Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(6): 1275-1279
Received: 19-08-2020
Accepted: 05-10-2020

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Effect of age of seedling on the performance of rice (*Oryza sativa* L.) cultivars

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Abstract
The field experiment study entitled "Effect of age of seedling on the performance of rice (*Oryza sativa* L.) cultivars" was conducted at Research Farm of Guru Kashi University, Talwandi Sabo, Bathinda during *Kharif* season of 2019. The experiment was laid out in split plot design comprising of 9 treatments combinations replicated thrice. The experiment consisted of three rice cultivar (PR 122, PR 126 and PR 127) in main plots and three age of seedling (30, 40 and 50days old) in sub-plots. Among the cultivars, PR 122 recorded highest value of growth parameters *viz*. plant height (116.9 cm), number of tillers (43.8), leaf area index (5.06), dry matter accumulation (4845 kg ha^{-1}). The highest number of effective tillers (41.8), panicle length (25.3 cm), number of grains $panicle^{-1}$ (165.5), 1000-grain weight (24.5 g), straw yield (117.8 q ha^{-1}) produced by cultivar PR 122 that consequently results in 8.3% and 14.2% higher grain yield than other cultivars. Among the age of seedling, transplanting of 30 days old seedling recorded highest growth parameter *viz*. highest plant height (119.9 cm), number of tillers (48.6), leaf area index (6.25), dry matter accumulation (4867 kg ha^{-1}) than other age seedling. The transplanting of 30 days old seedling gave highest yield attributes *viz*. highest number of effective tillers (46.7), panicle length (25.9 cm), number of grains $panicles^{-1}$ (202.7), 1000-grain weight (25.4 g), straw yield (175.7 q ha^{-1}) and harvest index (32.9%) that consequently results in 10.1% and 18.5% higher grain yield than 40 and 50 days old seedling, respectively.

Keywords: Rice, cultivars, age of seedling, grain yield

Introduction
Rice (*Oryza sativa*) is the most important and extensively cultivated cereal crop at global level. It is a staple food that fulfils the food requirements of more than half of the world s' population. It is major food grain in the diet of billions of peoples of Asia and South East Asia, will also continue to be so in the future. It belongs to the family *Poaceae.* It is edible starchy cereal grain that contains about 6-12% protein, 70-80% carbohydrate, and 1.2-2.0% mineral matter, small amount of fat and source of thiamine, niacin, riboflavin, iron and calcium. It is consumed after cooking. The by product of rice milling i.e. rice husk and bran are used as livestock feed. Broken rice is used in brewing and distilling industries and in manufacturing of starch and rice flour. Rice straw is used as a cattle feed, livestock bedding, electricity generation and also used for making mats and ropes.

Among the various rice growing countries across the globe, India is second largest producer and consumer of rice after China. In India it is in cultivation since ages and is grown over an area of about 43.37 million ha with annual production of about 115.60 million tonnes of paddy and average productivity of 3.96 tonnes per ha (Anonymous 2019) [1, 2]. In India rice is grown in most of the states under various climatic conditions and different techniques of crop production. West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Tamil Nadhu, Orissa and Bihar are major rice producing states. Punjab accounts for more than a tenth of India s' output of staple grain. In Punjab rice occupies an area of 3.06 million ha with total production of 13.38 million tonnes of rice. The average yield of paddy was 65.16 q ha^{-1} (Anonymous 2019) [1, 2].

Age of seedlings at transplanting has tremendous influence on dry matter production and laying the foundation for determining the number of panicles at harvest and thus influencing grain yield in rice production (Rajendran and Ganesa 2014) [17]. Tillering is an important agronomic trait that finally determined the number of panicles, grains $panicle^{-1}$ and grain yield per unit land area that greatly depends upon seedling age. Transplanting seedling at a proper age can provide appropriate ground for achieving potential production by reducing the death of tillers and providing the optimum period for completion of growing cycle of paddy (Li *et al.* 2003) [11]. Keeping these observations in view the present investigation "Effect of age of seedling on the performance of rice (*Oryza sativa* L.) cultivars" was taken up.

