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EFFECT OF PLANTING METHODS ON THE GROWTH AND YIELD OF COARSE RICE

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ABSTRACT

An experiment was conducted to determine the effect of seeding techniques on growth and yield of rice. It was laid out in a randomized complete block design (RCBD) with split plot arrangements. Sowing methods (flat and bed) were assigned to main-plot while seeding techniques (dry seed drill, dry seed broadcast, soaked seed drill, soaked seed broadcast and conventional transplanting technique) were maintained in sub-plots. The results showed that higher paddy yield was obtained in flat sowing method as compare to bed sowing. Flat sowing also had maximum number of tillers and panicles with the highest unfilled spikelets. Among seeding techniques, conventional transplanting technique had maximum number of tillers and panicles per unit area, spikelets per panicle and paddy yield than other seeding techniques. Based on the results obtained, it can be concluded that conventional transplanting on flat is a better planting technique of rice under the agro-climatic conditions of Dera Ismail Khan.

Key words: Rice, *Oryza sativa*, direct seeding, transplanting, yield.

INTRODUCTION

Rice is a short day summer crop grown under diverse climatic and edaphic conditions. It grows well in humid tropical regions with high temperature, plenty of rainfall and sunshine in heavy clay or 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 (Anonymous, 2002). In Pakistan, rice production has been limited by a number of factors such as water scarcity, high input costs, shortage of skilled labour, sub-optimal plant population and nutrition, weeds and pest infestation and low price of rice in the local market (Baloch *et al.,* 2004; Ali *et al*., 2007). Generally, rice growers face the problem of skilled labour shortage at the time of transplanting which results into low plant population and eventually low rice yield (Aslam *et al*., 2008).

To control the competitive prices in local and international products, it is imperative to reduce the factor by adopting the appropriate planting techniques for rice production. For this purpose research and development activities were initiated on new rice establishment technologies such as raised bed planting, direct seeding and aerobic rice cultivation in various parts of the world (Reddy and Reddy, 2000). These systems are to be adopted in countries like Pakistan because of the water shortage in most parts of the country (Baloch *et al.,* 2007).

In Pakistan, rice transplantation is usually performed by hired expensive labor, which is not specialized to maintain the required plant population to achieve higher productivity (Mann *et al*., 2007). To overcome this problem, direct seeding of rice seems only viable alternatives in rescuing farmers (Aslam *et al*., 2008). This technique reduces labour needs by more than 25% in term of working hours. The input requirements and the investment in direct seeded rice are much lower than in transplanted rice (Sunil *et al*., 2002). Direct seeded rice, if managed properly, can yield as high as transplanted rice (Hayat *et al*., 2003; Ali *et al*., 2007).

The present study was, therefore, undertaken to compare and standardize planting technique best suited to paddy growers under the agro-ecology of Dera Ismail Khan or similar environmental conditions prevailing in other parts of the country.

MATERIALS AND METHODS

The research was conducted at the Agricultural Research Institute, Dera Ismail Khan, in 2009. The experiment was laid out in a randomized complete block design with split plot arrangements having four replications. Sowing methods (flat and bed) were assigned to main-plot and seeding techniques (dry seed drill, dry seed broadcast, soaked seed drill, soaked seed broadcast and conventional transplanting technique) were maintained in sub-plots. The plot size was 1.8mx5m with 6 rows, 5 m long and 30 cm apart.

The land was given irrigation before its final preparation. It was then given 3-4 ploughing (including operation with disc plough, cultivator and rotavator). Sowing was done on beds by bed planter, while 30-day-old seedlings with roots holding a small lump of soil were transplanted manually in the main field. In direct seeding method, seeds were first kept immersing in water for 24 h

and then in moist gunny bags for 36 h until radical and plumule protrude. A seed rate of 100 kg ha^{-1} was used for sowing direct seeded plots as recommended by Baloch *et al*. (2000). Hand weeding was done twice after 25 and 50 days after sowing/transplanting. All other standard practices were followed accordingly. Soil analysis was done before sowing and after harvesting of rice, which showed that the experimental site was alkaline in nature with pH of 7.81 and electrical conductivity (EC) 0.35 ds/m suggesting that soil has no problem of salinity and sodicity. The texture of soil was silty clay loam. It was deficient in organic matter, mineral nitrogen (N) and phosphorous (P), while adequate in potash (K) contents. The pH, EC and soluble cations were decreased after crop harvest, while available P and K were increased (Table-1).

