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Economics of various INM modules of Basmati rice under various cultivation practices

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Abstract
Rice (*Oryza sativa*, L) is a staple food for more than 70 per cent of the people living in the Asian continent where more than 90 per cent of rice produced and consumed. In India rice is presently grown in an area of 43.86 M-ha with the production of 104.80 mt which is about 21.81% of world total food production (Agricultural statistics at glance 2015). Lay out of the experiment Crop, Variety, Design Main plot, Sub plot, Replication, No. of treatment, Total no. of plots, Plot size, SRI, Transplanting, Broad casting, Recommended doses of fertilizers (kg ha^{-1}), The treatments and their symbols used in layout in Cultivation practices SRI, Transplanting and Broad casting C_1, C_2 and C_3, INM modules 100% NPK + Zn, 75% NPK+Zn +25% FYM-N, 75% NPK+Zn+25% G.M-N, 50% NPK +Zn+25% FYM-N+25% GM-N and 75% FYM-N+25% GM-N symbols used in T_1 T_2 T_3 T_4 and T_5 respectively. Used of recommended dose for NPK+ZnSo$_4$ (120, 60, 60, 25 kg ha^{-1}). On the basis of pooled analysis of both the years the maximum grain yield (40.4 q ha^{-1}) were recorded in SRI (C_1). On the basis of pooled analysis of both the years the maximum straw yield (56.5 q ha^{-1}) were recorded in SRI (C_1). The maximum cost of cultivation (Rs.41508 and 42462 ha^{-1}) were computed under the cultivation practices C_2- transplanting with INM modules, highest net return (Rs.83007 and 87839 ha^{-1}) with benefit cost ratio (2.58 and 2.66) was computed under the cultivation practice C_1 with INM module T_3.

Keywords: Basmati rice, INM, SRI, transplanting and broad casting, yield, harvest index etc.

Introduction
Rice (*Oryza sativa*, L) is a staple food for more than 70 per cent of the people living in the Asian continent where more than 90 per cent of rice produced and consumed. It is extensively grown in tropical and sub-tropical regions of the world. It is grown in 112 countries in the world, covering every continent and is consumed by 2500 million people in developing countries (Datta and Khush, 2002) [3]. In India rice is presently grown in an area of 43.86 M-ha with the production of 104.80 mt which is about 21.81% of world total food production (Agricultural statistics at glance 2015). The production and productivity of scented rice are very low in India. The area under its cultivation has remain at 0.5-0.6 million hectares and production has stagnated at 1.0-1.5 million tones (Anonymous, 2014) [1]. SRI was developed in 1980 by Henri de Laulanie, a French Jesuit working with Madagascar farmers and formed a NGO "Association Tefy Saina", who spent more than three decades in Madagascar trying to devise better production methods that would improve the lives of rural household, who were impoverished and heavily dependent on rice (Laulanie, H, 1993) [10]. Integrated nutrient management (INM) aims to improve soil health and sustain high level of productivity and production (Prasad, B. and Prasad, R.(1995) [12].

Materials and Methods
This materials and methods deals with the details of materials used, experimental procedures followed and techniques adopted during the course of present investigation entitled "Economics of various INM modules of basmati rice under various cultivation practices". The present investigation was carried out at Instructional Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) during *kharif* season of 2014 & 2015. lay out of the experiment Crop, Variety, Design Main plot, Sub plot,Replication, No. of treatment, Total no. of plots, Plot size, SRI Transplanting, Broad casting, Recommended doses of fertilizers (kg ha^{-1}), Source of fertilizer and organic manure Paddy Variety (Pusa Basmati-1), Split Plot Design (SPD), Method of cultivation, INM Modules, 3, 5x3=15, 15x3=45, 5m x4m=20m^2, 25x25, 20x10, No distance, N:P:K:ZnSo$_4$ (120,60,60,25), Urea, DAP, Muriate of Potash, FYM, and Green Manure, Zinc sulphate respectively. Green mannuring through Sesbania crop.

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Treatments detail: The treatments and their symbols used in layout in Cultivation practices SRI, Transplanting and Broad casting C_1, C_2 and C_3,INM modules 100%NPK + Zn, 75%NPK+Zn +25% FYM-N, 75%NPK+Zn+25%G.M-N, 50% NPK +Zn+25%FYM-N +25% GM-N and 75% FYM-N + 25% GM-N symbols used in T_1 T_2 T_3 T_4 and T_5 respectively.Used of recommended dose for NPK+$ZnSo_4$ (120, 60, 60, 25 kg ha^{-1}).