Material and methods

The field experiment study entitled "Effect of age of seedling on the performance of rice (*Oryza sativa* L.) cultivars" was conducted during *Kharif* season 2019 at Research Farm of Guru Kashi University, Talwandi Sabo (Bathinda) which is situated between $29^0$59' N latitude and $75^0$5' E longitude with an altitude of 208.42 meters above the mean sea level. This tract is characterized by semi climate, where both summers and winters are extreme. The mean maximum and mean minimum temperature ranged 45.8^0C and 13^0.0 C, respectively recorded during May, 2019 to October, 2019. The experimental soil was loamy sand in texture with normal reaction (7.9), low in organic carbon (0.29%) and nitrogen (233.75 kg ha^{-1}), medium in phosphorus (15.03 kg ha^{-1}) and potassium (216.85 kg ha^{-1}). The experiment was laid out in split plot design with three replications. The treatments comprised of three rice cultivars *viz*. PR 122, PR 126 and PR 127 and three age of seedling *viz.* 30, 40 and 50 days old. Bundles of rice from each plot were threshed separately and grains were collected in separate bags for each plot. After cleaning the grains were weighed and presented in q ha^{-1}.Total produce was weighted in bundles after harvesting and four days of sun drying in open. After threshing the weight of grains was subtracted from total bundle weight and remaining was straw yield, which expressed in q ha^{-1} for presentation. Harvest index of each plot was calculated separately with grain yield and biological yield obtained from that plot by using the formula.

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

The data were subjected to statistical analysis by using EDTB, software. The comparigen of treatment mean was made by critical difference (CD) at p= 5%.

Results and discussion

Growth parameters of rice

Plant height significantly influenced by cultivars and age of seedling. Interaction between cultivars and age of seedling was non-significant. Cultivar PR 122 recorded tallest plant (116.9 cm) which was significantly higher than cultivar PR 126 and PR127. 30 days old seedling recorded significantly highest plant height (119.9 cm) than 40 and 50 days old seedling. This might be due to higher phyllochrons production in younger aged seedling before entering reproductive phase as well as less transplanting shock at this stage. The results were in conformity with the research findings of Kavitha *et al.* (2010) [10], Sanjeewanie and Ranamukhaarachchi (2011) [23]. Data regarding number of tillers per m row length presented in Table.1 revealed that cultivars PR 122 recorded highest number of tillers (43.8) which was significantly superior to cultivar PR 126 and PR 127. The tiller number differed significantly with cultivars possibly due to their genetic traits. Dhaliwal *et al.* (2007) [7] also reported the same results. Seedling age significantly affected tillers number. Transplanting of 30 days old seedling responded well and recorded significantly higher number of tillers (48.6) than other aged seedling. The reason for higher tillering capacity of younger aged seedling might be due to due to completion of more number of phyllochrons during vegetative phase and less transplanting shock than older aged ones. Similar results were founded by Pasuquin *et al.* (2008) [14]. The interaction effect between cultivars and age of seedling was non-significant. Leaf area index is considered to be a key factor for maximum dry matter production. The leaf area index was significantly influenced by different rice cultivars and age of seedling. PR 122 registered highest value (5.06) of leaf area index which was significantly superior to PR 126 and PR 127. This is mainly because cultivar genotype possesses heterosis resulting in vigorous root system, more number of tillers and greater source size (Chowdhary *et al.* 2010) [6]. 30 days old seedling produced higher value (6.25) of leaf area index in comparison to 40 days (4.27) and 50 days (2.97) old seedlings. This might be due to transplanting of younger aged seedling results in high root activity and photosynthetic activity that results in production of more number of tillers, leaves per hill and dry matter production than that of old aged seedling (Rewainy *et al.* 2007) [21]. The results of interaction between cultivars and age of seedling showed that cultivar PR 122 with 30 days old seedling recorded significantly higher value (6.76) of leaf area index compared to other treatment combinations. Significantly higher dry matter accumulation (4845 kg ha^{-1}) was recorded by cultivars PR 122 over other cultivars. The increase in dry matter accumulation was mainly due to more number of tillers and leaf area of plant. The results were in conformity with the reports of Ying *et al.* (1998) [28]. 30 days old seedling registered significantly higher dry matter accumulation (4867 kg ha^{-1}) as compared to 40 and 50 days old seedling. Sahoo *et al.* (2004) [22] reported that planting of younger seedling recorded greater shoot dry matter than that of older seedlings is attributed to faster recovery from transplanting shock, production of healthy plants with more number of tillers. With regards to interaction effect cultivar PR 122 with transplanting of 30 days old seedling recorded significantly higher dry matter accumulation than other treatment combinations.

