



Yield Performance of Lowland Paddy under Different Cultural Treatments in Kawlchaw East, Saiha District of Mizoram, India

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Abstract – Field experiments were conducted during summer and kharif, 2009 at farmers' field in NAIP cluster area of Kawlchaw East village in Saiha district, Mizoram, India, to study the performance of improved rice variety (Shah Sarang and RCPL-187-4) against local (sticky) variety as test crops under different treatments viz., control (no fertilizers), NPK (85, 50 and 45 kg/ha) and NPK+biofertilizers. Nursery bed preparation, main field preparation, weeding and harvesting were performed as per the conventional system of rice cultivation. Results revealed that higher plant length at maturity were recorded with local varieties than improved varieties. Rate of tillering was more in improved varieties, highest recorded with RCPL-187-4 under NPK+biofertilizers (11.56 tillers.hill⁻¹). Longest panicle length was observed with Shah Sarang (21.48 cm) and most number of grains per panicle in RCPL-187-4 (96.33) with NPK+biofertilizers treatment. Improved variety produced more yield than local one with application of fertilizers. RCPL-187-4 produced highest grain yield (3.76 t/ha) and straw yield (8.95 t/ha), followed by Shah Sarang (3.40 t/ha) under NPK+biofertilizers treatment. Also, highest increase in grain yield (150.37 %) over control was achieved in RCPL-187-4 with NPK+biofertilizers. Higher harvest index was obtained from the plots treated with fertilizers than from control plots (without fertilizers). Shah Sarang recorded highest harvest index (34.34%) amongst the varieties. Local variety had an invariable response to different levels of nitrogen, while breeding variety had a variable response. Improved variety had more harvest index compared to local variety for most combinations of fertilizer application levels, indicating that they allocated higher material to storage organs and transmitted more products from sources to its sinks (kernels). Higher net returns per hectare were obtained in improved varieties than the local variety. Cultivating RCPL-187-4 under NPK+biofertilizers fetched the highest benefit-cost ratio of 2.71. The local variety was most profitable when cultivated in control conditions.

Keywords – Rice, NPK, Biofertilizer, Harvest Index, Benefit-Cost Ratio.

I. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the important food cereal crops in the world and ranks second in terms of area and production. 50 per cent of the population in Asia grows about 90 per cent of the world's rice is grown and consumed as the primary staple food [1]. India has the largest area under rice cultivation occupying 29.4 per cent of the global area, but has the lowest yield. Rice is grown in an area of 44.6 million ha with a production of 109.5 million tonnes and average productivity of 2.62 tonnes per

ha [2,3]. Rice is the principal cereal crop grown followed by maize in the North-eastern states of India to meet household food and nutritional security in the region. Different rice farming situations, viz. Direct seeded, rain fed in upland (on steep slopes); Direct seeded rain fed on level bench terraces; Transplanted on wet terraces; and Transplanted in valley lands are practised in the North Eastern Hills of India. In Mizoram, rice is the staple food and it is grown in an area of 0.0407 million ha with a production of 0.0472 million tonnes and productivity of 1.16 tonnes per ha during 2010-11 [4]. The state is lagging much behind the other advanced states as far as the production and productivity of rice are concerned. Most of the farmers still practice the traditional slash and burn *jhum* cultivation with local varieties following indigenous techniques and systems developed by the tribal farmers using their ingenuity and skill. Moreover, there are only a few patches of flat lands where permanent wet rice cultivation is possible, generally scattered in the middle of hills and narrow valleys.

Improved high yielding varieties (HYVs) of rice is one of the key technologies that can bring about a self sufficiency in rice production. Average rice yields have increased considerably with the introduction of HYVs and improved crop management technologies [5]. Different varieties perform differently in a particular environment. It is for this reason that this study was conceptualized to find out which among the numerous rice varieties is best adopted in order for the farmers to know the right variety to grow. The present study has been designed to evaluate the performance and compare cost and revenue of different varieties, using benefit cost ratio technique. The study will be helpful for farmers in terms of knowing about the cost and revenue parameters associated with the adoption of improved variety over the local varieties of rice in the study area. Thus, the findings of this study can contribute to the improvement of rice production in the study site.

