COMPARISON OF DIFFERENT PLANTING METHODS FOR OPTIMIZATION OF PLANT POPULATION OF FINE RICE (*Oryza sativa* L.) IN PUNJAB (PAKISTAN)

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Low plant population is the major cause for low rice (*Oryza sativa* L.) yields in Pakistan which can be optimized using a proper sowing method. For the purpose, an experiment was conducted to determine the effects of different sowing methods on plant population and yield of fine rice cv. Super Basmati. The sowing methods included direct seeding by broadcast at field capacity (DSBFC), direct seeding by broadcast in standing water (DSBSW), direct seeding with drill at field capacity (DSDC), transplanting at 20cm apart rows (TR-20), farmer's practice (FP), transplanting by parachute method (TPM). Data on plant population, number of panicle bearing tillers, plant height, number of grains per panicle, spikelets per panicle, 1000-grain weight and grain yield was recorded. It was also observed that maximum paddy yield (3.06 t ha^{-1}) was produce by TR-20 while minimum paddy yield (2.52 t ha^{-1}) was observed in case of DSBSW. TR-20 proved to be the most productive planting method for rice cultivation.

Keywords: Rice (*Oryza sativa* L.), planting methods, planting density, parachute transplanting, direct seeding

INTRODUCTION

Rice is the most important cash crop of Pakistan. It adds nearly 2.58m tons grains per annum to meet the food requirements of the country. The average yield of rice crop in Pakistan is 2107 kg ha^{-1}(Govt. of Pakistan, 2006-07) which is very low as compared to potential yield. The important reasons for low rice yield include water shortage, weed infestation, prevalence of insect pests and diseases and inappropriate sowing method leading to low plant population. Low plant population can be optimized using a proper sowing method.

Transplanting is widely practiced in most of the Asian countries (Mabbayad and Obordo, 1971). Direct seeding is not feasible due to decreasing water availability for agriculture. Both of these methods have their own advantages and disadvantages. However, an efficient weed management in transplanted rice gave higher economic yields than direct seeding method (Hossain *et al.* 2002). But transplanting method is more laborious, time consuming and expensive than direct seeding (Hashi-moto *et al.* 1976). A lot of expenditure is required on raising nursery, its uprooting and transporting. Where as for direct seeding, only two man hours are required to sow the same area.

A recently developed method for rice transplantation “parachute method” however, over-comes some of these problems in the two traditional methods. It requires less labour, less time and is more efficient. Other advantages are good and quick stand establishment, higher tillering and thus higher paddy yield. However, parachute method of rice transplanting requires more skilled labour for nursery raising and transplanting. This study reports a comparison and an evaluation of different sowing methods on growth and yield parameters of fine rice (*Oryza sativa* L.)

MATERIALS AND METHODS

Studies were carried out at Agronomy Research Area, University of Agriculture, Faisalabad during summer 2006. The experiment was laid out in randomized complete block design (RCBD) with four replications having a net plot size was 2m x 3m. Rice cultivar Super Basmati was used as a test variety.

Experiment was comprised of the following treatments.

T_1= Direct seeding by broadcast at field capacity (DSBFC)
T_2= Direct seeding by broadcast in standing water (DSBSW)
T_3= Direct seeding with drill at field capacity (DSDC)
T_4= Transplanting at 20cm apart rows (TR-20)
T_5= Farmer's practice (FP)
T_6= Transplanting by parachute method (TPM)

Nursery for TR-20, FP and TPM were sown on 11 June where as direct seeding treatments (DSBFC, DSBSW and DSDC) were also carried out at the same date. For TR-20 and FP the 25 days old nursery was transplanted in the puddled field having standing water with 3cm depth. For TPM, seedlings were raised in plastic trays which were placed on raised beds. These trays were containing about 430 plugs (micro-pots of 1.3 cm dia. and 1.3 cm depth) with a tiny hole in the bottom to facilitate movement of water and nutrients at the rate of 400 trays per hectare. 1 to 2 seeds were dropped in each plug and covered with a thin layer of soil. Twenty five days older nursery with height of about 20 cm was transplanted by broadcasting in a projectile manner into puddled field. A basal dose of

