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Phenological Traits of Rice as Influenced by Seedling Age and Number of Seedling Per Hill under Temperate Region

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ABSTRACT
The research study "phonological traits of rice crop as influenced by seedling age and number of seedling per hill in temperate zone" was conducted at Agricultural Research Institute (N) Mingora, Swat, Khyber Pakhtunkhwa, Pakistan, during summer 2014. Rice was transplanted at three different seedling ages 20, 25 and 30 days after sowing and with various number (1, 2 and 3) of seedlings hill^{-1}. The experiment was conducted using Randomized Complete Block Design (RCBD) with split plot arrangement having four replications. Seedlings age were kept in main plot while number of seedlings hill^{-1} in sub plot. NPK was applied at the rate of 120:60:40 kg ha^{-1} respectively. Data was recorded on flag leaf area plant^{-1} (cm^2), number of tillers hill^{-1}, plant height (cm), panicle length (cm), number of primary branches panicle^{-1} and number of secondary branches panicle^{-1}, All the parameters were significantly affected by seedlings age and number of seedlings hill^{-1}. Maximum flag leaf area plant^{-1} (22.26 cm^2) was observed at seedling age 25 days after sowing, more number of tillers hill^{-1} (17), higher plant height (100.16 cm), higher panicle length (29 cm), more number of primary and secondary branches panicle^{-1} (12, 37), Maximum flag leaf area plant^{-1} (22.47 cm^2), more number of tillers hill^{-1} (18), higher plant height (100.27), higher panicle length (29 cm), more number of primary and secondary branches panicle^{-1} (12, 38). It was concluded on the basis of above results that phonology of rice crop influenced by seedling age and number of seedling hill^{-1}under temperate region.

INTRODUCTION

Rice (*Oryza sativa L.*) is the third largest crop after wheat (*Triticum aestivum* L.) and cotton (*Gossypium hirsutum* L.) and second major grain crop of Pakistan (Imran et al, 2015). It accounts for 5.9% of value added in agriculture and 1.3% of Pakistan's gross domestic product (Federal Bureau of Statistics, 2008-2009). Rice production in Pakistan occupies an area of 2.96 m t ha^{-1}, with a total production of 6.95 m tons and average yield of 2.35 t ha^{-1} (Federal Bureau of Statistics, 2008-2009). Rice is the second most widely consumed cereal in the world next to wheat and is the staple food for two thirds of the world's population (Imran et al, 2015). Over 2 billion people in Asia alone derive 80% of their energy needs from rice, which contains 80% carbohydrates, 7–8% protein, 3% fat, and 3% fiber (Imran et al, 2015). Until recently, rice was considered only a starchy food and a source of carbohydrates and some amount of protein. Rice protein, though small in amount, is of high nutritional value (Chaudhary and Tran, 2001).

Asia accounts for over 90% of the world's production of rice, with china, India and Indonesia producing the most (International Rice Research Institute, 2002). Only 6-7% of the world's rice crop is traded in the world market. Thailand, Vietnam, China and the United States are the world's largest exporters. The United States produces 1.5% of the world's rice crop with Arkansas, California and Louisiana producing 80% of the U.S. rice crop. Rice (*Oryza sativa* L.) production constitutes the major economic activity and a key source of employment for the rural population of Pakistan. The average yield of rice in Pakistan has been increased as a result of many research activities by more than 2% per year but still far less than other leading rice growing countries ((Imran et al, 2015). Number of seedling hill^{-1} is another important factor which can play an important role in the boosting yield of rice. Because it influences the tiller formation, solar radiation interception, nutrient uptake, rate of photosynthesis and other physiological phenomena ultimately affect the growth and development of rice plant (Imran et al, 2015). In densely populated rice field the interspecific competition between the plants is high which results in gradual shading, lodging and thus increase production of straw instead of grain. It is, therefore, necessary to determine the optimum number of seedlings hill^{-1} for high yield. (Ghosh *et al.,* 1998). (Khatun, 1995) who observed that the tiller production was higher among 30-days old seedlings transplanted. The age of seedlings at transplanting is important criteria in rice production as it primarily contributes to the number of tillers produced hill^{-1} in the system of rice intensification (SRI) (Latif, 1995). Among the improved cultural practices, seedling age and number of seedlings hill^{-1} can play important role in boosting yield of rice. Age of seedling is an important factor as it has a tremendous influence on the tiller production, grain formation and other yield contributing characteristics (BRRI, 1981). Kim *et al*. (1999) observed that 10-days old seedlings had more vigorous stem elongation and higher tillering ability compared with 15 and 40-days old seedlings. Stoop *et al*. (2002) reported that young seedlings below 10 days of age are transplanted in SRI (System of Rice Intensification), which produces higher number of tillers than normal rice production systems, which contribute