II. MATERIALS AND METHODS

The present study was carried out at farmers' field in NAIP cluster area of Kawlchaw East village (Lat 22°24'05.0"N, Long. 92°57'23.0"E, 177 m asl) in Saiha district, Mizoram, India in 2009 summer and kharif season. Plant materials consisted three varieties Shah Sarang (V₁), RCPL-187-4 (V₂) (obtained from ICAR, Shillong) and local (sticky) rice variety (V₃). Field



experiment was conducted in a randomized complete block design with three replications. Treatments consisted of different fertilizer application methods viz., Control (T_0), NPK (T_1) @ 85, 50 and 45 kg/ha in two splits and NPK+biofertilizers (T_2) (Azospirillum and Phosphobacter @ 200g in 500 ml of water). Nursery bed preparation, main field ploughing and puddling under the conventional system of rice cultivation were performed in May. Fertilizer application was carried out after 15 days of puddling. Seeds were sown in May and 30 days old seedlings were transplanted with a spacing of 20cm x 20cm into the plots of sizes 3m x 3m in June. Hand weeding were done twice at 20 and 35 days after transplanting in July and August, each followed by adopted doses of fertilizer application. 10 hills from each plot were selected randomly and observations on growth and yield characters in the following traits were recorded at critical stages of crop growth: plant height (cm), number of tillers per hill, panicle length (cm) and number of grains per panicle. The crop of each plots was harvested separately during October at full maturity when 90% of the grains become golden yellow in colour. The grain and straw weight of each plot were recorded after proper sun drying from crop harvested and then converted into $t.ha^{-1}$. The grain yield is adjusted at 12 % moisture level. Harvest index was calculated by using the following formula: Harvest index = (Grain yield) / (Grain + straw yield). Benefit Cost Ratios of different rice varieties has been calculated for finding the most profitable rice variety in terms of total and net revenue. More specifically the Benefit Cost Ratio (BCR) for each variety was: $BCR = VNR / TC$ where, VNR = Variety net revenue and TC = Total cost of the variety

III. RESULTS AND DISCUSSION

3.1. Growth attributes

Growth parameters of rice as influenced by different methods of rice cultivation are presented in Table 1. The average height of the different rice varieties tested differed from each other at maturity and according to treatments. Rice variety V_3 recorded the tallest height under T_2 treatment among the three varieties with a mean height of 89.36 cm and the shortest was observed in V_1 under T_0 treatment with a mean of 65.46 cm. The local variety produced more plant height than the improved varieties tested. The variation in plant height could be attributed to their genetic variability. The most number of tillers per hill was recorded with V_2 (11.56) under treatment T_2 . The more number of tillers in the improved varieties (V_1 and V_2) than the local variety (V_3) is thus supported as stated by others [6,7] that improved rice varieties have relatively high tillering capacity. The efficiency and production of tillers depended on environmental factors, however, nutrients absorbed and carbohydrates metabolized have also been demonstrated to play a role in tiller development [8]. Longest panicle length was observed with variety V_1 (21.48 cm) under treatment T_2 and most number of grains per panicle was observed in variety V_2 (96.33) under treatment T_2 . The differences in panicle length among the

rice varieties could be attributed to their genetic make-up. Maximum number of grains per panicle in treatment combination V_2T_3 showed its suitability to existing climatic condition of the place especially during the grain-filling stage of the panicle development. Varietal differences in number of filled grains per panicle in paddy has also been observed by others [9]. It was also observed that the plant height, number of tillers per hill, panicle length and number of grains per panicle, in each of the varieties increased in the order of treatments as $T_2 > T_1 > T_0$. Some authors [10, 11] also reported the increase in growth and yield components of rice with the application of N fertilization. Similar results were reported for lowland rice in other studies [12] that panicle length of rice varieties increased with the increasing rate of P fertilizer. The reduced number of grains per panicle from the control (T_0) plots in each of the varieties was mainly due to the lack of phosphorous as it is a limiting nutrient for grain filling. As seen from Table 1, the improved varieties showed superiority over local variety in number of tillers, panicle length and number of grains per panicle, while local variety produced higher plant height than improved variety. On the basis of these results, it seems that despite producing higher biomass, local varieties could not allocate more materials to the economic parts of plant; i.e. could not transmit more carbohydrate from sources towards kernels [13].

