ECONOMIC EFFECT OF DIFFERENT PLANT ESTABLISHMENT TECHNIQUES ON RICE, *ORYZA SATIVA* PRODUCTION

*Tahir Hussain Awan, Inalyat Ali, M. Ehsan Safdar, Mirza M. Ashraf and Muhammad Yaqub**

ABSTRACT

Economic effect of different plant establishment techniques on rice (*Oryza sativa* L.) production was studied at Rice Research Institute, Kala Shah Kaku, Lahore during kharif season 2001-2002 and 2002-2003. In this experiment, seven planting techniques were compared with the conventional method of transplanting. Five direct seeding techniques (drilling of soaked seed in wattar soil, drilling of soaked seed on raised beds-2 rows on each bed, drilling of soaked seed in zero-tilled soil, broadcasting of soaked seed in wattar soil and broadcasting of sprouted seed in puddled soil) and three transplanting techniques (parachute transplanting, line transplanting and farmer method of random transplanting) were included. The results showed that plant height, productive tillers/m^2, filled grains per panicle, 1000 grain weight, root length and paddy yield were significantly high in line transplanting and minimum in drill sowing of soaked seed in zero-tilled soil. Sterility was low in line transplanting (12.53%) and farmer method of random transplanting (13.07%) but high in drilling of soaked seed in zero-tillage (16.05%) and broadcasting of soaked seed in wattar soil (15.38%). Economics of planting methods showed that cost-benefit-ratio increased in case of line transplanting (1:1.62) due to maximum paddy yield followed by drilling in zero tilled soil (1:1.47). Although paddy yield in zero tillage drilling was the lowest but the cost-benefit ratio was better than the other six methods due to less cultivation cost. The lowest benefit was obtained in case of farmers practice (random transplanting).

KEYWORDS: *Oryza sativa*, sowing methods; seedlings; broadcasting; agronomic characters; Pakistan.

INTRODUCTION

Rice (*Oryza sativa* L.) is an important cereal crop of the world and nearly more than half of the population subsists on it. It is the main livelihood of rural population living in sub-tropical and tropical Asia and hundreds of millions people living in Africa and Latin America. A number of energy rich

*Rice Research Institute, Kala Shah Kaku, Lahore.

compounds such as carbohydrates, fat, protein and reasonable amount of iron, calcium, thiamine, riboflavin and niacin are found in rice (7). In Pakistan, rice is a leading cereal crop and occupies second position after wheat. It is a staple food of the people and supplies more calories than any other cereal. It is a very important source of foreign exchange earnings giving about US $ 932.549 annually through its export (3). It is grown on an area of 2.5 million hectares, with an annual production of 4.9 million tons having an average yield of 1970 kg per hectare (4), which is much lower than many other rice growing countries like Australia (10269 kg), Japan (6997), USA (6219 kg) and Mexico (6059 kg).

There exists a great scope of increasing rice production, as the present yield level is much lower than the potential of our existing varieties. A number of factors contribute to the low yield of this crop. Among these, less number of rice plants per unit area is major one. The main cause of low density of rice plant is scarcity of labour during the peak period of rice transplantation. Therefore, lack of labour alongwith the increased labour cost during the scorching heat of June and July has compelled the scientists and farmers to think about the substitution of conventional way of rice planting. Shifting from transplanting to direct seeding is a potential alternative available. Transplanting and direct seeding are two general methods used for rice planting in the world. Although transplanting is common but it is more laborious, cumbersome, time consuming and entails a lot of expenditure on raising nursery, its uprooting, transplanting, etc. Careless transplating by hired labour also results in low planting densities in the farmers fields. The scarcity and high cost of farm labour invariably delays transplanting and often leads to the use of aged seedlings (16) resulting in low yield (15). Although rice cultivation by transplanting is generally considered as superior to direct sowing, yet the latter is reported to be a successful method in some parts of the world (1), as it saves labour 12). Direct seeding has good stand establishment (17), higher tillering and sometimes higher grain yield (10). Other advantages are stable growth, reduced transplanting shock (13) but there is weed problem in direct seeding (22). In countries like USA, Australia, etc. direct seeding of rice is extensively used with profitable results. In some studies (2, 10, 13, 17) under proper cultural practices, direct seeding significantly outyielded the transplanted rice.

