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Evaluation of Planting Methods for Growth and Yield of Paddy (*Oryza sativa* L.) Under Agro-Ecological Conditions of District Shikarpur

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Abstract: A field trial was conducted in a randomized complete block design (RCBD) with three replications to evaluate the appropriate planting method of rice variety KSK 282 under field conditions. The trial was planted at farmers field, district Shikarpur during 2010 on silty clay loam textured soil with pH of 7.86, electrical conductivity (EC) 0.40 dSm^{-1}, organic matter 0.54%, N 0.075% and P 4.2 mg kg^{-1}. The treatments of the experiment were direct seed dibbling, pre germinated seed broadcast, direct seed drilling, random transplanting (farmer practice) and line transplanting. The results obtained during the study revealed that grain yield and cost benefit ratio of the different planting techniques were in the order line transplantation >, conventional transplantation >, direct seed dibbling >, direct seed drill >, pre germinated seed broadcast. The highest plant height (111.67 cm), productive tillers (337.67 m2), panicle count (330.67 m^2), root length (17.12 cm), seed index (27.27 g), straw yield (14.40 t ha^{-1}) and cost benefit ratio (1:1.82) were recorded in line transplanting technique. Based on the results obtained, it can be concluded that in areas where labour is available and cheap, line transplanting is a better planting technique of rice because it produces more yield and gross economic return than other methods.

Key words: *Oryza sativa* · Dibbling · Broadcast · Drilling · Transplantation · Cost benefit ratio

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the world's most important staple food crop for nearly half of the global human population [1-5] and a number of energy rich compounds such as carbohydrates, fat, protein and reasonable amount of iron, calcium, thiamine, riboflavin wwand niacin are found in rice [6]. Increase in population will require 70 percent more rice in 2025 than is consumed today [7]. Schoenly *et al*., [8] reported that Asia produces and consumes more than 90% of the world's rice.

Rice is an important cereal crop after wheat in Pakistan. It fulfills the total local requirements of rice as well as contributes towards foreign exchange earnings. Rice is cultivated on an area of 2.9 million hectare; with average yield of 2.3 t/ha [9]. It is high valued cash crop accounting 6.4% in total agriculture production and its share in gross domestic production is, 1.4% [10]. Pakistan grows high quality rice to meet both domestic demand and for the export which contribute about 15% of the total foreign exchange earnings [11].

Rice can be grown under diverse climatic and edaphic conditions and is a short day summer crop. It grows well in humid tropical regions with high temperature and sunshine in clay to clay loam soils. It is tolerant to a range of soils with pH from 4.5 to 8.5 and can be grown successfully on saline or sodic soils [12]. Paddy yields of Pakistan are lower as compared to countries like Australia, USA and Japan where yields are 10269, 62198 and 6997 Kg ha^{-1}, respectively [13].

In Pakistan, rice yield is low because of a number of factors such as water scarcity, delay plantings, high input costs, shortage of skilled labour, suboptimal plant population and nutrition, weeds and pest infestation and low price of rice in the local market [14-16]. Generally, rice growers face the problem of skilled labour shortage at the time of transplanting which results into delay plantation, low plant population and eventually low rice yield [17, 18].

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It is essential to reduce the factor by adopting the appropriate planting techniques for rice production to control the competitive prices in local and international markets. For this purpose research and development activities are initiated on new rice establishment technologies in various parts of the world [19]. These technologies are to be adopted in countries like Pakistan because of the water shortage in most parts of the country [20].

Alternative methods of rice planting seem the only viable solution of this problem. In Australia and USA, Direct seeded rice and bed planting are being used as resource conserving technologies which reduce pollution and improve living of the farming community by increasing profitability [21-23].

In most of the Asian countries transplanting is widely practiced [24]. But transplanting method is more laborious, time consuming and expensive than direct seeding [25]. The main cause of low density of rice plant is scarcity of labour during the peak period of rice transplantation. Careless transplanting by hired labour results in low plant densities in the farmer's field. The scarcity and high cost of farm labour invariably delays transplanting and often leads to the use of aged seedlings which cause low yield [26]. An efficient weed management in transplanted rice gave higher economic yields than direct seeding method. A lot of expenditure is required on raising nursery, its uprooting, transporting and transplanting. Whereas for direct seeding, only two man hours are required to sow the same area [27].

In the present study five rice planting methods were tested at traditional rice growing area of Sindh to determine the most productive method of rice production.