Table 1: Growth parameters of rice as influenced by age of seedling and cultivars

Treatments	Plant height (cm)	No. of tillers per m row length	Leaf area index	Dry matter accumulation (kg ha^{-1})
Cultivars				
PR 122	116.9	43.8	5.06	4845
PR 126	114.2	38.5	4.46	4085
PR 127	110.6	36.6	3.97	3925
CD (p=5%)	2.1	2.6	0.21	255.7
Age of seedling (days)				
30	119.9	48.6	6.25	4867
40	113.9	38.0	4.27	4230
50	107.9	31.5	2.97	3759
CD (p=5%)	1.5	1.3	0.20	134.4
Interaction	NS	NS	0.35	232.8

Table 2: Yield parameters of rice as influenced by age of seedling and cultivars

Treatments	No. of effective tillers per m row length	Panicle length (cm)	No. of grains $panicle^{-1}$	1000-grain weight (g)
Cultivars				
PR 122	41.8	25.3	165.5	24.5
PR 126	36.6	24.8	154.0	23.5
PR 127	34.7	24.2	141.0	23.0
CD (p=5%)	2.2	0.2	8.4	0.6
Age of seedling (days)				
30	46.7	25.9	202.7	25.4
40	36.6	24.8	144.2	24.7
50	29.7	23.6	113.6	20.7
CD (p=5%)	1.5	0.1	7.6	0.4
Interaction	2.6	NS	NS	NS

Yield parameters of rice

The number of the effective tillers one of most important yield contributing character data pertaining to number of effective tillers per m row length have been presented in

Table.2 showed that cultivar PR 122 recorded significantly more number of effective tillers (41.8) as compare to other cultivars. Production of higher number of effective tillers might be caused by genetic character, varietal performance. Seedling age showed remarkable influence number of effective tillers. Crop transplanted with 30 days old seedlings produced more number of effective tillers (46.7) than 40 days (36.6) and 50 days old (29.7). Younger aged seedling recorded more number of effective tillers due to less root damage at time of transplanting that helps in early establishment of plants, that facilities increased cell division and cell enlargement due to increased photosynthetic rate subsequently increasing plant height and number of tiller hill^{-1} than older aged seedling. Results are in agreements with reports of Singh *et al.* (2004) [25], Sarwar *et al.* (2011) [24] and Ali *et al.* (2013) [3]. With regards to interaction effect cultivar PR 122 with planting of 30 days old seedlings produced significantly highest number of effective tillers than other treatment combinations. The panicle length of PR 122 (25.3 cm) proved significantly higher to PR 126 (24.8 cm) and PR 127 (24.2 cm). The panicle length is more influenced by genetic character and less by environment factors. Similar result was reported by Bisne *et al.* (2009) [4].

It was observed from data that age of seedling significantly influenced the panicle length the highest panicle length (25.9 cm) was recorded at seedling age of 30 days which was statistically superior to 40 days and 50 days old seedling. Increase in panicle length might be due to more leaf area that resulted in more partitioning of assimilates towards panicles. Significant variation in panicle length was reported by Gasparillo *et al.* (2001) [8]. Cultivar PR 122 recorded highest number of grains panicles^{-1} (165.5) which was significantly higher than cultivar PR 126 (154.0) and PR 127 (141.0). This might be due to difference in genetic makeup of cultivars. Similar findings were reported by Mahajan *et al.* (2012) [12], Ramanjaneyulu *et al.* (2014) [19].

The highest number of grains panicle^{-1} (202.7) was produced by crop transplanted with 30 days old seedlings it was significantly higher than those obtained at other age of seedling (40 day and 50 days). The higher number of grains panicle^{-1} could be attributed to better establishment, early tillering and synchronised flowering by transplanting of seedling at optimum age.

The results were confirmed by Ali *et al.* (2013) [3]. The interaction effect cultivars and age of seedling on number of grains panicle^{-1} was non- significant. The cultivars differed significantly with respect to 1000-grain weight. The cultivar PR 122 recorded significantly higher 1000-grain weight (24.5 g) than PR 126 and PR 127.

This might be due to higher conversation of light energy into chemical energy and its subsequent translocation from source to sink. Similar types of results were found by Rahman *et al.* (2002) [16]. Age of seedling significantly influenced 1000-grain weight. Perusal of data revealed that the highest 1000-grain weight (25.4) was obtained by transplanting of 30 days old seedling which was significantly higher than those obtained by other aged seedlings.

This might be attributed to better crop growth and development and assimilates synthesis in grains (Husain *et al.* 2004) [9]. The interaction between cultivars and age of seedlings was found non-significant.