Cultivar IR-6 was used in this study. Fertilizers were applied @ 120:90:60 NPK kg ha^{-1}. All phosphorus and potash and half nitrogen were applied at the time of sowing/transplanting while the remaining nitrogen was applied in splits after 25 and 45 days after sowing/transplanting, respectively. Data were collected on number of seedling ($plot^{-1}$), number of tillers (m^{-2}), number of panicles (m^{-2}), number of spikelets ($panicle^{-1}$), unfilled spikelets (%), 1000-grain weight (g) and paddy yield (t ha^{-1}). The data obtained were subjected to analysis of variance technique by using MSTATC computer software and means were separated by LSD test (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Number of seedling ($plot^{-1}$): The data showed the maximum number of seedlings per unit area in dry seed and soaked seed broadcast method (Table-2). It might be attributed to higher number of seeds and their increased germination percentages, which subsequently increased the plant stand (Zeng and Shannon, 2004). While, the inverse was true for conventional transplanting technique where counted number of seedlings was used at proper spacing that resulted in minimum number of seedling per unit area (Baloch *et al*., 2007).

Number of tillers (m^{-2}): The data revealed that conventional transplanting produced maximum number of tillers than other seeding techniques (Table-3). Enhanced tillering in transplanting technique might be due to efficient utilization of nutrients at active tillering stage and availability of sufficient amount of light, water etc. in a comparatively larger net area for offshoot production (Awan *et al*., 2011). Sasaki *et al.* (1999) also recorded maximum number of tillers per unit area, which was negatively correlated with plant density. The minimum number of tillers recorded in dry seed drill was probably due to higher number of seeds and their increased germination percentages, which increased competition for nutrients and as a result plants could not utilize all available resources efficiently. Among sowing methods, bed sowing had higher number of tillers than that recorded in flat sowing. It was probably due to the reason that a thin layer of 2-3 cm irrigation water was maintained by intermittent wetting of beds to avoid seedling desiccation. This ensured water availability only to crop root zone during early growth stages and avoided seedling mortality as generally happened under submerged conditions.

Number of panicles (m^{-2}): The data presented in Table-4 indicated a significant increase in number of panicles in conventional transplanting technique over other sowing techniques. The maximum number of panicles in conventionally transplanted crop was due to producing maximum number of tillers per unit area on account of higher availability of nutrients (Aslam *et al*., 2008). These findings were supported by Prasad *et al.* (2001) who reported that transplanting technique increased all the growth and yield attributes of rice significantly over seeding and puddle sowing of sprouted seeds. Dry seed drill produced minimum number of panicles per unit area. When there were less number of tillers per unit are, automatically panicles will be less as is evident from the results of dry seed drill treatment. Among sowing methods, flat sowing produced more number of panicles than bed sowing. It might be due to the reason that each individual tiller enjoyed uniform supply of nutrients due to ample availability of space, light and aeration and also the advantage of less severe competition amongst germinated seeds/seedlings, which resulted in more number of panicle-bearing tillers per unit area in flat sowing (Baloch *et al*., 2007).

Number of spikelets ($panicle^{-1}$): Number of spikelets per panicle was non-significantly affected by sowing methods (Table-5). However, among different techniques, conventionally transplanted rice produced maximum number of spikelets per panicle. It was probably due to the reason that plant utilizes edaphic conditions more efficiently in transplanted crop, than that in direct seeded rice, and therefore produces maximum number of spikelets per panicle (Yang *et al*., 1998). Other reason could be the better availability and utilization of nutrients in properly spaced transplanted crop during panicle growth period (Awan *et al*., 2011). Conversely, lower light interception due to higher vegetative biomass and uneven space and aeration resulted in minimum number of spikelets per panicle in soaked seed broadcast. Hayashi *et al.* (2007) also stated that direct seeding produced minimum spikelets per panicle.