MATERIALS AND METHODS

A field trial was conducted in a randomized complete block design (RCBD) with three replications to evaluate the appropriate planting method of rice variety KSK 282 under field conditions. The trial was planted at farmers field, district Shikarpur (Latitude: 27.94°and Longitude: 68.63°) during 2010. Before sowing of rice the soil of the experimental area was analyzed and results showed that the soil was alkaline in nature with pH of 7.86, electrical conductivity (EC) 0.40 dSm^{-1}, organic matter 0.54%, N 0.075% and P 4.2 mg kg^{-1}. The texture of soil was silty clay loam.

The experiment was comprised of following treatments,

T1 = Direct seed dibbling
T2 = pre germinated seed broadcast
T3 = Direct seed drilling
T4 = Random transplantation (farmer practice)
T5 = Line transplantation

The seed rate for direct seed dibbling was 55 kg ha^{-1}, 80 kg ha^{-1} for the direct seed drilling and 90 kg ha^{-1} for germinated seed broadcasting and 37.5 kg ha^{-1} for transplanting methods. Nursery was raised for seedling transplanted rice and later thinned at three weeks old and transplanted within average of three seedlings per hill on well prepared seed beds, at 22.5cm x 22.5cm within and between rows, just as in direct seed dibbling method, whilst that of direct seed drilling was 5cm x 20cm within and between rows. Plantation of direct seed dibbling, seed drilling and broadcasting of germinated seeds were done on the day seeds were sown in the nursery for transplantation, to maintain the same seedling age for all treatments.

Fertilizer of nitrogen at the rate of 125 kg ha^{-1} in the form of urea and phosphorus at the rate of 70 kg ha^{-1} in the form of triple super phosphate (TSP) was applied. Full dose of P and half dose of N was applied as basal and remaining dose of N was applied at panicle initiation stage. All other agronomic practices were kept uniform for all the treatments.

Standard procedures were adopted to record the data on various growth and yield parameters during the course of study. Economic analysis was done by calculating the gross income considering the market rates of paddy and straw. Cost of production was calculated. Varying cost of all the sowing methods were added in each treatment. Net income was calculated by formula as a difference of gross income and variable cost. Cost Benefit Ratio (CBR) was calculated by dividing gross income by total cost of production. The data obtained were subjected to analysis of variance technique by using statistix 8.1 computer software and means were separated by LSD test [28].

RESULTS AND DISCUSSION

Plant Height: Plant height was significantly affected at 5% probability level by different sowing methods.

The highest plant height (112 cm) was recorded in seedling line transplantation followed by conventional transplanting (109.86 cm). The minimum plant height (103 cm) was recorded in pre germinated seed broadcast treatment. Different planting methods significantly affected the plant height, while the maximum plant height in line transplanting was due to the reason that plants were at specific distance and the competition between the plants were minimum and deep penetration of roots resulting in efficient nutrient uptake and good plant growth. The results are in accordance with [29-33] who reported that transplanting plant height over direct seed sowing.

Number of Productive Tillers: Number of productive tillers was influenced significantly by different planting treatments. Line transplantation produced highest number (338 m^2) of productive tillers followed by 328 m^2 in conventional transplanting treatment. While pre germinated seed broadcast produced minimum number (301 M^2) of productive tillers. It was observed during the study that, emergence was low in pre germinated seed broadcast as reported by Chapman and Carter [34] that seeds are often not properly buried in broadcast plots resulting in low germination and establishment counts. Rowland and Whiteman [35], Naklange *et al.,* [36] and Oyewole and Attah [37] also indicated that, broadcasting generally depresses seed germination and thereby affect crop establishment due to less root- soil contact to exploit the soil resources fully.

Panicle Count m^{-1}: The data presented in Table 1 indicated significant increase in number of panicles in line transplantation over other sowing techniques. The maximum number of panicles (331 m^2) was recorded in line transplantation and the minimum number of panicles (285 m^2) were recorded in pre germinated seed broadcast. The highest number of panicles in line transplantation treatment was due to maximum number of productive tillers were found in the treatment. These findings are in agreement with those obtained by Aslam *et al*., [18] and Parsad [38] who reported that transplantation of rice increased all the growth and yield attributes of rice over direct seeding.

Root Length cm: The data presented in Table 1 showed that the highest root length (17.12 cm) was recorded in line transplantation treatment, which was significantly different with other treatments. The lowest root length was recorded in germinated seed broadcast treatment. These results are in agreement with those obtained by Tahir *et al*., [39], who reported that transplantation of rice reduces higher root length as compared to other methods of sowing.

