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Effect of age of seedling, spacing and genotypes on growth and yield of paddy (*Oryza sativa* L.) under system of rice intensification

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Abstract: Field experiments were conducted during two consecutive years of 2008-09 and 2010-11 at instructional farm of krishi vigyan kendra daleepnagar Ramabainagar formerly Kanpur Dehat UP India to study the effect of age of seedling, spacing and genotypes on growth and yield of Paddy (*Oryza sativa* L.) under system of rice intensification where genotype and age of seedling were assigned in main plot while spacing were allocated into sub plots under split plot design. Significant increase was observed for plant height, number of tillers/hill, days to 50 per cent flowering and panicle length with the use of 12 days old seedlings by PHB-71 genotype under 25×25 cm spacing. Significantly higher growth attributes were obtained with the use of 12 days old seedlings of variety PHB- 71 under narrow transplanting as compared to rest of the treatments. Higher growth and yield attributing characters were resulted into significantly higher grain and straw yields of Paddy with the treatment combination of transplanting with 12 days old seedlings at 25×25 cm spacing under hybrid genotype and it was most remunerative and sustainable under Indo-gangetic plains of UP.

***Key words*:** Paddy, Growth attributes Age of Seedlings, Genotype, Spacing, Grain Yield and System of Rice Intensification

Introduction

Rice (*Oryza sativa* L.) is a staple food of millions of people in India and abroad. Ever increasing population and rapid sub-division and fragmentation of holdings compels to adopt and develop new technologies to meet the upcoming challenges and food security. Rice- wheat cropping system is prominent in indo-gangetic plains with wide range of input use and management practices. India produced about 104.4 million tonnes of paddy from the area of about 43.65 million hectares during 2013-14 (http://eands.dacnet.nic.in/latest_2006.htm). While Uttar Pradesh ranks 2nd in area and producing about 14.41 million tonnes occupying about 13.38 percent share of rice while in terms of productivity UP ranks 5th with an average yield of 3180 kg/ha exceeding far above the national average productivity of 2228 kg/ha (http://eands.dacnet.nic.in/latest_2006.htm). Poor soil health, shortage of irrigation water, aberrant weather condition, lack of rains during active crop growth stages and increasing cost of cultivation forces the researcher and policy makers to concentrate on emerging challenges ahead. So that demand for food and supply can be balanced as per need in due course of time. However, real challenge lies in achieving the goal on sustainable basis. In order to meet the goal, future research and development strategies must be eco-friendly and economically viable as well as lucrative to farmers.

Major threat arises from shrinking of important resources like land and water. As an estimate suggest that, for production of one kilogram of rice requires 4000-5000 liters of fresh water. Because horizontal expansion is limited, we need to focus on strategies helpful for vertical expansion of resources. Vertical expansion can be achieved with promotion and adoption of improved agro-technologies, use of hybrid rice varieties and boosting the system of rice cultivation intensively (SRI). Initially system of rice intensification was developed by one medagaskaran namely Henry De-Laulani during 1980s. Unfortunately SRI was confined within Medagaskar till 1999. However, in India firstly it was adopted by one downtrodden lady Mrs. Kunnu Devi achieving the productivity of rice upto 128 q/ha. Rice is cultivated under flooded or submerged condition. Because standing water is suppose to control weeds, slowly this practice became standard and it is widely believed that rice can't yield well without large quantities of water. However, it can in fact be cultivated with the same supply of water as other cereals (Parthasarathy, 1963). Rice cultivation is a very water-intensive activity. To produce one kilo of rice requires 3,000-5,000 litres of water. About two to three times more water is needed for rice cultivation than other irrigated crops. It is estimated that irrigated rice receives 34-43% of the world's irrigation water (Bouman et al., 2007). The SRI comprises use of younger seedling, planting of single seedling/hill, wider spacing, use of organic manure and without submergence during growth stages while controlling weeds by use of cono-weeder. This controls weeds effectively and mix it into soil in-situ which ultimately function as green manure. Therefore, a study was undertaken with objective to enumerate the appropriate age of seedling, spacing and genotypes of paddy (*Oryza sativa* L.) under system of rice intensification.