The present study was designed to determine the most appropriate planting method of fine rice which can maximize the yield and net profit in Pakistan.

MATERIALS AND METHODS

A study was conducted at Rice Research Institute, Kala Shah Kaku, Lahore during 2001-02 and 2002-2003 (cv. Super Basmati). Layout system of the trial was randomized complete block design replicated thrice in a net plot size of 9 x 57 meter. Seven different planting techniques were compared with farmers conventional method of transplanting. Plant establishment techniques included five direct seeding techniques i.e. drilling of soaked seed in wattar soil, drilling of soaked seed on raised beds (2 rows on each bed), drilling of soaked seed in zero-tilled soil, broadcasting of soaked seed in wattar soil, broadcasting of sprouted seed in puddled soil and three transplanting techniques viz. parachute transplanting, line transplanting and farmer's method of random transplanting. Direct seeding treatments were sown on 10th June and three transplanting treatments were transplanted on 10th July. Broadcasting of soaked and sprouted seed was done manually while drilling of soaked seed was done by zero- tillage drill machine. Transplanting was done manually. In line sowing treatments plant to plant and row to row spacing was maintained at 22.5 cm. In parachute transplanting efforts made to maintain plant to plant spacing equal and 2,00,000 plant population per hectare was maintained. For weed control recommended herbicide was applied 20 days after sowing in direct seeded plots while 5 days after transplanting in case of transplanted treatments. Other agronomic and cultural practices were kept standard and uniform for all treatments. Data on plant height, root length, paddy yield, productive tillers per square meter, grains per panicle, sterility percentage and 1000 grain weight were recorded by counting three samples taken randomly from each repeat. Data collected were statistically analyzed using Fisher's analysis of variance technique and treatments means were compared by LSD at 0.05 probability (19).

RESULTS AND DISCUSSION

Data regarding plant height (Table 1) indicated that line transplanting method produced higher plant height (132 cm) which was statistically similar to that of farmer's practice of random transplanting (129cm). The lowest plant height was recorded in the treatment where soaked seed was broadcasted in wattar soil (115 cm) followed by soaked seed drilled in wattar soil (119 cm). Maximum plant height in line transplanted rice may be attributed to well puddled soil in transplanted rice which enhanced deep penetration of roots resulting in efficient nutrient uptake and good plant growth. These results are similar to those reported by Maqsood (11) which state that transplanting enhanced plant height and panicle length over direct seeding. Plant height in

case of drill sowing on beds was more than other direct seeding methods due to more loose soil which facilitated more access to nutrients by roots and plants established well.

Table 1. Effect of different plant establishment techniques on the paddy yield (t/ha) and its components of Super Basmati.

Planting techniques	Plant height (cm)	Productive tillers/m^2	Grains/ Panicle	Sterility (%)	1000 grain weight(g)	Root length (cm)	Paddy yield (t/ha)
Drilling of soaked seed in wattar soil	119de	268de	99b	15.45a	20.67bc	14.16d	3.57cd
Double-row drilling of soaked seed on beds	127 b	336a	106ab	12.88b	20.81b	14.75c	3.83bc
Drilling of soaked seed in zero-tilled soil	121cd	262de	87c	16.05a	20.01c	12.08e	3.01e
Broadcasting of soaked seed in wattar soil	115e	290bcd	92c	15.38a	20.60b	13.79d	3.32de
Broadcasting of sprouted seed in puddle soil	121cd	315abc	99b	13.21b	20.07bc	13.85d	3.66bcd
Parachute transplanting	125bc	324ab	107a	13.07b	21.48b	16.05b	4.02b
Line transplanting (standard)	132a	276cd	109a	12.53b	22.49a	17.32a	4.97a
Farmers practice of random transplanting	129ab	229e	100b	13.07b	21.35b	17.12a	3.39de
LSD values	4.540	42.00	6.82	1.054	0.7113	0.5834	0.3452
CV%	2.09	8.33	3.89	4.31	1.95	3.23	7.27

Data regarding productive tillers/m^2 (Table 1) revealed that double row drilling of soaked seed on beds produced higher (336 productive tillers/m^2) which was statistically similar to parachute transplanting (324 tillers/m^2) and broadcasting of sprouted seed in puddled soil (315 tillers/m^2). However, farmer's practice of random transplanting produced minimum (229 productive tillers/m^2). These results are in consonance with those of Sharma (17) and Naklange *et al.* (13). Higher number of productive tillers in double row drilling on beds, parachute transplanting and broadcasting of sprouted seed in puddled soil might be due to higher planting density in these treatments.