3.2 Yield and Harvest Index

The grain yield, straw yield and harvest yield of different rice varieties tested as influence by different rice cultivation methods are presented in Table 2. In the absence of any treatment, the grain yield of local variety, V_3 was $1.31 t.ha^{-1}$ as compared to $1.58 t.ha^{-1}$ and $1.50 t.ha^{-1}$ of improved varieties, V_1 and V_2 respectively. This result is in conformity that hybrid rice yield is 20-30% more than the conventional varieties [14]. It was also observed that in each of the varieties, the grain yield per hectare increased in the following order of treatments given as $T_2 > T_1 > T_0$. Grain yield ha^{-1} increased with the increment of the fertilizer doses. Highest grain yield of $3.76 t.ha^{-1}$ was recorded with treatment combination V_2T_2 and the lowest grain yield of $1.31 t.ha^{-1}$ from the treatment combination V_3T_0 . The greatest grain yield by the use NPK and NPK+biofertilizers were both observed with the variety RCPL-187-4 with increase of 88.15 % and 150.37 % respectively over the control (without fertilizers). The higher yield reported may be due to more filled grains per panicle and more number of tillers. El-Rewainy [15] reported that applying 40 kg N/fed caused significant increase in plant height, number of panicles/ m^2 , panicle length, panicle weight, number of filled grains/panicle as well as grain and straw yields while P fertilizers application showed significant increase in grain yield in other studies [16] over control treatments. The highest straw yield was obtained from the treatment combination of V_2T_2 ($8.95 t.ha^{-1}$) and the lowest from the treatment V_1T_0 ($4.87 t.ha^{-1}$). It was observed in the improved varieties, the straw yield increased with levels of treatments as $T_2 > T_1 > T_0$, while the straw yield of local variety had decreased with the level of treatment as



$T_2 < T_1 < T_0$. This result, thus indicate that local varieties had an invariable response to different levels of fertilization while the improved varieties had a variable response [17]. Numerically the maximum harvest index was obtained from the variety improved variety, Shah Sarang and the lowest harvest index was obtained from the local variety. Greater harvest index was obtained from the treatment plots and the lowest from control plots (without fertilizers). The harvest index (%) differed from 13.26 to 34.34 across the variety and fertilizer application levels. Among the treatment combination, V_1T_2 produced the highest harvest index (34.34%) which was followed by V_1T_1 (32.42%) and V_2T_2 (29.56%). The lowest value of harvest index (13.26%) was obtained from the treatment combination of V_3T_0 . Higher harvest index in improved varieties thus indicate efficient partition of photosynthetic products for grain production of economic yield. Such significant differences may due to the characteristics of each variety which include number of filled grains, length of panicle and tillering capacity.

3.3 Benefit-cost ratio

Costs of cultivation per hectare of the different varieties under various methods of cultivation were computed and are presented in Table 3. Almost the same average cost was observed for all the varieties under different treatments valued at local market price. Local varieties incurred a slight higher cost due to higher price of seed materials. Net return values per hectare were lesser from the control plots as compared with the fertilizer treated plots in case of improved varieties, owing to higher grain and straw yields from these treated plots. Whereas in the case of local variety, net return values did not increase with increase in cost of cultivation. It could be seen that the highest net returns were obtained in improved varieties, V_1 (Rs 39900) and V_2 (Rs 47750) than the local variety, V_3 (Rs 24510) when subjected to NPK+biofertilizer treatment, T_3 which yielded maximum grain. It was also observed that the benefit-cost ratio of the improved varieties increased with level of treatments applied as $T_2 > T_1 > T_0$. Highest benefit-cost ratio of 2.71 was achieved V_2T_2 treatment combination, indicting the most profitable variety. Local variety had higher benefit-cost ratio from control plot than the treated plots, thus showing its incompetence to greater yield with fertilizer application.