Unfilled spikelets (%): The occurrence of sterility is greatly affected by plant density. The data showed non-significant effects of sowing methods on unfilled spikelets (Table-6). Though statistically similar to soaked

seed drill, dry seed broadcast and dry seed drill, the conventionally transplanted crop showed higher sterility than soaked seed broadcast treatment. The higher percent unfilled spikelet in conventional transplanting technique was probably due to severe competition of plants for resources on account of higher number of tillers and panicles per unit area. Awan *et al*. (2011) stated that maximum sterility %age in spaced planting is because of more tertiary tillers production, which bear late flowering. Among them some are fertilized and majority remains un-fertilized due to weak tillers.

Table 1. Physio-chemical characteristics of soil of the experimental site.

Parameters	Unit	Pre-sowing	Post-harvesting
pH	-	7.81	7.80
Electrical conductivity	ds/m	0.35	0.20
Ca + Mg	mg/l	3.10	2.50
HCO_3	mg/l	1.20	1.60
Cl	mg/l	1.02	1.34
Organic matter	%	0.64	0.70
Nitrogen	%	0.032	0.035
Sand	%	16.2	16.4
Silt	%	47.8	47.2
Clay	%	36.0	36.4
Texture class	-	Silty clay loam	Silty clay loam
Phosphorous	mg/kg	3.2	3.5
Potassium	mg/kg	128	132

1000-grain weight (g): The data revealed non-significant differences among sowing methods (Table-7). However, grain weight in soaked seed broadcast treatment was significantly at par with other seeding techniques and higher than conventionally transplanted crop. It might be due to production of less number of tillers per unit area, which facilitated translocation of solutes throughout the grain developmental stages and eventually activated the florets to absorb nutrients to their fullest extent and develop heavy kernels in soaked seed broadcast technique (Baloch *et al*., 2007). The level of severe competition for soil and climatic resources, production of more number of tillers and panicles per unit area and the highest sterility percentage resulted in lower grain weight in transplanted crop.

Paddy yield (t ha^{-1}): The data showed significantly higher paddy yield in flat sowing (Table-8). It might be due to production of comparable number of seedlings, spikelets per panicle, grain weight and higher number of panicles per unit area than in bed sowing method. As far as seeding techniques are concerned, the maximum paddy yield was recorded in conventional transplanting. The minimum paddy yield was obtained in soaked seed drill treatment. The higher paddy yield recorded in transplanting technique was attributed to good crop conditions, efficient utilization of natural resources (soil, light, water, air etc.) which resulted in higher number of tillers and panicles per unit area and spikelets per panicle (Aslam *et al*., 2008) than in direct sown dense populated crop. These results were also in agreement with Jaiswal and Singh (2001) who reported that transplanted crop produced maximum paddy yield, which was significantly higher than broadcasting and direct seeding techniques.

Table 2. Number of seedling (plot^{-1}) as affected by different seeding techniques in rice.

Seeding techniques	Sowing methods		Means
	Flat sowing	Bed sowing	
Dry seed drill	333.25^{cd}	246.75^{de}	290^{b}
Dry seed broadcast	512.75^{ab}	662.50^{a}	587.625^{a}
Soaked seed drill	341.75^{cd}	278.75^{cde}	310.25^{b}
Soaked seed broadcast	411.25^{bc}	630^{a}	520.625^{a}
Transplanting	144^{e}	144^{e}	144^{c}
Means	348^{NS}	392	

$LSD_{0.05}$ for seeding techniques = 110.6
$LSD_{0.05}$ for sowing methods x seeding techniques = 156.4
NS = Non-significant
Means sharing similar letter (s) in respective column/row do not differ significantly at 5% level of probability.

Table 3. Number of tillers (m^{-2}) as affected by different seeding techniques in rice.

Seeding techniques	Sowing methods		Means
	Flat sowing	Bed sowing	
Dry seed drill	329.50^{f}	320.25^{fg}	324.87^{d}
Dry seed broadcast	344.25^{de}	355.25^{c}	349.75^{b}
Soaked seed drill	341.25^{e}	348.50^{cde}	344.87^{b}
Soaked seed broadcast	312.50^{g}	354.25^{cd}	333.37^{c}
Transplanting	399.50^{a}	388.00^{b}	393.75^{a}
Means	345.40^{b}	353.25^{a}	

$LSD_{0.05}$ for seeding techniques = 7.45
$LSD_{0.05}$ for sowing methods = 12.23
$LSD_{0.05}$ for seeding techniques x sowing methods = 10.54
Means sharing similar letter (s) in respective column/row do not differ significantly at 5% level of probability.