NPK @ 100-67-62 kg ha^{-1} was applied. Whole of the phosphorus and potash were applied at the time of sowing. Half of nitrogen was applied at sowing and remaining half 30 days after transplanting. All other agronomic practices were kept uniform for all the treatments. The data on various growth and yield parameters were recorded using the standard procedures during the course of study. Economic analysis was done by calculating the gross income considering the support price of paddy and market rates of straw. Cost of collaborate 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. Benefit Cost Ratio (BCR) was calculated by dividing gross income by total cost of production.

The data collected were analyzed statistically by using Fisher's analysis of variance technique and differences among treatments were compared by Least Significant Difference test (LSD) at 0.05 Probability level (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Plant height was affected significantly by different sowing methods. The plant height (85.93 cm) was recorded in TR-20 which was statistically similar to FP and TPM. The minimum plant height was recorded in DSBSW and was statistically par with DSDC and DSBFC. The difference in plant height was due to different establishment methods while maximum plant height in TR-20 was due to the reason that plants were at specific distance leading to reduced competition (Awan *et al.*, 2007). Number of panicle bearing tillers was influenced significantly by various sowing methods (Table-1). Treatment (TPM) produced higher number (289 m^{-2}) of panicle bearing tillers while DSWC produced minimum panicle bearing tillers (218.4 m^{-2}). Less number of panicle bearing tillers in direct seeding may again be explained in terms of availability of moisture and nutrients to the crop plants at the panicle initiation stage. The availability of moisture and nutrients was low due to lack of proper distance and more number of weeds in direct sowing. Moreover roots of plant could not penetrate deep enough to exploit the soil resources fully, giving a fair chance to the weeds to compete with the crop plant. Similar results were reported by Naklange *et al.* (1996).

The number of tillers were significantly higher in TPM treatment, which produced 300.8 tillers m^{-2} (Table 1). The higher number of tillers in TPM compared to the other methods of direct seeding might be attributed to the availability of sufficient amount of nutrients and moisture at tillering initiation stage due to the deep placement of seedling and better establishment of roots. Secondly, this method had no transplanting shock as it had a mud ball along its roots, hence started growth one week earlier. Availability of nutrients and moisture in direct seeding has been low due to the presence of more number of weeds and shallow plant root growth (Craigimiles *et al.* 1968; Ramamoor thy *et al.* 1974) FP treatment produced maximum number (96.55) of grains per panicle which was statistically at per with TR-20. The minimum number (82.18) of grains per panicle was produced by the DSBSW treatment. Less number of grains per panicle in direct seeding might again be explained in terms of low availability of moisture and nutrients at grain formation stage. The availability of moisture and nutrients was low due to the fact that there were more number of weeds in direct seeding and also roots of plant could not penetrate deep enough to exploit the soil resources fully (Jana *et al.* 1981; Singh *et al.* 1981).

Statistically higher number (114.40) of spikelets per panicle was produced by the FP method followed by TR-20 (107.00 spikelets per panicle) against the minimum number of spike lets per panicle in DSBSW which was statistically at par with DSBFC treatment. Naklange *et al.* (1996) reported the same results. The grain weight is an important yield component and has a major contribution towards grain yield. However, 1000-grain weight of field crops is a very stable varietal character. The treatment means did not differ significantly from each other. However, on the basis of the data obtained 1000-grain weight varied between 18.71g to 20.15g (Table 1).