IV. CONCLUSION

Having compared the growth attributes, yield components total costs, total production and total net production of the different improved and local rice varieties, under different levels of fertilizer application treatments, RCPL-187-4 was observed the most profitable variety followed by Shah Sarang to be cultivated under NPK+biofertilizer application. Local (sticky) variety can

be most profitably cultivated under control (no fertilizers) conditions. Awareness about the cultivation of these improved profitable varieties should be created.

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REFERENCES

- [1] Said, A., Zada, A. and Tahir, M. 2000. Improved cultural practices for profitable rice production in North West Frontier Province. Pakistan: TASRAN Computer Associate, Mingora, Swat.
- [2] Devi, K.S. and Ponnarasi, T. 2009. An Economic Analysis of Modern Rice Production Technology and its Adoption Behaviour in Tamil Nadu. *Agricultural Economics Research Review* Vol. 22, pp 341-347.
- [3] Directorate of Rice Development. 2011. State-wise area, production and productivity of rice during 2006-07 to 2010-11. Directorate of Rice Development, Government of India, Ministry of Agriculture (Deptt. of Agri. & Co-operation) 250 – A, Patliputra colony, Patna-800013 (BIHAR).
- [4] PhilRice, 2002. Hybrid Rice. "Q&A". Series No. 01. May 2002. RhiLRice Maligaya, Muñoz, Nueva Ecija. p. 4-6.
- [5] Zhende, Y. 1988. Proceedings of the International Symposium on Hybrid Rice. "Agronomic Management of Rice Hybrids Compared with Conventional Varieties". Changsha, Hunan, China.
- [6] De Datta, S. K. 1984. Crop establishment techniques and cultural practices for upland rice. In An overview of upland rice research. IRRI. pp 357-378.
- [7] Ntanos, D.A. and Koutroubas, S.D. 2002. Dry matter and N accumulation and translocation for Indica and Japonica rice under Mediterranean conditions. *Field Crops Res.* 74: 93-101.
- [8] Obaidullah, M. 2007. Influence of clonal tillers age on growth and yield of inbred and hybrid rice. M.S. Thesis Dept. Agron., Sher-e-Bangla Agricultural University. Dhaka-1207.
- [9] Fageria, N. K., Baligar, V.C. and Clark, R.B. 2006. *Physiology of Crop Production*. New York: The Haworth Press.
- [10] Fageria, N. K. 2009. *The Nutrient Use of Crop Plants*. Boca Raton, FL: CRC Press.
- [11] Sahar, A. and Burbey, N. 2003. Effect of nitrogen, phosphorus and potassium (NPK) compound dosages on the growth and yield of lowland rice. *J. Stigma (Indonesia)*, 11(1): 26-29.
- [12] El-Batal, M.A., AbdEl-Gawad, M.H., Fatma Abdo, A. and El-Set AbdEl-Aziz, A. 2004. Zagazig. *J. Agric. Res.*, 31, 473-490.
- [13] IRRI. 1988. Hybrid Rice. International Rice Research Institute. Los Banos, Laguna p. 25
- [14] El-Rewainy, I.M.O. 2002. The effect of different nitrogen fertilizer source on yield and some agricultural characters in rice. Ph.D., Thesis, Fac. Agric., Shebin El-Kom, Menofia Univ., Egypt.
- [15] Zaman, S.K., Razzaque, M.A., Karim, S.M.R. and Bhuiyan, N.I. 1995. Rice response to phosphorus in wetland soil. *Pakistan J. Sci. Ind. Res.*, 38(11-12): 438-440.
- [16] Ahmadikhah A. and Mirarab, M. 2010. Differential response of local and improved varieties of rice to cultural practices. *Archives of Applied Science Research*, 2 (5): 69-75.
- [17] IRRI. 1973. Annual report for 1972. International Rice Research Institute. Los Banos, Philippines.