Seed sowing and nursery raising: For direct seeding treatments the seed rate of 40 kg ha^{-1} was used for broad-casting. The seed were soaked in water for 12 hours, and covered with moist gunny bag for 24 hours for sprouting. For transplanting and SRI, the nursery was raised by sowing of the seed at the rate of 40 kg ha^{-1} and 6 kg ha^{-1}, respectively. In direct seeding methods the sowing was done by broad-casting of sprouted seeds. The date of direct seeding treatment and sowing in the nursery for transplanting and SRI in main field were kept same and it was done on 27th june in 2014 and 29th june in 2015, respectively.

Yield and yield attributes: Finally grain and straw yield per plot was converted in q/ha by conversion factor. Different values were calculated for each treatment as per details given below: Gross return (Rs ha^{-1}) = Total income from grain and straw yields, Net return (Rs. ha^{-1}) = Gross return – total cost of cultivation and Benefit cost ratio= Net return/total cost of cultivation. Harvest index of experimental plot was calculated with the help of following formula.

$$\text{Harvest Index (\%)} = \frac{\text{Economic Yield (Grain yield)}}{\text{Biological Yield (Grain + straw)}} \times 100$$

Inter culture operation

Table 1: Calendar of operations has been given as under transplanting cultivation system 2014 and 2015

S. No.	Operation	2014	2015	S. No.	Operation	2014	2015
1.	Nursery sowing	27.06.14	29.06.15	9.	Spacing	20x10 cm	20x10 cm
2.	Ploughing	17.07.14	19.07.15	10.	Hand weeding	13.08.14	13.08.15
3.	Harrowing and planking	18.07.14	20.07.15	11.	1st top dressing of urea	15.08.14	14.08.15
4.	Layout and bunding	19.07.14	21.07.15	12.	2nd hand weeding	01.09.14	03.09.15
5.	Basal fertilizer application	20.07.14	21.07.15	13.	2nd top dressing of urea	03.09.14	06.09.15
6.	Puddling	21.07.14	22.07.15	14.	Harvesting	10.11.14	13.11.15
7.	Transplanting	22.07.14	23.07.15	15.	Threshing and weighing	16.11.14	18.11.15
8.	Irrigation	As per need	As per need				

Table 2: Calendar of operations has been given as under **SRI cultivation** system 2014 and 2015

S. No.	Operation	2014	2015	S. No.	Operation	2014	2015
1.	Nursery sowing	27.06.14	29.06.15	9.	Irrigation	As per need	As per need
2.	Ploughing	06.07.14	08.07.15	10.	Hand weeding	30.07.14	02.08.15
3.	Harrowing and planking	07.07.14	09.07.15	11.	1st top dressing of urea	02.08.14	04.08.15
4.	Layout and bunding	08.07.14	10.07.15	12.	2nd hand weeding	20.08.14	22.08.15
5.	Basal fertilizer application	08.07.14	10.07.15	13.	2nd top dressing of urea	23.08.14	25.08.15
6.	Puddling	09.07.14	11.07.15	14.	Harvesting	30.10.14	02.11.15
7.	Transplanting	10.07.14	12.07.15	15.	Threshing and weighing	05.11.14	07.11.15
8.	Spacing	25x25 cm	25x25 cm				

Table 3: Calendar of operations has been given as under Broadcasting sowing cultivation system 2014 and 2015

S. No.	Operation	2014	2015	S. No.	Operation	2014	2015
1.	Ploughing	22.06.14	24.06.15	8.	Hand weeding	23.07.14	25.07.15
2.	Harrowing and planking	23.06.14	25.06.15	9.	1st top dressing of urea	25.07.14	27.07.15
3.	Layout and bunding	24.06.14	26.06.15	10.	2nd hand weeding	20.08.14	22.08.15
4.	Basal fertilizer application	25.06.14	27.06.15	11.	2nd top dressing of urea	22.08.14	24.08.15
5.	Puddling	26.06.14	28.06.15	12.	Harvesting	28.10.14	30.10.15
6.	Sowing	27.06.14	29.06.15	13.	Threshing and weighing	02.11.14	04.11.15
7.	Irrigation	As per need	As per need				

Experimental Findings

Grain yield (q ha $^{-1}$): On the basis of pooled analysis of both the years the maximum grain yield (40.4 q ha^{-1}) were recorded in SRI (C_1) which was 16.38% higher than Conventional (C_2) and the minimum (27.6 q ha^{-1}) in Broadcasting (C_3) which was 25.78% lower over Transplanting (C_2) method. The pooled data of the both years of investigation revealed that the maximum grain yield was recorded in T_3 (37.3 q ha^{-1}), followed by T_1 (36.3 q ha^{-1}) while the minimum in T_5 (30.8 q ha^{-1}). It was also found that T_3 showed only 2.83% increase and T_5 recorded 19.23% decreased over T_1 (RDF) treatment respectively. The interaction among the method of cultivation and different INM modules were found non significant.