to higher grain yield. Kewat *et al.* (2002) reported that grain yield decreases after transplanting younger seedlings (14 days), which might be due to the higher mortality rate as compared to that of older seedlings (28 days). According to Reddy (1992) transplanting 30-days old seedlings gave more grain yield than 45 and 60-days old seedlings. The age of seedling had a significant effect on number of grains panicle^{-1} (Hariom *et al.,* 1989). It was also observed that the 40-days old seedlings gave higher number of panicles than 20 or 60-days old seedlings (Rashid *et al.,* 1990). Number of panicles m^{-2}, number of grain panicle^{-1}, and 1000 grains weight was highest among 30-days old seedlings (Raju *et al*., 1989). Grain yield increased with age of seedlings at transplanting of up to 35 days (Imran et al, 2015). Faruk *et al.* (2009) reported that the highest grain yield was recorded from two seedlings hill^{-1} and the lowest one was recorded from single seedling hill^{-1}. LAI increased with increase in seedling age up to four weeks and then reduced gradually (Das and Mukherzee, 1989). Findings from research work of (Imran et al, 2015) revealed that the number of basal tillers hill^{-1} increased among 30-days old than 60-days old seedlings.

Therefore, this study was designed to investigate the influence of transplanting age and number of seedlings hill $^{-1}$ to get higher yield of rice in swat valley.

MATERIALS AND METHODS

The experiment on "The effect of seedlings age and number of seedling per hill on the growth and yield components of rice" was conducted at Agricultural Research Institute (North) Mingora Swat, Khyber Pakhtunkhwa, Pakistan during summer, 2014. The experiment was laid out in randomized complete block design (RCBD) with split plot arrangement having three replications. Age of seedling was allotted to main plots while number of seedlings hill^{-1} was allotted to sub plots. A subplot size of 1.2 m x 3 m was used. Each sub plot was consisted of 6 rows having 20 cm R-R and P-P distance respectively. NPK was applied at the rate of 120:60:40 kg ha^{-1} respectively and all other agronomic practices were carried out uniformly for all the experimental units throughout the growing season. Data was recorded on the following parameters. Flag leaf area plant^{-1} (cm^2), Plant height (cm), Tillers hill^{-1}, Panicle length (cm), Grains panicle^{-1}, Number of primary branches panicle^{-1} and number of secondary branches panicle^{-1},

The following factors were studied.

A. Main plot factor (Seedlings age)	B. Sub plot factor (Number of seedlings hill^{-1})
20 days old seedling	1 seedling hill
25 days old seedling	2 seedling hill
30 days old seedling	3 seedling hill

Flag leaf area plant^{-1} was taken at flowering stage and measured by the help of a ruler by measuring leaf length and width and multiplying by correction factor (0.75). Plant height was measured by meter rod from the base of the stem till the tip of the panicle at maturity by taking a sample of five plants randomly from each subplot. Five hills were randomly selected from each subplot and counted the number of tillers hill^{-1} and data was averaged. Panicle length of three selected plants was measured by using ruler and data was averaged. From each sub plot three panicles were randomly selected, and the number of seeds was counted and then average was taken to determine number of grains panicle^{-1}. From each sub plot three panicles were randomly selected, and the numbers of primary branches were counted and then average was taken to determine number of primary branches panicle^{-1}. From each sub plot three panicles were randomly selected, and the number of secondary branches was counted and then average was taken to determine number of secondary branches panicle^{-1}.

The data thus collected was subjected to statistical analysis and treatment means were compared using LSD value through STATISTIC-8.1 package.

