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EVALUATION OF PLANT SPACING AND SEEDLINGS PER HILL ON RICE (*ORYZA SATIVA* L.) PRODUCTIVITY UNDER TEMPERATE CONDITIONS

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This study was conducted to evaluate the influence of different plant spacing (15x15 cm, 15x20 cm, 20x20 cm) and seedlings per hill (1-5) on growth and yield of newly released rice variety Shalimar rice-1. Maximum plant height, tillers number, leaf area index, dry matter accumulation, yield and yield related traits were observed from closer spacing (15x15 cm). Yield increased in closer spacing was 8.97% higher in closer spacing (15x15 cm) than 20x20 cm spacing possibly owing to improved interception of photosynthetically active radiation. Amongst the number of seedlings per hill, maximum yield related traits and yield was recorded when 3 seedlings per hill were transplanted.
Keywords: Plant density, rice, seedlings per hill**,** tillering**,** transplanting

INTRODUCTION

Rice (*Oryza sativa* L.) is a staple food of more than 60% of the world's population and provides more calories per hectare than any other crop. It is estimated that more than 40% world's population use rice as major source of calories (Khush, 2005.). In India, rice is extensively grown on an area of 36.95 million ha with production and productivity of 110.50 million tonnes and 2.91 t ha^{-1} respectively (Anonymous, 2010). In Jammu and Kashmir state, rice is a staple food covering an area of 2490 thousand ha with the production and productivity of 4223 thousand tones and 1.71 t ha^{-1}, respectively (Anonymous, 2009). The growth period of rice gets limited by low temperature in spring and autumn also temperature fluctuations at flowering and grain filling stage results in higher spikelet sterility. The plant population and number of seedlings per hill are the two cultural practices which exercise considerable influence on the stand geometry of the transplanted rice, and hence its yield. Closer spacing and high number of seedlings per hill in rice has been found to compensate the loss in yield due to greater number of plants and tiller population per unit area of land (Das *et al.,* 1998). The plant spacing and seedlings per hill can further influence variations through alteration in the attainment of phenophases and eventually the development of plant canopy.

MATERIALS AND METHODS

The field experiment was conducted during Kharif season 2005 at Agronomy Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar. The experiment site is situated at an altitude of 1587 m above sea level, at a distance of 15 km towards the north of Srinagar between 34^o 08' N latitude and 74^o 83'E longitude. The experiment was laid out in a randomized block design with factorial arrangement of fifteen treatments replicated thrice. The treatments consisting of three levels of planting space viz. 15×15 cm, 15×20 cm, 20× 20 m and five levels of seedlings $hill^{-1}$ viz. 1-seedling $hill^{-1}$, 2-seedlings $hill^{-1}$, 3-seedlings $hill^{-1}$, 4-seedlings $hill^{-1}$, 5-seedlings $hill^{-1}$. The soil before sowing was analyzed for various physical, chemical and physico-chemical properties as per the standard procedure described by Jackson (1973). Analysis revealed that soil was silty clay loam in texture, with initial organic carbon 0.58%, alkaline $KMnO_4$ N 220 kg ha^{-1}, Olsen's P 14.12 kg ha^{-1}, NH_4OAC K 248 kg ha^{-1}, pH of 6.92, solubridge conductivity (EC ds m^{-1} at 25^0C) of 0.31 and CEC of 12.4 C mol kg^{-1}. The 30 days old seedlings were transplanted at a spacing of 15x15 cm, 15x20 cm, 20x20 cm with 1, 2, 3, 4 and 5 seedlings $hill^{-1}$. A basal dose of entire phosphorus, potassium and zinc was applied @ 60 kg P_2O_5 ha^{-1}, 45 kg K_2O ha^{-1} and 20 kg $ZnSO_4$ ha^{-1}, respectively. Nitrogen (120 kg ha^{-1}) was applied in 3-splits (50% as basal and remaining in two equal splits at maximum tillering and panicle initiation). A newly released medium duration (138-145 days) rice variety "Shalimar rice-1" was used as the test crop.

