19	1.43	0.89	4.18	4.19
Interaction						
S. Em (±)	3.11	2.31	0.78	0.49	2.30	2.31
CD (P = 0.05)	NS	NS	NS	NS	NS	NS

tillering, better uptake of N, P and K and thereby increased growth and yield attributes. Similar reduction in yield due to delayed transplanting was also reported by Ashem *et al.* (2010) and Changmai (2015). SRI recorded significantly higher grain yield (60.77, 59.91 and 60.34 q/ha in 2014, 2015 and pooled, respectively) than conventional method. Similar results were also reported by Singh *et al*. (2013) and Ranjitha and Reddy (2014). The increase in grain yield under SRI was owing to vigorous root growth resulting in better N, P and K uptake and reproductive growth.

Total nutrient uptake by rice: There was no statistical difference in total N and K-uptake by rice due to different dates of transplanting in both the years. However, its effect on total P uptake was significant (Table 2). The highest total P uptake (22.08 and 20.56 kg/ha in 2014 and 2015, respectively) was recorded in rice transplanted on 20 June and the lowest was on 20 July. SRI resulted in significantly higher uptake of total N (69.10 and 69.43 kg/ha), P (21.88 and 20.54 kg/ha) and K (61.13 and 61.97 kg/ha) in 2014 and 2015, respectively as compared to the conventional method. This was due to the higher yield and higher N, P and K content in grain and straw which was, in turn, because of better vegetative and reproductive growth leading to production of more biomass. These results are in agreement with the findings of Vallois and Uphoff (2000) and Ranjitha and Reddy (2014). In SRI method, application of more organic manure along with inorganic fertilizers and incorporation of weeds by cono weeder increased release of nutrients to the soil, which led to enhanced biomass production and ultimately resulted in higher NPK uptake.

Yield attributes and grain yield of relayed niger: The number of capitulum/plant differed significantly due to varying dates of rice transplanting in 2014-15 (Table 3). The highest number of capitulum/plant was recorded under rice

Table 3: Yield attributes and seed yield (q/ha) of niger as influenced by date of transplanting and method of cultivation of rice.

Treatment	Capitulum / plant		Seeds/ capitulum		1000 seed weight (g)		Seed yield (q/ha	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Date of rice transplanting (D)								
20th June	18.85	17.82	29.53	28.47	3.84	3.82	5.49	4.60
5th July	18.42	17.62	29.50	28.45	3.84	3.83	5.46	4.30
20th July	16.82	16.27	27.67	26.65	3.70	3.60	4.82	3.51
S. Em (±)	0.62	0.67	0.50	0.51	0.18	0.20	0.17	0.17
CD (P=0.05)	1.95	NS	NS	NS	NS	NS	0.54	0.56
Method of rice cultivation (M)								
Conventional	17.84	17.14	28.45	27.41	3.78	3.75	5.23	4.06
SRI	18.21	17.32	29.34	28.30	3.80	3.76	5.29	4.23
S. Em (±)	0.56	0.60	0.41	0.42	0.15	0.16	0.14	0.15
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (D x M)								
S. Em (±)	1.01	1.09	0.70	0.72	0.26	0.28	0.25	0.25
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Rice equivalent yield of niger and rice-niger relay system as influenced by date of transplanting and method of cultivation of rice.

Treatment	Rice equivalent yield of niger (q/ha)			Rice equivalent yield of rice-niger relay system (q/ha)		
	2014-15	2015-16	Pooled	2014-15	2015-16	Pooled
Date of rice transplanting						
20 June	17.57	14.72	16.14	77.04	74.31	75.68
5 July	17.47	13.76	15.62	76.00	72.20	74.10
20 July	15.42	11.23	13.32	71.35	67.15	69.25
S. Em (±)	0.55	4.10	0.23	2.22	1.73	1.81
CD (P=0.05)	1.75	0.57	0.73	NS	5.46	5.70
Method of rice cultivation						
Conventional	16.74	12.99	14.86	71.91	68.70	70.30
SRI	16.93	13.54	15.23	77.69	73.74	75.71
S. Em (±)	0.45	0.46	0.22	1.81	1.41	1.56
CD (P = 0.05)	NS	NS	NS	5.71	4.45	4.92
Interaction						
S. Em (±)	0.78	0.81	0.33	3.14	2.45	2.70
CD (P = 0.05)	NS	NS	NS	NS	NS	NS

Sale price of seeds of rice =Rs.1250.00/q and niger = Rs. 4000.00/q

Table 5: Total NPK-uptake by niger at harvest as influenced by date of transplanting and method of cultivation of rice.