Results and Discussion

Flag leaf area plant^{-1} (cm^2)

Data concerning flag leaf area plant^{-1} are presented in Table 1. Analysis showed that seedling age and number of seedlings hill^{-1} significantly affected flag leaf area plant^{-1}. The interaction between seedlings age and number of seedlings hill^{-1} was non-significant. More flag leaf area plant^{-1} (22.26 cm^2) was recorded at seedling age 25 days, while smaller flag leaf area plant^{-1} (19.77 cm^2) was attained at seedling age 30 days. In case of numbers of seedlings hill^{-1} higher flag leaf area plant^{-1} (22.47 cm^2) was produced by three numbers of seedlings hill^{-1}, while smaller flag leaf area plant^{-1} (18.25 cm^2) was produced by one number of seedling hill^{-1}. This may be due to suitable temperature, best age of seedling and may be genetic makeup. (Das and Mukherzee, 1989) reported that flag leaf area increased with the increase in seedling age up to 30 days and then reduced gradually. The findings of the results are correlated with those of Imran et al. (2015) who reported that maximum leaf area per seedling was noted in nursery sown on D3. Higher flag leaf area plant^{-1} (22.47 cm^2) was recorded in three numbers of seedlings hill^{-1}, while lower flag leaf area plant^{-1} (18.25 cm^2) was recorded in one number of seedling hill^{-1}. (De Datta, 1981) revealed that flag leaf area present at flowering greatly affect the amount of assimilates available to the panicles.

Number of tillers hill^{-1}

Data regarding number of tillers hill^{-1} are presented in Table1. Seedling age and number of seedlings hill^{-1} significantly affected number of tillers hill^{-1}. Interaction between seedling age and number of seedlings hill^{-1} was non-significant. More number of tillers hill^{-1} (17) was recorded at seedling age 30 days. Less number of tillers hill^{-1} (16) was attained at seedling age 20 days. In case of number of seedlings hill^{-1} more number of tillers hill^{-1} (18) was recorded in three number of seedlings hill^{-1}, while less number of tillers hill^{-1} (15) in one number of seedling hill^{-1}, followed by two number of seedlings hill^{-1}(17). This might be due to the easier establishment of seedlings after transplanting because they suffer less root damage during uprooting, with minimum transplanting shock and mortality rate. The findings of the results are correlated with those of Imran et al. (2015) who reported that maximum number of tillers enhanced with nursery sown on D3. Effect of seedling age and number of seedlings hill^{-1} on number of tillers hill^{-1} was significant. Khatun (1995) observed that effect of seedling age were significant on tillers production hill^{-1}. In case of number of seedlings hill^{-1} more number of tillers hill^{-1} (18) was recorded in three number of seedlings hill^{-1}, while less number of tillers hill^{-1} (15) was produced by one number of seedling hill^{-1}. Increase in the number of seedling will increase the number of tillers. Ashraf *et al.* (1999) stated that number of seedling hill^{-1} significantly affected the number of tiller hill^{-1}.

Plant height (cm)

Plant height significantly affected by seedling age and number of seedlings hill^{-1} Interaction between seedling age and number of seedlings hill^{-1} was non-significant. Taller plant height (100.16 cm) was recorded at seedling age 30 days followed by seedling age 25 days (99.16 cm). Shorter plant height (98.38 cm) was recorded at seedling age 20 days. In case of number of seedlings hill^{-1} taller plant height (100.27 cm) was recorded in three number of seedlings hill^{-1}, while smaller plant height (98.11 cm) were observed in one number of seedling hill^{-1}, followed by two number of seedlings hill^{-1}(99.31 cm). This might be due to more vigor and root growth because of more leaf area which stimulates increased cell division causing more stem elongation. (Sangsu *et al*., 1999: Rahman, 2001) also found that seedling age significantly affected the plant height. In case of number of seedling hill^{-1} taller plant height (100.27 cm) was recorded in three number of seedlings hill^{-1}, while smaller plant height (98.11 cm) were observed in one number of seedling hill^{-1}, followed by two number of seedlings hill^{-1}(99.31 cm). This might be due to vigorous stem elongation of seedlings. Farooq *et al*. (2007) also observed an increasing trend in plant height after transplanting three seedlings hill^{-1}.

Panicle length (cm)

Data on panicle length as affected by seedling age and number of seedling hill^{-1} are presented. Data revealed that seedling age and number of seedling hill^{-1} significantly affected panicle length. Interaction between seedling age and number of seedlings hill^{-1} was non-significant. Higher panicle length (29 cm) was recorded at seedling age 30 days, while smaller panicle length (27.50 cm) was observed at seedling age 20 days. In case of number of seedlings hill^{-1} higher panicle length (29.10 cm) was recorded in three number of seedlings hill^{-1}, while smaller panicle length (27.60 cm) were observed in one number of seedling hill^{-1}, followed by two number of seedlings hill^{-1}(28.35 cm). Increase in panicle length might be due to bumper leaf area which resulted in more partitioning of assimilates toward panicle. In case of number of seedling hill^{-1} high panicle length (29.10 cm) was recorded in three number of seedlings hill^{-1}, while smaller panicle length (27.60 cm) were observed in one number of seedling hill^{-1}, followed by two number of seedlings hill^{-1} (28.35 cm). Gasparillo *et al*. (2001) noted significant variation of panicle length due to age of seedling.

