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Influence of different rice establishment methods on yield, labour productivity, economic water productivity and energetics in CO (R) 51

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ABSTRACT

A field experiment was conducted at wetland farm of Tamil Nadu Agricultural University, Coimbatore during kharif 2017 to study the influence of different rice establishment methods on yield, labour productivity, economic water productivity and energetics in CO (R) 51. The experiment was carried out with five transplanting and four direct sown methods of establishment. The results revealed that crop established through square planting (SRI) with single seedling recorded significantly higher grain yield (6860 kg/ha), straw yield (10195 kg/ha), total output energy (228092 MJ), net energy gain (210452 MJ) and energy use efficiency (12.9%) compared to other establishment methods. Among the different rice establishment methods labour productivity (2.38) and economic water productivity (Rs 93.8/ha mm) were registered higher in drum seeding method under pudddled condition.

Keywords: Rice; crop establishment; square planting; drum seeding; economic water productivity; energy use efficiency

INTRODUCTION

Rice (*Oryza sativa* L) is one of the important cereal crops which play a key role in food security. More than 90 per cent of total rice production in the world is consumed in Asian countries where it is a staple food for a majority of the population (Mohanty 2013). Among many food grain crops cultivated in India rice has the pride of being cultivated over an area of 43.5 Mha with a production of 104.4 MT which contributes to 41.5 per cent of total food grain production of the country (Ministry of Agriculture and Farmers Welfare 2016). Considering these facts International Year of Rice 2004 AD had the slogan of Rice is life. Rice is the one among the crops that require more water to produce per unit of economic product.

It is estimated that about 3000-5000 litres of water is required to produce 1 kg of rice by conventional transplanting method of rice cultivation (Rao et al 2013). Method of stand establishment influences the performance of rice through its effect on growth and development. Although transplanting has been reported to be the best establishment method (Singh et al 1997) yet due to high water and labour requirement some alternatives like dry and wet direct seeding are being explored to ensure optimum plant population at a lower cost. Development and adoption of alternative rice production technologies to save water and labour need to be emphasized in the context of water and labour scarcity situation.

Direct seeding of sprouted seeds on to puddled soil (wet seeding) by drum seeder holds special significance in the present day production systems by saving time, labour, energy and increasing profitability (Subbaiah and Balsubramanian 2000). The recently developed system of rice intensification (SRI) method which decreases the use of inputs such as water and labour is reported to have 20-30 per cent higher or even more grain yield compared to conventional method of cultivation in India (Mitra et al 2013). In the present study a field experiment was conducted to find out the

influence of different rice establishment methods on yield, labour productivity, economic water productivity and energetics in CO (R) 51.

MATERIAL and METHODS

A field experiment was conducted in the wetland farm of Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu during July to November of 2017. The experimental site was located in the western agro-climatic zone of Tamil Nadu at 1l^{o} N latitude, 77^{o} E longitude and at an altitude of 426.72 m amsl. The experiment was conducted to study the influence of different rice establishment methods on yield, labour productivity, economic water productivity and energetics in CO (R) 51. The soil of experimental field was deep clay loam and classified taxonomically as typic haplustalf. The soil had the pH of 8.23, EC of 1.2 dS/m and the nutrient status was low in available nitrogen (265.6 kg/ha), medium in available phosphorus (20.9 kg/ha), high in available potassium (458.0 kg/ha) and medium in soil organic carbon content (0.61%). The experiment was carried out in randomized block design with nine treatments and three replications.

The treatments were conventional transplanting (T_1), line transplanting (T_2), seedling throwing (T_3), square planting (SRI) with single seedling (T_4), square planting (SRI) with double seedling (T_5), direct wet seeded rice (broadcasting) (T_6), direct planting system (DPS) (T_7), drum seeding (T_8) and drum seeding with green manure (T_9).

The recommended dose of 150:50:50 kg NPK/ha was applied for all the treatments. The grain and straw yields were recorded per plot and converted to tons/ha. The labour productivity was calculated for each treatment and expressed in rupee output (gross return) per rupee labour cost (labour cost). Economic water productivity, a function of total water consumed and gross return obtained by the crop was expressed in Rs/ha. Energy use efficiency (energy ratio) is the ratio of energy output (MJ/ha) and energy input (MJ/ha). The energy content of various inputs was calculated as given by Devasenapathy et al (2009) and energy of all the components was computed.

RESULTS and DISCUSSION

The results of the present findings are given in Table 1.