Standard line transplanting method achieved higher grain (109/panicle) which was statistically similar to that obtained in parachute transplanting (107/panicle) and double row drilling of soaked seed on beds (106/panicle). On the other hand, minimum grains were produced by drilling of soaked seed in zero tilled soll (87/pancile) and broadcasting of soaked seed in wattar soil (92/panicle). Higher number of grains in standard line transplanting and parachute transplanting might be attributed to more availability and uptake of water and nutrients by crop plants during panicle growth period. More

number of grains per panicle in direct seeding on beds might be due to the fact already mentioned above. Earlier scientists report similar findings (8, 11). Highest percentage of sterile grains (16.05) was found in drilling of soaked seed done in zero-tilled soil which remained statistically at par with drilling of soaked seed in wattar soil (15.45) and broadcasting of soaked seed in wattar soil (15.38). However, lowest sterility percentage (12.53) was observed in standard line transplanting. Kim *et al.* (8) also reported that maximum sterility percentage was recorded in direct sown rice while minimum in transplanted rice.

1000-grain weight was influenced by enhanced grain growth during grain development period. It is clear from the data (Table 1) that higher grain weight (22.49 g) was recorded in manual line transplanting which significantly differed from all other treatments. However, soaked seed drilled in zero tilled soil gave minimum 1000-grain weight (20.01 g). These results agree to those of Singh *et al.* (18) and Jana *et al.* (6) who reported that 1000-grain weight was higher in transplanted rice as compared to the other methods of sowing (direct seeding). Root length showed similar trend as seen in plant height. Line transplanting and farmer's practice showed higher root length (17.32 cm and 17.12 cm) while soaked seed drilled in zero-tilled soil produced the lowest (12.08 cm).

Standard line transplanting method produced significantly higher paddy yield (4.97 t/ha) followed by parachute transplanting (4.02 t). Howêver, drilling of soaked seed in zero tilled soil achieved the lowest paddy yield (3.01 t/ha) which was statistically at par with broadcasting of soaked seed in wattar soil and farmer's practice. Higher paddy yield in transplanting method was attributed to greater root length, more grains per panicle, higher 1000-grain weight and less sterility percentage. These results are in the line with those of Thakur (20) and Mahajin *et al.* (9) who reported that grain yield increased significantly with transplanting over direct seeding. Maqsood (11) also reported that transplanting method increased paddy yield by about 6.87 percent in 1994 and 23.74 percent in 1995 over direct seeding method.

Cost-benefit ratio

Economics of planting methods (Table 2) showed that cost-benefit ratio increased in case of line transplanting (1:1.62) due to maximum paddy yield

Table 2. Economics and cost-benefit ratio of different rice planting methods

Treatments	Paddy yield (t/ha)	Cost (Rs/ha)	Income (Rs/ha)	Profit (Rs/ha)	Cost benefit ratio
Drilling sowing	3.57	30455	41055	10600	1:1.35
Drill on beds (2 rows)	3.83	30949	44045	13096	1:1.42
Drilling in zero tilled soil	3.01	23581	34615	11034	1:1.47
Broadcasting of soaked seed in wattar soil	3.32	29647	38180	8533	1:1.29
Broadcasting of sprouted seed in puddle soil	3.66	32920	42090	9170	1:1.28
Parachute transplanting	4.02	36546	46230	9684	1:1.26
Line transplanting manually	4.97	35390	57155	21765	1:1.62
Farmers practice (random transplanting method)	3.39	33854	38985	5131	1:1.15

Paddy price @ Rs. 460/40 kg, Cost-benefit ratio = Total income ÷ total cost, No. of parachute trays = 225/acre @ Rs. 10/tray, Life of tray = 2 years

followed by drilling in zero tilled soil (1:1.47). Although paddy yield in zero tillage drilling was the lowest but cost-benefit ratio was better than other six methods due to less cultivation cost. The lowest benefit (1:1.15) was obtained in case of farmer's practice (conventional transplanting).

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