Treatment	Total uptake by niger (kg/ha)					
	N-uptake		P-uptake		K-uptake	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Date of rice transplanting						
20 June	22.92	19.42	6.22	5.19	13.15	11.12
5 July	22.81	18.19	6.03	4.80	13.04	10.50
20 July	19.88	15.57	4.86	3.87	10.95	9.02
S. Em (±)	0.53	0.61	0.26	0.17	0.49	0.44
CD (P=0.05)	1.66	1.94	0.83	0.55	1.56	1.39
Method of rice cultivation						
Conventional	21.68	17.51	5.69	4.56	12.29	10.14
SRI	22.05	17.94	5.71	4.68	12.47	10.28
S. Em (±)	0.43	0.50	0.22	0.14	0.40	0.36
CD (P = 0.05)	NS	NS	NS	NS	NS	NS
Interaction						
S. Em (±)	0.75	0.87	0.38	0.25	0.70	0.62
CD (P = 0.05)	NS	NS	NS	NS	NS	NS

Table 6: Soil microbial population after harvest of rice and niger as influenced by date of transplanting and method of cultivation.

Treatment	After rice harvest				After niger harvest			
	Fungus (10^5 cfu/g soil)		Bacteria (10^6 cfu/g soil)		Fungus (10^5 cfu/g soil)		Bacteria (10^6 cfu/g soil)	
	2014	2015	2014	2015	2014	2015	2014	2015
Date of transplanting								
20 June	26.33	29.03	36.53	39.6	46.33	50.23	58.26	61.96
5 July	26.10	28.53	36.36	39.43	45.03	48.76	56.16	58.90
20 July	25.33	27.73	32.93	36.16	43.26	46.33	55.10	59.16
S. Em (±)	1.36	1.34	1.99	1.66	3.12	2.89	3.51	3.36
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Method of cultivation								
Conventional	25.76	28.15	35.10	38.30	43.37	46.88	55.08	58.91
SRI	26.25	28.70	35.45	38.49	46.38	50.00	57.93	61.11
S. Em (±)	1.11	1.10	1.62	1.36	2.54	2.36	2.86	2.74
CD P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Interaction								
S. Em (±)	2.73	2.71	3.99	3.33	4.41	4.09	4.96	4.769
CD P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Initial soil fungal population = 36.53 (10^5 cfu/g soil) and Initial soil bacterial population = 48.13 (10^6 cfu/g soil).

transplanted on 20 June followed by 5 July and significantly higher over 20 July in 2014-15. Higher number of capitulum /plant with early transplanted rice was owing to better growth of the relay crop favoured by desired days of association with early transplanted rice. Method of rice cultivation had no significant effect on capitulum/plant and both the factors failed to exert significant effect on seeds/capitulum and 1000-seed weight of relayed niger.

The different dates of rice transplanting had significant on seed yield of relayed niger. Significantly higher seed yield of niger was found in 20 June transplanting as compared to 20 July in both the years. Higher niger yield under 20 June transplanting was owing to better plant stand and higher capitulum/plant and seeds/capitulum (Anonymous 2014). There was no statistical difference between two methods of rice cultivation in respect of seed yield of niger.

Rice equivalent yield (REY) of relayed niger and rice-toria relay system: Date of transplanting had significant effect on REY of niger. Significantly higher REY of niger was found in 20 June transplanting than 20 July and was at par with 5 July transplanting (Table 4). The date of rice transplanting showed significant effect on rice equivalent yield (REY) of rice-niger relay system in 2015-16 and pooled. The highest REY of rice-niger system was recorded under 20 June rice transplanting which was at par with 5 July and were significantly higher than that of 20 July transplanting. This indicated that delay in rice transplanting cause significant reduction in yield of both rice and relay crops.

Method of rice cultivation had no significant effect on REY of niger. However, it had significant effect on REY of rice-niger relay system (Table 4). REY of rice-niger system under SRI was significantly higher than the conventional method and this was mainly because of the higher yield of both rice and niger under this treatment.

Total NPK-uptake by niger: Dates of rice transplanting showed significant effect on total NPK-uptake by niger. The highest total N, P and K-uptake by niger was recorded under 20 June rice transplanting which was at par with 5 July transplanting and both dates of transplanting were superior to 20 July transplanting (Table 5). Higher biomass production in niger under 20 June rice transplanting resulted in higher total N, P and K- uptake under this treatment. Method of rice cultivation had no significant effect on nutrient uptake by niger.