RESULTS AND DISCUSSION

***Phenological stages*:** Phenology is a descriptive study of organisms in relation to their environment. Knowledge of crop phenology is important because for optimal yield in an environment, it is necessary to match the life cycle of the crop to the length of growing season. The phenology of the crop varies under different environments created by varying the crop geometry and population density. Rice transplanted

at 20x20 took more number of days to reach different phenological stages than 15x20 cm and 15x15 cm. Regarding the treatment comprising seedlings hill^{-1}, marginally lesser difference was observed between 1, 2, 3, 4, and 5-seedlings hill^{-1} in attaining different phenophases (Fig.1). The reason being more of crop growth and nutrient availability at wider spacing than the closer spacings. Similar findings of higher number of days taken in wider spaced and less density sown crop to reach various phenophases were recorded by Lenka (1998) and Virdia *et al.* (1993).

Spacing: Plant spacing caused the variation in yield parameters. The plant spacing of 20x20 cm significantly recorded higher panicle length, panicle weight more of spikelets panicle^{-1}, grain panicle^{-1} in comparison to 15x20 cm and 15x15 cm spacing. The wider spacing showed an advantageous factor for better development of panicles, hence more panicle length, panicle weight, spikelets number and filled grains panicle^{-1}. Efficient utilization of growth resources, less intra species competition coupled with higher availability of nutrients among the widely spaced crop plants may be ascribed the reason for superiority in yield components of rice. Similar findings were opined by Kumari *et al.* (2000) and Singh *et al.* (2003).