Table 3: Grain yield, straw yield and harvest index of rice as influenced by age of seedling and cultivars

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
Cultivars			
PR 122	84.0	177.8	32.0
PR 126	77.5	160.1	32.6
PR 127	73.7	154.7	32.4
CD (p= 5%)	2.0	3.6	NS
Age of seedling (days)			
30	85.5	175.5	32.9
40	77.6	163.8	32.0
50	72.2	153.1	32.1
CD (p= 5%)	1.5	3.9	0.4
Interaction	2.6	6.9	NS

Grain yield, straw yield and harvest index of rice

The cultivar PR 122 recorded significantly higher grain yield (84 q ha^{-1}) as compared to other cultivars PR 126 (77.5 q ha^{-1}) and PR 127 (73.7 q ha^{-1}). Cultivar PR 122 gave 8.3% and 14.2% higher grain yield over PR 126 and PR 127, respectively. The study indicated that better growth and yield parameter of cultivars PR 122 (i.e. higher dry matter production, leaf area index, number of effective tillers, panicle length, and panicle weight, number of grains per panicle and test weight value) helped in recording higher grain yield over other cultivars. Similar types of results were reported by Rahaman *et al.* (2002), Chowdhary *et al.* (2005) [6] and Singh *et al.* (2018) [26].

Age of seedling exerted significant influence on grain yield of rice. The highest grain yield (85.5 q ha^{-1}) was recorded by 30 days old seedlings which were significantly superior to 40 and 50 days old seedlings. In respect of relative increment in grain yield of 30 days old seedling over 40 and 50 days old seedling was 10.1% and 18.4%, respectively. The increment in yield under younger aged seedling was mainly due to higher photosynthetic rate and metabolic efficiency for assimilation of energy and partitioning in to yield attributes *viz.* Effective tillers, panicle length, panicle weight, number of grains panicle^{-1} and thousand grain weights and thus increased grain yield. Similar types of results of performance of younger aged seedling of rice over older aged were reported by Rao *et al.* (2006) [20], Pasquin *et al.* (2008), Sarwar *et al.* (2011) [24], Ram *et al.* (2014) [18] and Singh *et al.* (2018) [26]. The interaction effect of cultivars and age of seedling was significant. It was observed that significantly highest grain yield (92.9 q ha^{-1}) was recorded by cultivar PR 122 with the transplanting of 30 days old seedling than other treatment combinations.

Data pertaining to straw yield have been presented in Table.3 revealed that cultivars and age of seedling significantly influenced straw yield. It was evident from data that cultivar PR 122 recorded maximum straw yield (177.8 q ha^{-1}) that was significantly higher than cultivar PR 126 (160.0 q ha^{-1}) and PR 127 (154.7 q ha^{-1}). PR 122 gave 11.0% and 14.9% higher

straw yield over PR 126 and PR 127. Production potential of cultivar, vigourness (genetic traits) and physiological efficiency of cultivar responsible for higher growth attributes *viz*. plant height, number of tillers and dry matter accumulation that resulted in production of higher straw yield. It was clear from data that age of seedling exerted significant influence on straw yield. The highest straw yield (175.7 q ha^{-1}) was obtained from transplanting of 30 days old seedling that was significantly superior to other aged seedling. 30 days old seedling gave 7.26% and 14.7% higher straw yield over 40 and 50 days old seedling. This might be attributed to more plant height, number of tillers and dry matter accumulation at harvest by younger aged seedling than older ones. Results are in agreements with earlier observations of Kavitha *et al.* (2010) [10], Manjunatha *et al.* (2010) [13] and Sarwar *et al.* (2011) [24]. The table.3 showed the significant interaction effect between cultivars and age of seedling. The cultivar PR 122 with transplanting of 30 days old seedling produced significantly higher straw yield (194.5 q ha^{-1}) in comparing to other treatment combinations.

Different cultivars did not exert any significant influence on harvest index. Age of seedling showed significant influence on harvest index. 30 days old seedling recorded highest harvest index value (32.9%) which was significantly superior to 40 days and 50 days old seedling. The highest harvest index from 30 days old seedling might be due to the proper crop growth and development and assimilate synthesis in the grains The similar results were reported by Singh *et al.* (2010), Pramanik and Bera, (2013) [15]. The interaction effect between cultivars and age of seedling was non- significant.

Conclusion

Based on the results of present investigation following conclusions have been drawn.

Rice cultivar PR 122 recorded significantly higher growth parameters, yield parameters and 8.3% and 14.1% higher grain yield as compared to cultivar PR 126 and PR 127, respectively. Among the age of seedlings, 30 days old seedling recorded higher value regarding growth parameters, yield parameters and 10.1% and 18.4% higher grain yield as compared to 40 days and 50 days old seedling, respectively. Transplanting of cultivar PR 122 with 30 days old seedling showed its superiority in producing higher yield of rice.

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