Treatment TR-20 produced significantly higher paddy yield (3.06t ha^{-1}) against the minimum in DSBSW i.e. (2.52t ha^{-1}). The highest paddy yield (3.06 t ha^{-1}) obtained with TR-20 compared to other sowing methods might be attributed to more number of grains per panicle and higher grain weight. The plants in this treatment were well established and translocation of carbohydrates continued for a longer period of time to produce more number of kernels, resulting in higher yield. A study regarding the various plant establishment techniques for rice conducted by Awan *et al.* (2007) revealed that maximum paddy yield (4.97 t ha^{-1}) was resulted from transplantation in lines and was followed by the parachute transplanting which produced 4.02 t ha^{-1} of paddy.

Economic analysis (Table 2) indicated that maximum net income of Rs.6427.09 ha^{-1} was obtained from TR-20 treatment followed by FP (Rs.5911.21 ha^{-1}). Higher net income with TR-20 was due to higher paddy and straw yield. The TPM treatment gave net income of Rs. 3864.97 ha^{-1}. Minimum net income of Rs.1253.55 was obtained from DSBSW. Maximum benefit cost ratio (Table 2) of 1.21 was noted in TR-20 followed by FP while minimum benefit cost ratio was recorded for DSBSW. However, TPM gave the BCR values of 1.12. Awan *et al.* (2007) reported that line sowing of rice provides maximum benefit cost ratio.

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

Treatments	Plant height (cm)	No. of panicle bearing tillers (m^{-2})	Total number of (m^{-2})	Number of grains per panicle	Spikelets per panicle	1000- grain weight (g)	Grain yield (t ha^{-1})
DSBFC	66.44 b	240.0d	253.7 c	86.13 c	63.38 e	19.15	2.71 b
DSBSW	60.12 b	225.3 e	240.6 d	82.18 d	60.30 e	18.71	2.52 c
DSDC	67.08 b	218.4 f	230.09 e	88.29 bc	89.06 d	19.69	2.78 b
TR-20	85.93 a	284.4 b	295.7 a	94.70 a	107.00 b	20.15	3.06 a
FP	85.20 a	273.0 c	285.0 b	96.55 a	114.40 a	19.42	2.97 a
TPM	82.09 a	289.0 a	300.8 a	90.40 b	101.40 c	19.55	3.03 a

The numbers not sharing a letter in common, differ significantly at $p \leq 0.05$

Table 2. Economic analysis and benefit cost ratio of different sowing methods for fine rice *(Oryza sativa* L.)

Treatments	Paddy Yield (kg ha^{-1})	Paddy Yield Value (Rs. 460/40 kg)	Straw Yield (kg ha^{-1})	Straw yield Value Rs. (0.103 Kg^{-1})	Gross Income (Rs. ha^{-1})	Total Cost of Production (Rs. ha^{-1})	Net Income (Rs. ha^{-1})	B.C.R
DSBFC	2710.00	31165.00	13730.00	1414.19	32579.19	28794.13	3785.06	1.13
DSBSW	2520.00	28980.00	14340.00	1477.02	30457.02	29203.47	1253.55	1.04
DSDC	2780.00	31970.00	13790.00	1420.37	33390.37	28794.13	4596.24	1.15
TR-20	3060.00	35190.00	1452.00	1495.56	36685.56	30258.47	6427.09	1.21
FP	2970.00	34155.00	13662.00	1487.18	35642.18	29730.97	5911.21	1.20
TPM	3030.00	34845.00	13480.00	1388.44	36233.44	32368.47	3864.97	1.12

DSBFC = Direct seeding by broadcast at field capacity
DSBSW = Direct seeding by broadcast in standing water
DSDC = Direct seeding with drill at field capacity
TR-20 = Transplanting at 20cm apart rows
FP = Farmer's practice
TPM = Transplanting by parachute method
B.C.R. = Benefit cost ratio

CONCLUSION

On the basis of these results it can be concluded that transplantation of rice at 20 cm apart rows was better than direct seeding. Parachute transplanting method also gave better yield but its net return was low due to high cost. So, cost of production for parachute method could be reduced by localizing the manufacturing of nursery trays and reusing them.

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