Materials and Methods

The field trial was conducted during rainy season of 2008-09 and 2010-11 at instructional farm of Krishi Vigyan Kendra Daleepnagar Ramabainagar under split plot design. Geographically, the current experimental site falls under sub-tropical climate in Indo-Gangetic plains with alluvial calcareous soils and lies between 26°36'45.29"N latitude and 80° 5'45.10"E longitude at an altitude of 132 meters above mean sea level. The instructional farm is situated 29 kilometers from Kanpur on the river bank of Pandu under central

plain zone of Uttar Pradesh having sub-tropical climate, often subjected to extreme heat up to 46^{0}C during summer and cold winter up to 3^{0}C during winter season. Sunshine, temperature and rainfall are most important factor influencing growth, development and yields of crops (Upadhaya, 2005). At higher temperature weed seeds and harmful microorganisms get destroyed (Adhikari, 2001). On an average 85% of total rainfall is received during summer monsoon season with uneven distribution. The experimental soil was slightly alkaline silty loam with medium in organic carbon (SOC, 0.29-0.32 %), low in available N (163.85-1165.46 kg/ha) and low in P (18.06-18.57 kg/ha) and high in available K (213.60 – 214.70 kg/ ha). This investigation was carried out to study the effect of seedling's age, spacing and genotypes on growth and yield of paddy (*Oryza sativa* L.) under system of rice intensification. The nursery was raised on the mixture of soil, FYM and sand in 4:2:1 ratio. The pre soaked and sprouted seed was broadcasted @ 5.0 – 6.0 kg/ha followed by vegetative mulching and water spraying. Before transplanting irrigation was given in main plots then left over for whole night. The seedlings were planted on marks made by marker pre arranged at 25×25 and 30×30 cm spacing. Genotype-1 (NDR- 359) and genotype- 2 (PHB- 71) along with 10 and 12 days old seedlings were allocated to main plot while spacing of 25×25 and 30×30 cm was assigned in sub- plots. Crop was applied with uniform fertilizer dose of 150:60:40 kg/ha N,P & K through urea, diammonium phosphate and murate of potash where half of inorganic N, full phosphorus, potash and farm yard manure were applied as basal and remaining half nitrogen in two equal splits one at after first irrigation and second at panicle emergence stage. Weeding was done through cono-weeder predesigned to cut the weed plant in-situ and mix them into soil resulting into addition and incorporation of weeds as green manure. Observation on growth characters *viz.*, plant height, number of tillers/hill, days to 50 % flowering and Panicle length. Among yield attributes i.e. number of grains/Panicle, test weight, grain yield and straw yields were recorded at harvest stage.

Results and Discussion

Growth attributes: Perusal of data presented in table-1 revealed that genotype, age of seedlings and alteration in spacing significantly influenced the growth characters of Paddy. Hybrid genotype acquired higher plants than composite variety. Age of seedling plays vital role in increasing internodal elongation. Significantly longer plants were found with the transplanting of 12 days old seedlings. Kim *et al. (*1999) and Thakur (1994) noted higher plants with younger seedlings while Murthy *et al*. (1993) reported that plant height did not vary with the use of different aged seedlings for transplantation. Plant height was significantly higher with the spacing of 25×25 cm than the other one. This might be due to proper spacing allows maximum amount of cosmic energy to be penetrated upto ground led by higher formation and accumulation of photosynthates by plants. Krupakara Reddy (2004) reported that the highest plants were produced with planting pattern of 25 x 25 cm as compared to planting pattern of 20 x 20 cm.

Significantly more number of tillers/hill were recorded with PHB-71 genotype than high yielding NDR-359. Seedling age produced considerable difference in acquiring higher number of tillers/hill which was significantly more with transplanting of 12 days old seedlings. Ginigaddara and Ranamukhaarachchi (2011) also found that younger seedlings had greater ability to produce greater number of tillers/hill than older seedlings. Singh *et al.* (2007) observed that when a seedling is transplanted carefully at the initial growth stage, the trauma of root damage caused during uprooting is minimized following a rapid growth with short *phyllochrons*. Krishna *et al.* (2008) noted that rice seedlings transplanted before commencing the fourth *phyllochron* retained their higher tillering potential than that of seedlings of more than 14 days old. Makarim *et al*. (2002) stated that 14 days old seedlings have performed better in tiller production than transplanting 21 to 23-d-old seedlings. Spatial arrangement of 25 x 25 cm produced significantly higher number of tillers than wider spacing. Similarly, Fernandes and Upholf (2002) obtained more number of tillers with transplanting at 25 x 25 cm spacing.