Table 1: Average Growth performance of different rice variety in Kawlchaw East, NAIP-ICAR cluster, Saiha district of Mizoram

Growth parameters	Treatments	Rice variety		
		Shah Sarang (V ₁)	RCPL-187-4 (V ₂)	Local (sticky) (V ₃)
Plant height (cm)	Control (T ₀)	65.46	62.15	67.35
	NPK (T ₁)	78.47	76.26	78.42
	NPK+biofertilizer (T ₂)	79.36	80.42	89.36
No. of tillers (per hill) after 90 days transplantation	Control (T ₀)	6.72	7.52	4.36
	NPK (T ₁)	9.52	10.24	6.38
	NPK+biofertilizer (T ₂)	11.24	11.56	7.08
Panicle length (cm)	Control (T ₀)	20.42	18.46	13.36
	NPK (T ₁)	21.22	20.48	13.38
	NPK+biofertilizer (T ₂)	21.48	20.48	15.52
No. of grains per panicle	Control (T ₀)	75.38	72.78	54.25
	NPK (T ₁)	80.25	84.46	66.56
	NPK+biofertilizer (T ₂)	88.35	96.33	68.37

Table 2: Harvest index (%) of rice varieties under different treatments in Kawlchaw East, NAIP-ICAR cluster, Saiha district of Mizoram

Treatments	Dry Grain Yield (t/ha)	Dry Straw Yield (t/ha)	Harvest index (%)
V ₁ T ₀	1.58	4.87	24.48
V ₁ T ₁	2.90 (83.80)	6.05 (24.20)	32.42
V ₁ T ₂	3.40 (115.49)	6.50 (33.56)	34.34
V ₂ T ₀	1.50	5.18	22.44
V ₂ T ₁	2.82 (88.15)	7.84 (51.29)	26.46
V ₂ T ₂	3.76 (150.37)	8.95 (72.62)	29.56
V ₃ T ₀	1.31	8.58	13.26
V ₃ T ₁	1.47 (11.86)	8.14 (-5.04)	15.26
V ₃ T ₂	1.71 (30.51)	8.11 (-5.42)	17.42

V₁- Shah Sarang; V₂- RCPL-187-4; V₃- Local (sticky) variety,
T₀- Control; T₁- NPK; T₂- NPK+biofertilizer
Figures in brackets indicate increase % over control values

Table 3: Cost of plantation and Benefit-cost ratio analysis of three different rice variety in the NAIP-ICAR cluster at Kawlchaw East, Saiha district of Mizoram

Input/Outputs/Returns (in *INR per ha)		Rice Variety								
		Shah Sarang			RCPL-187-4			Local (sticky)		
		T ₀	T ₁	T ₂	T ₀	T ₁	T ₂	T ₀	T ₁	T ₂
Inputs	Ploughing	2000	2000	2000	2000	2000	2000	2000	2000	2000
	Puddling	1500	1500	1500	1500	1500	1500	1500	1500	1500
	Seeds	600	600	600	600	600	600	800	800	800
	Raising Nursery	2000	2000	2000	2000	2000	2000	2000	2000	2000
	NPK	-	3000	3000	-	3000	3000	-	3000	3000
	Biofertilizer	-	-	500	-	-	500	-	-	500
	Transplanting	3000	3000	3000	3000	3000	3000	3000	3000	3000
	Weeding	1000	1500	1500	1000	1500	1500	1000	1500	1500
Harvesting	3500	3500	3500	3500	3500	3500	3500	3500	3500	
Cost of cultivation		13600	17100	17600	13600	17100	17600	13800	17300	17800
Outputs	Grain yield	23700	43500	51000	22500	42300	56400	26200	29400	34200
	Straw yield	4870	6050	6500	5180	7840	8950	8580	8140	8110
Gross returns		28570	49550	57500	27680	50140	65350	34780	37540	42310
Net returns		14970	32450	39900	14080	33040	47750	20980	20240	24510
Benefit-cost ratio		1.10	1.90	2.27	1.04	1.93	2.71	1.52	1.17	1.38

T₀- Control; T₁- NPK; T₂- NPK+biofertilizer
Source: Field survey (* rates as per existing local market price)