Straw Yield: The optimum plant population at specific distance was maintained in line transplantation treatment therefore, the 1 highest paddy straw yield (14.40 tha^{-1}) was recorded in line transplantation treatment followed by conventional transplantation with 13.49 t ha^{-1}. The lowest straw yield (11.64 t ha^{-1}) was recorded in pre germinated seed broadcast treatment. Similar results were obtained by Muhammad *et al*., [40] who reported that the maximum rice straw was obtained by rice seedlings transplantations due to better establishment/ growth of rice plants instead of direct seed sowing.

Table 1: Growth and yield parameters of KSK 282 (*Oryza sativa* L.) as affected by different sowing methods.

Treatments	Plant height (cm)	Productive tillers m^{-2}	Panicle count m^{-2}	Root length (cm)	Seed index (g)	Straw yield (t ha^{-1})	Paddy yield (t ha^{-1})
Direct seed dibbling	107.17 c	315.33 bc	299.33 bc	15.04 b	26.5 bc	12.33 bc	4.91 bc
Germinated seed broadcast	103 d	300.67 c	285 c	12.91 d	25.68 d	11.64 c	3.74 c
Direct seed drilling	107.67 bc	308.33 bc	298.33 bc	13.64 c	26.08 cd	12.03 c	4.05c
Random transplanting (farmer practice)	109.87 ab	328 ab	315.67 ab	16.85 a	26.77 ab	13.49 ab	4.67ab
line transplanting	111.67 a	337.67 a	330.67 a	17.12 a	27.27 a	14.40 a	5.23a
LSD at $\alpha = 0.05$	0.815	6.32	5.52	0.18	0.18	0.37	0.17

Means followed by the same letters in columns are not significantly different at $\alpha = 0.05$.

Table 2: Economic analysis and cost benefit ratio of different sowing methods of KSK 282 *(Oryza sativa* L.).

Treatment	Straw yield t ha^{-1}	grain yield t ha^{-1}	Total cost of production Rs ha^{-1}	Gross income Rs ha^{-1}	Net income Rs ha^{-1}	Cost benefit ratio
Direct seed dibbling	12.33	4.19	65500	109687	44187	1:1.67
Pre germinated seed broadcast	11.64	3.74	58750	98700	39950	1:1.68
Direct seed drill	12.03	4.05	62000	106125	44125	1:1.71
Seedling transplantation (conventional)	13.50	4.67	71750	121950	50200	1:1.69
Seedling transplantation (line)	14.40	5.23	74250	135675	61425	1:1.82

Seed Index: The grain weight is an important yield component and has a major contribution towards grain yield. It is clear from the data in Table 1 that higher grain weight (27.27g) was recorded in transplantation in line, which significantly differed from all other treatments. However minimum grain weight (25.68 g) was recorded in pre germinated seed broadcast treatment. These findings are similar to those of Singh *et al*., [41], Jana *et al*., [42] and Tahir *et al.*, [39], who reported that 1000 grain weight was higher in transplanted rice as compared to other methods of sowing.

Paddy Grain Yield: Line transplantation produced significantly higher grain yield (5.23) followed by conventional transplantation (4.67). Pre germinated seed broadcast produced lowest grain yield of (4.67). Higher grain yield in line transplantation was due to higher 1000 grains weight, number of panicles m^{-2}, number of productive tillers and greater root length. All these parameters were high in line transplantation because of Proper spacing for good water management [43] photosynthetic activities and assimilate partitioning [44], thereby resulting in good yield in well spaced rice fields. The low paddy yields recorded in pre-germinated seed broadcasting methods than seedling transplanting method could have been due to exposure of seeds to pest destruction and weed competition in broadcast conditions. The results are quite in line with Thakur [45], Mahajin *et al*., [46] and Maqsood [29], who achieved higher grain yield in transplanted technique as compared to direct sowing.

Cost Benefit Ratio: Table 2 indicated that the maximum net income of Rs. 61425 was obtained from line transplantation followed by conventional transplantation (Rs. 50200). Higher net income from transplanted treatments was due to higher straw and paddy yield. The minimum net income (Rs. 39950) was obtained from pre germinated seed broadcast treatment. Table 2 also showed that cost benefit ratio also increased in case of line transplantation (1:1.82) whereas, the lowest benefit (1:1.67) was obtained in case of direct seed dibbling. The results are in conformity with Awan *et al*., [30], who reported that line sowing of rice provides maximum benefit cost ratio.

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