Table 1: Effect of genotype, age of seedling and spacing on plant height (cm), number of tillers/hill, days to 50 % flowering, Panicle length (cm), number of grains/Panicle, test weight (g) grain yield and straw yield of paddy (*Oryza sativa* L.) under system of rice intensification (two years' pooled data)

Treatments	Plant height (cm)	No of Tillers /hill	Days to 50 % flowering	Panicle length (cm)	No of grains/ panicle	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)
Genotypes								
NDR-359	82.75	36.83	79.50	18.46	156.09	23.61	68.72	75.48
PHB- 71	99.50	75.83	104.75	24.37	256.68	23.82	108.78	119.57
S. Em±	1.09	0.44	0.22	0.21	1.85	0.007	0.29	0.51
CD at 5%	3.77	1.53	0.78	0.74	6.40	0.024	1.00	1.76
Age of Seedlings								
10 days	86.25	52.08	89.33	19.73	194.93	23.71	86.8	95.34
12 days	96.00	60.58	94.92	23.10	217.84	23.73	90.69	99.72
S. Em±	1.10	0.45	0.23	0.22	1.85	0.07	0.29	0.51
CD at 5%	3.78	1.54	0.78	0.75	6.41	N.S.	1.01	1.77
Spacing for transplanting								
25×25 cm	93.92	58.17	93.5	22.17	212.44	23.75	89.59	98.54
30×30 cm	88.33	54.5	90.75	20.67	200.32	23.68	87.91	96.52
S. Em±	0.35	0.49	0.16	0.21	0.78	1.79	0.44	0.5
CD at 5%	1.14	1.59	0.54	0.69	2.56	N.S.	1.44	1.63

Days to 50 percent flowering and Panicle length (cm) were significantly higher when 12 days old seedlings were transplanted at spacing of 25×25 cm by hybrid genotype. Krishna and Biradarpatil (2009) found that younger seedlings matured earlier than the older one. This might be due to aged seedlings required more days to panicle initiation because of slow establishment of seedlings than younger seedlings and delayed formation of tillers and longer time to recover from transplanting shock resulted into poor yield. Similar findings were also reported by Ginigaddara and Ranamukhaarachchi (2011).

Yield and yield attributing characters: Yield is the final product of growth and yield contributing characters. Data presented in table-2 revealed that hybrid genotype acquired significantly higher number of grains per panicle than high yielding genotype while older seedling gained more number of grains/panicle by transplanting of 12 days old seedlings than younger one. Spatial arrangement of 25×25 cm was found significantly better than wider transplanting at 30×30 cm. Higher growth characters might have resulted into greater number of grains/panicle. Similar findings were reported by Ginigaddara and Ranamukhaarachchi (2011). 1000 grain weight is a genotypic character that might be responcible for significantly higher test weight with hybrid genotype rather than NDR- 359. Age of seedlings and spatial arrangements were unable to exert any significant difference to 1000 grain weight. In similar fashion Trillana *et al.* (2001) reported that the 1000 grain weight least affected by the environmental factors.

Perusal of data showed that grain yield was greatly influenced by genotype capability. Vigorous genotype produced significantly maximum grain yield than NDR- 359. PHB- 71 acquired 58.29 per cent higher grain yield than conventional genotype. Transplanting of 12 days old seedling produced significantly highest (90.69 q/ha) grain yield which was 4.48 per cent higher than younger one. Greater penetration of cosmic energy on crop geometry might be resulted into significantly higher grain yield (89.59 q/ha) which was 1.91 percent higher with the spacing of 25×25 cm than that obtained under 30×30 cm spacing. Krishna and Biradarpatil (2009) found significantly higher rice yield ha^{-1} with 12-d-old seedlings while More *et al.* (2007) found increased grain yield due to use of 15-d-old seedlings by 10.38 and 16.50% over the use of 20 and 28-d-old seedlings, respectively. Krupakara Reddy (2004) noted that the planting pattern of 25 x 25 cm produced highest grain yield than 20 x 20 cm spacing. The lowest grain yield was recorded with the planting pattern of 35 x 35 cm which was in parity with 30 x 30 cm.

Increased growth characters and yield attributes might have resulted into significantly higher straw yield with the use of 12 days old seedling under spatial arrangement of 25 x 25 cm than 30 x 30 cm spacing by PHB- 71 genotype than NDR-359. The percentage increase through hybrid genotype was about 58.41 percent than other. Similarly use of 12 days older seedling exerted significant increase of 4.59 percent in straw yield while 25 x 25 cm spacing produced 2.09 percent increase in straw yield than 30 x 30 cm spacing. Ali *et al.* (2013) and Naidu et al (2013) concluded that transplanting of younger seedlings produced more productive tillers $hill^{-1}$ and filled grains $panicle^{-1}$ resulted into increased grain and straw yield. While Fernandes and Upholf (2002) reported that spatial arrangement also increases the grain and straw yields.

Hybrid genotype (PHB 71) produce higher yields than conventional variety. Higher growth attributes were resulted to acquire lengthier panicle, seed and straw yields through use of 12 days old seedling for transplanting and comparatively closure spacing of 25×25 cm. PHB-71 genotype was proven superior with use of 12 DOS and closure spacing with regard to yields and economics.

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