Straw yield (q ha $^{-1}$): On the basis of pooled analysis of both the years the maximum straw yield (56.5 q ha^{-1}) were recorded in SRI (C_1) which was 11.16% higher than Conventional (C_2) and the minimum (41.8 q ha^{-1}) in Broadcasting (C_3) which was 21.69% lower over Transplanting (C_2) method. The pooled data analysis of the both the years showed that the maximum straw yield was recorded in T_3 (52.1 q ha^{-1}), followed by T_1 (51.5 q ha^{-1}) while the minimum in T_5 (47.1 q ha^{-1}). It was also found that T_3 showed only 1.20% increase and T_5 recorded 9.17% decreased over T_1 (RDF) treatment respectively. The interaction among the method of cultivation and different INM modules were found non significant.

Harvest index: On the basis of pooled analysis of both the years the maximum harvest index (41.6%) were recorded in SRI (C_1) which was 2.51% higher than Conventional (C_2) and the minimum (39.7%) in Broadcasting (C_3) which was 2.11% lower over Transplanting (C_2) method. On the basis of pooled data analysis of the both the years the maximum harvest index was recorded in T_3 (41.6%), followed by T_1 (41.0%) while the minimum in T_5 (39.4%). It was also found that T_3 showed only 1.48% increase and T_5 recorded 3.87% decreased over T_1 (RDF) treatment respectively. The interaction among the method of cultivation and different INM modules were found non-significant.

Cost of cultivation: A cursory glance over the data presented in table (5) obviously showed that the cost of cultivation varied due to wide deference in combination of inorganic and organic manure in different INM modules. The maximum cost of cultivation (Rs.41508 and 42462 ha^{-1}) were computed under the cultivation practices C_2- transplanting with INM modules T_5 (75% FYM-N + 25% GM-N) followed by C_2-transplanting with INM modules T_4 (50%NPK +Zn+25% FYM-N +25% GM-N) and the minimum cost of cultivation (Rs.30310 and 31190 ha^{-1}) was obtained under cultivation practices C_1 and $T_{1,}$ during the year 2014 and 2015, respectively.

Table 4: Effect of INM modules on Grain yield, straw yield and harvest index of basmati rice under various cultivation practices

Treatments	Grain yield (q/ha)			Straw yield (q/ha)			Harvest index (%)		
	2014	2015	Polled	2014	2015	Polled	2014	2015	Polled
A. Cultivation practices									
C_1	39.5	41.3	40.4	55.5	57.5	56.5	41.5	41.7	41.6
C_2	33.9	35.5	34.7	50.0	51.7	50.8	40.4	40.7	40.6
C_3	27.0	28.2	27.6	41.0	42.5	41.8	39.6	39.8	39.7
SEm ±	0.6	0.5	0.4	1.0	0.9	0.6	0.7	0.6	0.4
C D(P=0.05)	2.6	2.3	1.5	3.9	3.6	2.2	2.9	2.6	1.6
B. Integrated nutrient management modules									
T_1	35.5	37.1	36.3	50.6	52.4	51.5	41.0	41.3	41.0
T_2	33.8	35.3	34.6	49.0	50.7	49.8	40.7	40.9	41.0
T_3	36.5	38.1	37.3	51.2	53.0	52.1	41.5	41.7	41.6
T_4	31.4	32.9	32.2	47.1	48.7	47.9	40.0	40.2	40.1
T_5	30.1	31.5	30.8	46.3	48.0	47.1	39.3	39.6	39.4
SEm ±	0.8	0.8	0.5	1.0	1.1	0.8	0.7	0.7	0.3
C D(P=0.05)	2.4	2.5	1.6	3.9	3.4	2.3	2.0	2.0	0.9

Gross Return: A perusal of data presented in table (5) reveals that the maximum gross return (Rs.115072.00 and 120784.00 ha^{-1}) was computed under the cultivation practices C_1- transplanting with INM module T_3 followed by $C_1$with T_1 and minimum gross return ha^{-1} (Rs.65564.00 and 68448.00 ha^{-1}) was computed under cultivation practices C_3 with INM module T_5during the year 2014 and 2015, respectively.