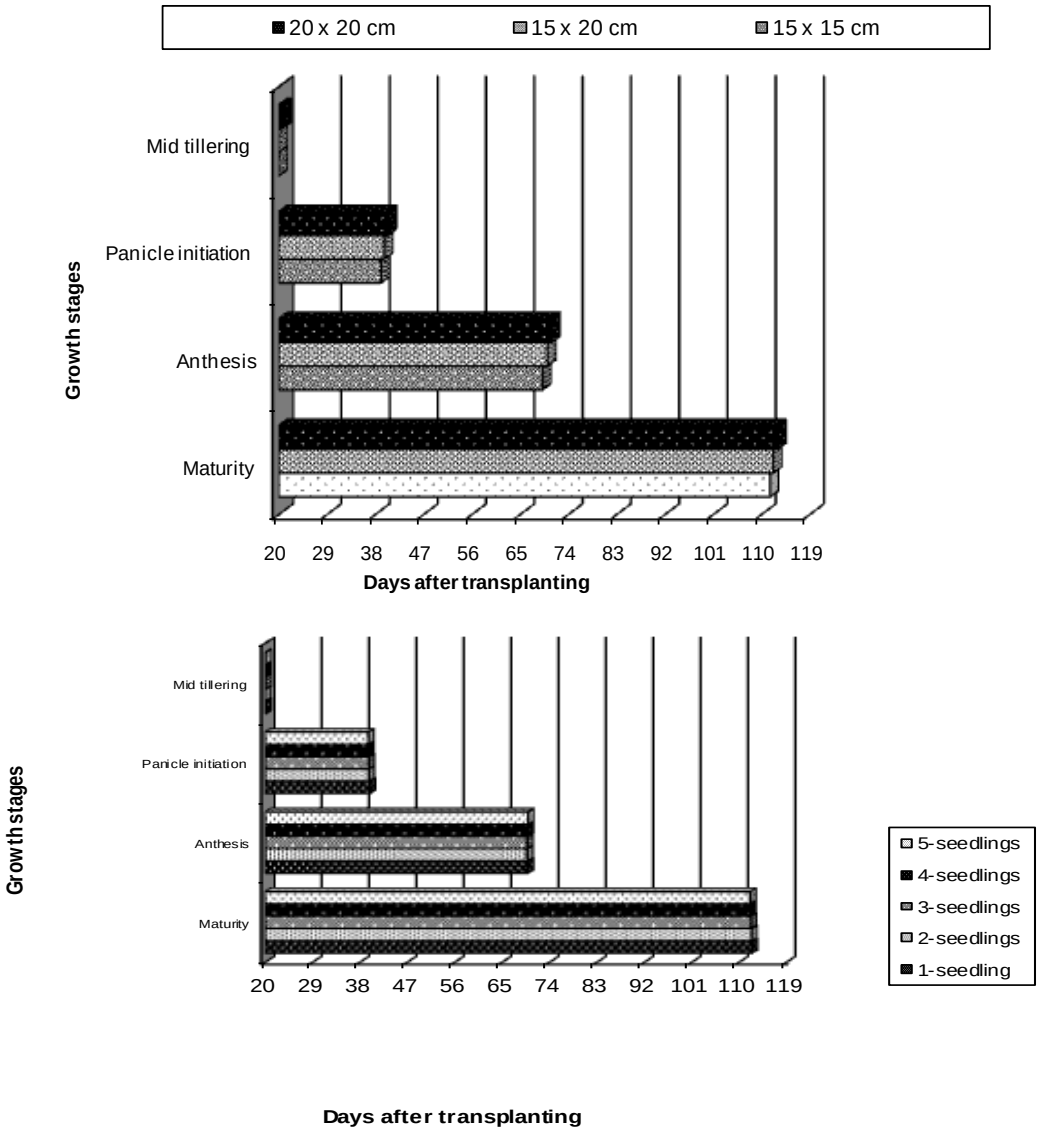

Figure 1. Number of days taken to reach different growth stages as influenced by spacing and seedlings hill^{-1}

Table 1. Yield attributes, grain and straw yields of rice as influenced by spacing and seedlings hill^{-1}

Treatments		Effective tillers (m^{-2})	1000-grain weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Spacing (cm)					
15x15	**(S_1)**	383.4	23.3	67.1	92.8
15x20	**(S_2)**	359.2	23.0	64.7	90.1
20x20	**(S_3)**	348.6	22.8	61.5	84.7
***SE (m)* ±**		**2.35**	**0.35**	**0.40**	**0.59**
C.D (0.05)		**6.81**	**NS**	**1.17**	**1.72**
Seedlings hill^{-1}					
1	**(H_1)**	358.4	22.7	64.1	89.2
2	**(H_2)**	367.7	23.4	65.4	90.8
3	**(H_3)**	370.4	23.3	67.9	92.8
4	**(H_4)**	362.0	22.9	62.9	87.4
5	**(H_5)**	360.1	22.9	61.8	85.7
***SE (m)* ±**		**3.03**	**0.45**	**0.52**	**0.77**
C.D (0.05)		**8.79**	**NS**	**1.52**	**2.22**

However, the case was just reversed for number of effective tillers m^{-2}, being maximum under 15x15 cm spacing and lowest under 20x20 cm spacing. The possible reason might be the balance between vegetative and reproductive growth and classical compensation in high yielding varieties between components of yield. The results were in agreement with Yoshida and Parao (1972). The different plant spacing did not influence the 1000-grain weight. However, higher values were observed with closer spacing. Similar findings were endorsed by Dongarwar *et al*. (2002). Among the plant population tested 15x15 cm spaced crop gave significantly more grain and straw yields than 15x20 cm and 20x20 cm. This might be due to cumulative influence of higher plant population, higher temperature in the canopy, more leaf area index, more of light interception and higher number of effective tillers m^{-2} resulting in yield enhancement at 15x15 cm spacing. Maximum grain yield registered under closer spacing was opined by Rajathinam and Balasubramaniyan (1999) and Singh *et al*. (2003).

***Seedlings hill^{-1}*:** The data on seedlings hill^{-1} showed the higher values of yield attributes with 1-seedlings hill^{-1} followed by the decreasing trend with the increase in seedling number hill^{-1}. The lowest was observed with 5-seedlings hill^{-1}. Planting less number of seedlings hill^{-1} enabled the plant to produce healthy tillers which had undergone normal physiological growth and field duration, resulting in more healthy panicles with more filled spikelets. Whereas, transplanting 4 to 5-seedlings hill^{-1} resulted in production of weak panicles with less filled spikelets. This may be due to healthy and efficient individual plant growth at lesser seedling density. With the increase in number of seedlings hill^{-1}, grain and straw yield increased up to 3-seedlings hill^{-1} but further increased to 5-seedlings hill^{-1} showed decreased trend. This might be due to less number of effective tillers m^{-2} and lesser assimilation rate at 5-seedlings hill^{-1}. The higher yield with low seedling density might be due to higher percentage of productive to total tillers and more interception of light. Also, grain filling is the process of remobilization from stored reserves, particularly from stem, leaves, and from current photosynthesis. So, it may be inferred that the effectiveness of grain filling is decided by the conditions of particular tiller. Hence, planting of fewer seedlings resulted in higher grain yield (Table 1). The result corroborates the findings of Banik *et al*. (1997).

The results conclude that it is advantageous to transplant rice (Shalimar rice-1) at closer spacing (15x15 cm) with 3-seedlings hill^{-1}.

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