Table 7: Effect of date and method of rice transplanting on available N, P2O5 and K2O content in soil at the end of two year-crop cycle.

Treatment	Available N, P_2O_5 and K_2O content (kg/ha)		
	N content	P_2O_5 content	K_2O content
Date of rice transplanting			
20 June	294.02	17.31	154.54
5 July	303.95	16.56	160.72
20 July	321.07	22.59	172.97
S. Em (±)	2.91	17.31	2.43
CD (P=0.05)	9.17	2.78	7.68
Method of rice cultivation			
Conventional	299.83	16.89	148.14
SRI	312.85	20.76	177.35
S. Em (±)	2.37	16.56	1.99
CD (P = 0.05)	7.48	2.276	6.27
Interaction			
S. Em (±)	4.11	22.59	3.45
CD (P = 0.05)	NS	NS	NS

Soil fungal and bacterial population after rice and niger harvest: The different dates of transplanting and method of rice cultivation had no significant effect on soil fungal and bacterial population after rice and niger harvest (Table 6).

Soil nutrient status at the end of two year crop cycle: Dates of rice transplanting brought about significant differences in available N, P_2O_5 and K_2O content in soil (Table 7). The lowest available N, P_2O_5 and K_2O in soil was recorded under 20 June transplanting. As N, P and K uptake by rice and niger was higher under 20 June transplanted rice as compared to latter dates, lower available soil N, P_2O_5 and K_2O after harvest of niger was the resultant. Method of rice cultivation had also significant effect on the available N, P_2O_5 and K_2O in soil. Significantly higher available N, P_2O_5 and K_2O (312.85, 20.76 and 177.35 kg/ha, respectively) found under SRI as compared to conventional method might be owing to more nutrient availability and higher soil microbial population resulting from application of more organic manure. Similar findings were also reported by Singh *et al*. (1999) and Manna *et al*. (2006).

From this study, it can be concluded that for increasing yield of rice-niger relay system and rice equivalent yield of the system, winter rice is to be transplanted on 20 June adopting SRI method of cultivation.

REFERENCES

Annonymous, (2017). Economic Survey of Assam, 2017-18. Govt. of Assam, Transformation and Development Department, Directorate of Economics and Statistics.

Ashem, S. S., Thakuria, K. and Kurmi, K. (2010). Double transplanting of late transplanted *sali* rice under lowland situation**.** *Oryza*. **47**(4): 328-330.

Changmai, R. (2015). Planting techniques on productivity of organically grown scented rice (*Oryza sativa* L.) in Assam. *M. Sc.* (*Agri.*) *Thesis*, Assam Agricultural University, Jorhat.

Deka, P., Hazarika, C. and Das, P. (2013). Agricultural diversification in Assam under Trade Liberalization. *Journal of Academia and Industrial Research*. **2**(5):

Manna, K.K., Brar, B.S. and Dhillon, N. S. (2006). Influence of long term use of FYM and inorganic fertilizers on nutrient availability in a typic Ustochrept. *Indian J. Agric. Sci*. **76**(8): 477-480.

Panse, V.G. and Sukhatme, P.V. (1985). Statistical Methods for Agricultural Workers, Indian Council of Agricultural Research, New Delhi.

Pramer, D and Schmidt, E.L. (1965). *Experimental Soil microbiology*. Burgess Publi. Co. Minneaodis.

Ranjitha, P. S. and Reddy, K.I. (2014). Effect of different nutrient management options on rice under SRI method of cultivation- a review. *International Journal of Plant, Animal and Environmental Sciences.* **2**(1): 201-204.

Singh, A.P., Mitra, B.N. and Tripathi, R.S. (1999). Influence of soil enrichment with organic and chemical sources of nutrients on rice –potato cropping system. *Indian J. Agric. Sci.* **69**(5): 376-378.

Singh, R. K., Singh, A.N., Ram, H., Prasad, S. R. and Chauhan, R.K. (2013). Response of basmati rice varieties to system of rice intensification (SRI) and conventional method of rice cultivation. *Ann. Agric. Res. New Series*. **34**(1): 50-56.

Uzzaman, T., Sikder, R.K., Asif, M.I., Mehraj, H. and Jamal Uddin, A.F.M. (2015). Growth and yield trial of sixteen rice varieties under System of Rice Intensification. *Scientia*. *Agriculturae*. **11**(2): pp.81-89.

Vallois, P and Uphoff, N. (2000). System of Rice Intensificaion (SRI), Malagasy Early Rice Plantin System. *Technical pages*. **1**: 3.