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Studies on Plant Population and Stand Establishment Techniques for Increasing Productivity of Rice in Dera Ismail Khan, Pakistan

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Abstract: Rice production in Pakistan is constraint by many factors pertaining to prevalent planting techniques. A research on the feasibility of new planting techniques (direct seeding on flat, transplanting on flat, direct seeding on ridges, transplanting on ridges and parachute planting) in transplanted and direct wet-seeded rice was undertaken at Dera Ismail Khan region of Pakistan's North West Frontier Province during 2002 and 2003. Among the planting techniques, the best performance for the yield formation and economic evaluation was noted for transplanting on flat during both years. Chinese parachute planting technology also showed very promising results in most of the parameters. Direct seeding on ridges could not excel transplanting on flat and parachute planting during both cropping seasons. The findings concluded the feasibility of parachute planting technology along with traditional rice transplanting on flat over all other planting techniques being practiced in the area.

Key words: rice; plant population; planting techniques; grain yield; leaf area index; Pakistan

Rice is the second most important food crop in Pakistan's economy. It is the third largest agricultural production in terms of area under the different crops [1]. The average yield of rice is 1.83 t/ha in Pakistan, comparing to 8.4 t/ha in Egypt and 6.6 t/ha in USA. Rice production has been limited by a number of factors, such as water scarcity, high inputs, non-availability of skilled labour, sub-optimal plant population, weeds and pest infestation, low price of rice [2].

The key of maintaining optimum plant population by using appropriate planting technique(s) has been reported by many scientists for increasing the productivity of rice. Ghosh and Sharma [3] reported that the maintenance of optimum plant population is the key to get higher productivity of rice. But the required plant population in Pakistan cannot be maintained due to scarcity of skilled labour [4-5]. This attributed to some factors such as hot weather and other off-farm activities. To overcome these problems, some alternatives need to be put into practice. Farmers generally adopt direct seeding which is economical, feasible and effective in maintaining optimum plant population, but practically, its feasibility is in question due to severe drawbacks related to poor seed quality, poor land preparation, heavy weed invasion, poor water management, large tonnage seed requirement and predation of germinating seed by several predators.

To avert the risks of direct seeding, there are some new planting techniques being introduced in the rice planted countries. These new techniques include bed planting and parachute technology, which could save 25 percent of water [6]. Similarly, in permanent bed planting rice-wheat system, 35-40 percent of irrigation water could be saved [7]. Parachute planting (seedling broadcasting), a new planting technique recently introduced in Pakistan, requires less labour and time than manual transplanting, because planter do not have to bend down to plant each seedling. In addition, the seedlings themselves are less likely to be damaged during the transplanting process [7-8]. With this technology, optimum plant population could be easily maintained. Many scientists advocate field modifications in planting technique(s) with the view to save water, get the maximum yield and retained profits. New water-saving techniques such as bed planting [6] and parachute technology [7] are more efficient than traditional techniques. Moreover, crop

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lodging is less in bed planted crop due to the better root development.

The present research was formulated with the objective of increasing productivity through standardization of plant stand establishment and planting technique and solving the socio-economic problems of paddy growers in the area.

MATERIALS AND METHODS

The study was initiated at the Agricultural Research Institute, Dera Ismail Khan, Pakistan, during 2002 and 2003. Dera Ismail Khan (31º49′ N, 70°55′ E) is the southern district of the North West Frontier Province (NWFP) of Pakistan. It is hot and dry in summer with moderate spells of rain during the monsoon season. The elevation ranges from 121 to 210 m above sea level. The average maximum temperatures in summer and winter are 45℃ and 8℃, respectively. The experiments were carried out in fields where the previous crop was wheat during 2002 and chickpea during 2003. The soil was silty clay with a pH of 8.3 and the content of organic matter is less than 1% (Table 1).

The experiments were arranged in a randomized complete block design with four replications. The plot area was 3 m × 5 m. Rice variety used was IR6. In bed planting, seeds were sown through bed planter while the seedlings were transplanted manually on raised beds with a plant density of 0.20 m × 0.20 m. In parachute planting, all the plots were puddled three days before transplanting. The 25-day-old seedling with roots holding a small lump of soil was transplanted manually. In direct seeding, seeds were first kept immersing in water for 24 h and then in moist gunny bags for 36 h till the radicle and plumule protruding through the hull. A seed rate of 100 kg/ha was used in direct seeding plots. One-month-old rice seedlings were transplanted in the respective plots on June 20 each year. Fertilizer, zinc and insecticide were applied equally to all the treatments according to the standard recommendations.

Table 1. Physio-chemical characteristics of the soils used for the experiments.

Characteristic	2002	2003
Previous crop	Wheat	Chickpea
Texture class	Silty clay	Silty clay
pH (1:5)	8.3	8.3
EC × 10^6 (dS/m)	250	250
Ca^{2+} + Mg^{2+} (mol/L)	1.1	1.55
HCO_3^- (mol/L)	1.8	1.4
Cl^- (mol/L)	1.3	1.7
Organic matter (%)	0.62	0.96
N (%)	0.03	0.05
P (mg/L)	7.0	7.0

Source: Soil Chemistry Laboratory, Agricultural Research Institute, Dera Ismail Khan, Pakistan.

Data were recorded about plant population, number of panicles, number of spikelets, sterility percentage, 1000-grain weight and grain yield, number of leaves per plant and leaf area index (LAI). In addition, costs and incomes were investigated for each technique, and economic analysis was done. The data were analyzed statistically by using analysis of variance technique and subsequently Least Significance Test (LSD) was applied for comparing the treatment means by MSTATC computer software [9].

RESULTS AND DISCUSSION

Plant population

The ultimate productivity of a crop is determined by plant population per unit area. In the study, there was significant difference in plant population among the treatments (Table 2). Direct seeding on ridges had higher plant population compared to direct seeding on flat (21.2 seedlings/m^2) and transplanting on flat (21.0 seedlings/m^2) during 2002 (Table 3). Similarly, statistically higher plant population (30.5 seedlings/m^2) was noted in direct seeding on flat, followed by direct seeding on ridges (22.5 seedlings/m^2) and transplanting on flat (21.0 seedlings/m^2) in 2003. The higher plant population in direct seeding on ridges was probably due to the reason that the seed was sowed on ridges maintaining proper plant spacing. Similarly, the direct seeding on flat also resulted in higher plant population mainly due to larger net area for flat planting compared to bed sowing. The plant population in parachute planting remained the same (17.0 seedlings /m^2) during both years due to the use of counted seedlings per unit area. The higher plant population in