Table 4. Number of panicles (m^{-2}) as affected by different seeding techniques in rice.

Seeding techniques	Sowing methods		Means
	Flat sowing	Bed sowing	
Dry seed drill	325.50^{cd}	312.50^{de}	319.00^{d}
Dry seed broadcast	334.25^{bc}	351.25^{b}	342.75^{b}
Soaked seed drill	327.25^{cd}	345.50^{b}	336.37^{bc}
Soaked seed broadcast	305.50^{e}	348.25^{b}	326.87^{cd}
Transplanting	382.75^{a}	381.75^{a}	382.25^{a}
Means	347.85^{a}	335.05^{b}	

$LSD_{0.05}$ for seeding techniques = 12.12
$LSD_{0.05}$ for sowing methods =17.13
$LSD_{0.05}$ for seeding techniques x sowing methods = 17.82
Means sharing similar letter (s) in respective column/row do not differ significantly at 5% level of probability.

Table 5. Number of spikelets (panicle^{-1}) as affected by different seeding techniques in rice.

Seeding techniques	Sowing methods		Means
	Flat sowing	Bed sowing	
Dry seed drill	144.75^{b}	139.07^{b}	141.91^{ab}
Dry seed broadcast	129.42^{bc}	124.52^{bc}	126.97^{cd}
Soaked seed drill	138.62^{b}	137.75^{b}	138.18^{bc}
Soaked seed broadcast	128.22^{bc}	111.95^{c}	120.08^{d}
Transplanting	167.17^{a}	141.30^{b}	154.23^{a}
Means	141.64^{NS}	130.92	

$LSD_{0.05}$ for seeding techniques = 14.58
$LSD_{0.05}$ for sowing methods x seeding techniques = 20.61
NS = Non-significant
Means sharing similar letter (s) in respective column/row do not differ significantly at 5% level of probability.

Table 6. Unfilled spikelets (%) as affected by different seeding techniques in rice.

Seeding techniques	Sowing methods		Means
	Flat sowing	Bed sowing	
Dry seed drill	21.02^{NS}	23.45	22.24^{a}
Dry seed broadcast	18.92	26.29	22.60^{a}
Soaked seed drill	19.40	26.72	23.06^{a}
Soaked seed broadcast	15.66	19.13	17.39^{b}
Transplanting	23.28	24.75	24.02^{a}
Means	19.65^{b}	24.07^{a}	

$LSD_{0.05}$ for seeding techniques = 4.69
$LSD_{0.05}$ for sowing methods = 5.65
NS = Non-significant
Means sharing similar letter (s) in respective column/row do not differ significantly at 5% level of probability.

Table 7. 1000-grain weight (g) as affected by different seeding techniques in rice.

Seeding techniques	Sowing methods		Means
	Flat sowing	Bed sowing	
Dry seed drill	24.40^{NS}	24.62	24.51^{a}
Dry seed broadcast	24.02	24.27	24.15^{a}
Soaked seed drill	24.75	24.37	24.56^{a}
Soaked seed broadcast	24.65	25.12	24.88^{a}
Transplanting	23.07	22.85	22.96^{b}
Means	24.18^{NS}	24.25	

$LSD_{0.05}$ for seeding techniques = 1.07
NS = Non-significant
Means sharing similar letter (s) in respective column/row do not differ significantly at 5% level of probability.

Table 8. Paddy yield (t ha^{-1}) as affected by different seeding techniques in rice.

Seeding techniques	Sowing methods		Means
	Flat sowing	Bed sowing	
Dry seed drill	4.01^{b}	2.97^{d}	3.49^{c}
Dry seed broadcast	4.35^{b}	3.36^{c}	3.85^{b}
Soaked seed drill	3.56^{c}	2.18^{e}	2.87^{d}
Soaked seed broadcast	3.45^{c}	3.51^{c}	3.48^{c}
Transplanting	5.20^{a}	4.82^{a}	5.01^{a}
Means	4.11^{a}	3.37^{b}	

$LSD_{0.05}$ for seeding techniques = 0.26
$LSD_{0.05}$ for sowing methods = 0.37
$LSD_{0.05}$ for seeding techniques x sowing methods = 0.75
Means sharing similar letter (s) in respective column/row do not differ significantly at 5% level of probability.

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