Net return and Benefit cost ratio: The data pertaining to net return and benefit cost ratio exhibited in table (4) revealed that the highest net return (Rs.83007 and 87839 ha^{-1}) with benefit cost ratio (2.58 and 2.66) was computed under the cultivation practice C_1 with INM module $T_{3,}$ and minimum net return (Rs.27653 and 29477 ha^{-1}) with benefit cost ratio (0.72 and 0.75) was computed under the cultivation practices C_3 and INM modules T_5 during the year 2014 and 2015, respectively.

Table 5: Economic of various treatment combinations

Treatments combination	Total cost of cultivation (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		BCR (Rs^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015
C_1T_1	30310	31190	111988	116924	81678	85734	2.69	2.74
C_1T_2	31865	32745	106998	111592	75133	78837	2.35	2.40
C_1T_3	32065	32945	115072	120784	83007	87839	2.58	2.66
C_1T_4	32620	34500	100194	104506	66574	70006	1.98	2.02
C_1T_5	35480	36360	95798	100002	60318	63642	1.70	1.75
C_2T_1	36338	37292	97356	101634	61018	64342	1.67	1.72
C_2T_2	37893	38847	92872	96944	54979	58097	1.45	1.49
C_2T_3	38093	39047	97089	101364	58996	62317	1.54	1.59
C_2T_4	39648	40602	86766	90586	47118	49984	1.18	1.23
C_2T_5	41508	42462	83546	87224	42038	44762	1.01	1.05
C_3T_1	32741	33801	76710	72880	43969	39079	1.34	1.15
C_3T_2	34296	35356	73262	75480	38966	40124	1.13	1.13
C_3T_3	34496	35556	81494	85072	46998	49516	1.36	1.39
C_3T_4	36051	37111	68048	71050	31997	33939	0.88	0.91
C_3T_5	37911	38971	65564	68448	27653	29477	0.72	0.75

Result and Discussion

Grain yield, straw yield and harvest index: The data related to grain yield, straw yield and harvest index are presented in the Table No. (4).The maximum grain yield, straw yield and harvest index were recorded under C_1-SRI as compared to other cultural practices. These result may be attributed to the higher growth and yield attributing characters in SRI, the younger seedling might have adopted the transplanting shock quickly and established themselves well from very early stage that help in promoting early growth and yield contributing characters which may be responsible for better growth and higher grain and straw yield and harvest index as compared with planting of older seedling. The greater space (25 x 25 cm) in SRI also provide chance to plants for absorbing higher nutrients and better growth. These could be corroborated with the findings of Premi and Kalia (2003) [13], Reddy *et al.* (2003) [14], Mulu (2004) [11], Gupta and Sharma (2007), Ghosh *et al.* (2014) [6] and Ghosh *et al.* (2015) [4, 5]

As the INM modules are concern, the maximum grain, straw yield and harvest index are observed under T_3-75% NPK + Zn + 25% GM-N followed by T_1-100% NPK + Zn. It may be attributed to maximum growth and yield contributing characters recorded in T_3 followed by T_1. the higher yields in GM-N based INM treatment as compared to FYM-N based INM treatment may be because FYM-N slowly mineralized as compared to GM-N. thus the availability of nutrients by FYM become slower than GM. Further many other growth promoting substances also release during decomposition of green manure. This might be because the Sesbania green manure slowly but continuously maintains nitrogen supply during most of rice growing season. Further organic manure alone in combination with inorganic fertilizer might prevent nutrient losses due to its slow release and might supply nutrient in optimum amount with crop demand responsible for increase in grain, straw yield and harvest index. These results could be corroborated with the findings of Khursheed*et al.* (2013), Ghosh *et al.* (2014) [6] and Ghosh *et al*. (2015) [4, 5].

The variation in the cost of cultivation was found due to variation in doses of Inorganic and organic manure which is the major inputs. Grain yield was major output factor, which caused difference in net income and net return per rupees invested in table (5). The highest net return (Rs. 83007 and 87839 ha^{-1}) was found under treatment combination of C_1-T_3 which was closely followed by C_1-T_1- 100% NPK+Zn (Rs. 81678 and 85734 ha^{-1}) in the Ist and IInd, year of experimentation. The variation in cost of cultivation might be due to variation in cost of different INM modules. Similar findings were observed by Sharma *et al.* (2006) [15] and Zayed *et al.* (2013) [19].

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