Number of primary branches panicle^{-1}

Data regarding number of primary branches panicle^{-1} are presented. Analysis indicated that seedling age and number of seedling hill^{-1} significantly affected number of primary branches panicle^{-1}. Interaction between seedling age and number of seedling hill^{-1} was non-significant. More number of primary branches panicle^{-1} (13) was observed at seedling age 30 days followed by seedling age 25 days (12). Less number of primary branches panicle^{-1} (11) was recorded at seedling age 20 days. In case of number of seedlings hill^{-1} more number of primary branches panicle^{-1} (12) was recorded in three number of seedlings hill^{-1}, while less number of primary branches panicle^{-1} (11) were recorded in one number of seedling hill^{-1}. This might be due to the highest panicle length. Kamdi *et al*. (1991) also found number of primary and secondary branches panicle^{-1} of rice increases with seedling ages. In case of number of seedling hill^{-1} more number of primary branches panicle^{-1} (12) and number of secondary branches panicle^{-1} (38) was recorded in three number of seedlings hill^{-1}. Asif *et al*. (1997) also stated that number of primary and secondary branches panicle^{-1} was significantly affected by seedling age.

Number of secondary branches panicle^{-1}

Data concerning number of secondary branches panicle^{-1} are significantly affected by seedling age and number of seedling hill^{-1}, while interaction between seedling age and number of seedling hill^{-1} was non-significant. More number of secondary branches panicle^{-1} (37) was recorded at seedling age 30 days, while less number of secondary branches panicle^{-1} (34) was observed at seedling age 20 days. In case of number of seedlings hill^{-1} more number of secondary branches panicle^{-1} (38) was recorded in three number of seedlings hill^{-1}, while less number of secondary branches panicle^{-1} (33) were recorded in one number of seedling hill^{-1}, followed by two

number of seedlings hill^{-1}(36). This might be due to the highest panicle length. Kamdi *et al*. (1991) also found number of primary and secondary branches panicle^{-1} of rice increases with seedling ages. In case of number of seedling hill^{-1} more number of primary branches panicle^{-1} (12) and number of secondary branches panicle^{-1} (38) was recorded in three number of seedlings hill^{-1}. Asif *et al*. (1997) also stated that number of primary and secondary branches panicle^{-1} was significantly affected by seedling age.

Seedling Age hill^{-1}	Flag LA (cm^{-2})	No of Tiller H^{-1}	Plant height (cm)	Panicle length (cm)	Primary branches	Secondary branches
20 days	20.30 b	16 b	98.38 b	27.50b	11c	34b
25 days	22.26 a	17 ab	99.16 ab	28.54a	12b	35ab
30 days	19.77 b	17 ab	100.16 a	29.00a	13a	37a
LSD (0.05)	1.81	1	1.12	0.89	1	3
No of seedling hill^{-1}						
1 seedling	18.25 b	15 c	98.11 c	27.60 c	11 b	33 c
2 seedling	21.61 a	17 b	99.31 b	28.35 b	12 a	36 b
3 seedling	22.47 a	18 a	100.27 a	29.10 a	12 a	38 a
LSD (0.05)	0.91	1	0.77	0.51	1	2
Interaction						
SA x NS	ns	ns	ns	ns	ns	ns

Table.1 ***Flag leaf area (cm^2), no of tillers h^{-1}, plant height (cm), Panicle length (cm), Primary branches and Secondary branches as affected by seedling age and number of seedling hill^{-1}***

Means followed by similar alphabets in rows or columns are not significantly different at p≤0.05 level of probability.

CONCLUSION

It was concluded from the study that "Seedling age 30 days" transplanted with three number of seedlings hill^{-1} in the system of rice intensification (SRI) improved flag leaf area plant^{-1}, number of tillers hill^{-1}, plant height, panicle length, grains panicle^{-1}, number of primary branches panicle^{-1}, number of secondary branches panicle^{-1}, as compared to other seedling ages 20 and 25 days and number of seedling 2 and 3 hill^{-1} which leads later to highest paddy yield, and biological yield.

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