Yield of rice

In cereal crops like rice both grain and straw are the valuable economic parts. In the present investigations higher grain and straw yields were obtained with square planting (SRI) with single seedling (6860 kg/ha and 10195 kg/ha respectively) which were comparable to square planting (SRI) with double seedling (6670 kg/ha and 9780 kg/ha respectively) method. Square planting (SRI) with single seedling had edge of 36.65 and 23.54 per cent of grain and straw yields respectively over direct wet seeded rice (broadcasting). This might be due to the increased yield attributing characters like increased number of tillers/m^2, dry matter production, leaf area index, panicle length, 1000-grain weight and low sterility percentage (Thakur et al 2011).

Labour productivity

The drum seeding method recorded higher labour productivity and less number of labourers/ha followed by drum seeding with green manure. Transplanting treatments recorded more number of labourers/ha and lower labour productivity. This might be due to the reason that transplanting of rice seedlings required more labour and time than direct sown methods.

The findings of the present study are in line with the observations made by Santhi et al (1998) who reported that transplanting of rice seedlings is a highly labour intensive and expensive operation and be replaced with direct seeding. This could reduce labour needs by more than 20 per cent in terms of working hours required. Drum seeding method required eight persons whereas line sowing of sprouted seeds and transplanting methods required 20 and 40 labourers/ha respectively. Thus it was found that there was a significant saving of labour in the drum seeding method of rice establishment.

Economic water productivity

Among the different establishment methods drum seeding and direct planting system recorded higher economic water productivity (Rs 93.8/ha mm) and it was comparable with direct planting system (T_7), square planting (SRI) with single seedling (T_4), drum seeding with green manure (T_9) and square planting (SRI) with double seedling (T_5).

Increased economic water productivity in direct sown treatments might be attributed to increased grain yield with decreased water consumption due to

Table 1. Influence of different crop establishment methods on yield, labour productivity, economic water productivity and energetics of rice

Treatment	GY	SY	WR	EWP	LR	LP*	IE*	OE*	NEG*	EUE*
T_1: Conventional transplanting	6080	8990	1250	72.8	129	1.96	19364	201751	182387	10.4
T_2: Line transplanting	6002	8890	1250	71.8	146	1.71	19391	199354	179964	10.3
T_3: Seedling throwing	6150	9165	1250	73.9	122	2.1	19500	206405	186905	10.6
T_4: SRI with single seedling	6860	10195	1100	93.3	138	2.07	17640	228092	210452	12.9
T_5: SRI with double seedlings	6670	9780	1100	90.5	133	2.08	17749	220299	202550	12.4
T_6: Direct wet seeded rice	5020	8140	925	82.9	119	1.8	18375	176794	158419	9.6
T_7: Direct planting system	5870	8720	925	93.4	118	2.08	17422	195289	177867	11.2
T_8: Drum seeding	5820	8600	925	93.8	101	2.38	17685	192025	174340	10.9
T_9: Drum seeding with green manure	5620	8480	925	91.2	108	2.18	15635	188614	172979	12.1
SEd	325	435	67	3.5	-	-	-	-	-	-
$CD_{0.05}$	695	890	140	7.1	-	-	-	-	-	-

*Not statistically analyzed

GY: Grain yield (kg/ha), SY: Straw yield (kg/ha), WR: Water requirement (mm), EWP: Economic water productivity (Rs/ha mm), LR: Labour requirement (number/ha), LP: Labour productivity, IE: Input energy (MJ/ha), OE: Output energy (MJ/ha), NEG: Net energy gain (MJ/ha), EUE: Energy use efficiency

early maturity of 6 to 10 days than transplanted methods. Sai Kiran (2015) reported that increased water productivity in direct sown methods was due to considerable saving of irrigation water, greater increase in yield of crop and higher nutrient use efficiency.

Energetics

Square planting (SRI) with single seedling (T_4) recorded higher total output energy, net energy gain and energy use efficiency of 228092 MJ, 210452 MJ and 12.93 per cent respectively followed by square planting (SRI) with double seedling (T_5). Lower total output energy, net energy gain and energy use efficiency were recorded under direct wet seeded rice (broadcasting). Among the different crop establishment methods total input energy utilized was higher under transplanting treatments viz seedling throwing (19500 MJ), line transplanting (19391 MJ) and conventional transplanting (19364 MJ).

The higher energy use efficiency in square planting (SRI) with single seedling might be due to increased grain and straw yields with reduced number of labourers as compared to other transplanting methods. Similar observations were made by Mohanty et al (2014).

CONCLUSION

Square planting (25 x 25 cm) with single seedling and population of 160000/ha can be recommended for puddled condition with assured water and labour to attain maximum yield of CO (R) 51. As an alternative to transplanting methods without much reduction in yield drum seeding can be recommended with reduced irrigation water (925 mm) and labour (101 labourers/ha).

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