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Effect of divergent plant spacings and age of seedlings on yield and economics of hybrid rice (*Oryza sativa*)

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ABSTRACT

An investigation was conducted during the rainy seasons of 1998 and 1999, to evaluate the effect of divergent plant spacings and age of seedlings on yield and economics of 'Pro-Agro 6201' hybrid rice (*Oryza sativa* L.). Transplanting seedlings at a closest spacing 20 cm × 10 cm produced significantly highest grain (63 q/ha) and straw (162 q/ha) yields and benefit : cost ratio (2.8) than wider spacings of 20 cm × 20 cm and 20 cm × 15 cm but was comparable to 15 cm × 15 spacing. Similarly, transplanting of 21 and 28 day-old-seedlings registered significantly higher grain and straw yields, net monetary returns and benefit : cost ratio than transplanting of thin and lanky seedlings of 14 days.

Key words : Hybrid rice, Plant spacing, Age of seedling, Economics

Rice has played a vital role in sustaining the foodgrain production in India during last three-and-half decades. The increase in the productivity of rice during this period was made possible by the development and wide-spread cultivation of high-yielding inbred varieties in varying agro-climatic conditions. But those varieties are now showing insignificant increase in respect of yield even after further refinement in the production technology. Presently, several rice hybrids are being marketed by various private as well as government seed agencies, with assurance of 15–20% additional yields over inbred varieties under the same level of management. The growth habit of hybrid plants are distinct from those of inbred varieties particularly during early growth stages owing to hybrid vigour (Siddiq, 1993). So, there are chances that the available information on suitable plant spacing and age of seedlings for inbred varieties may or may not be suitable for these newly released hybrids. Since, the farmers of Kymore Plateau and Satpura hill zone of Madhya Pradesh are growing hybrid rice ('Pro-Agro 6201') without satisfactory yield levels. Therefore an investigation in this direction was carried out.

MATERIALS AND METHODS

The field experiment was conducted during the rainy seasons of 1998 and 1999 at Agricultural Engineering Farm, Jabalpur Madhya Pradesh on sandy-loam soil having pH 6.2, electrical conductivity 0.2 dS/m, organic carbon 0.66% and analysing low in available N (250 kg/ha), medium in P (22.4 kg/ha) and K (258 kg/ha). The experiment was laid out in split-plot design. Twelve treatment combinations resulting from 4 plant spacings (20 cm × 20 cm, 20 cm × 15 cm, 20 cm × 10 cm and 15 cm × 15cm) as main plot treatments and 3 ages of seedlings (14, 21 and 28 days old) as subplot treatment were replicated 4 times. Staggered sowing in nursery was done to raise the seedlings of different age. The transplanting in the main field was done on 30 and 31 July in the respective years. The crop was fertilized with 120 kg N, 60 kg P and 40 kg K/ha. The one-third dose of N and entire dose of P and K were applied at the time of transplanting and rest of the nitrogen was given in 2 equal splits, at 21 and 52 days after transplanting in both the years. The economics of each treatment was worked out on the basis of prevailing market price of inputs used and output obtained. The cost of nursery preparation, main field preparation, fertilizers, weed control, irrigations, plant protection, harvesting and transportation, threshing and winnowing as well as land rent were Rs 295, 950, 2,630, 1,200, 330, 780, 1,200, 900 and 2,500 respectively. However, the selling of prices of grain and straw were Rs 550 and 50 q/ha, respectively, for working out the gross monetary returns under the different treatments.

RESULTS AND DISCUSSION

Seedling mortality

Transplanting of hybrid rice at different plant spacings and age of seedlings had a significant influence on the seedling mortality (%) recorded at 10 days after transplanting (DAT) in each plot. Transplanting at a widest spacing (20 m × 20 cm) recorded the significantly highest mortality (3.1%) over close spacings of 15 cm × 15 cm and 20 cm × 10 cm, which had only 1.5 and 1.3% mortile seedlings respectively (Table 1). However, the difference between former and 20 cm × 15 cm spacing did not attain the level of significance. The lower seedling mortality in case of closer plant spacings might be due to better mechanical support to seedlings from either side within the row that prevented the shaking as well as falling of seedlings. Transplanting of 14-day-old seedlings also showed maximum mortality (4.0%) which was identically reduced to 1.4 and 0.9% when 21 and 28-day-old seedlings were transplanted, respectively. The maximum mortality under transplanting of 14-day-old seedlings may be attributed to thin and lanky seedlings.

Yield attributes

Different plant spacings had marked influence on almost all yield-attributing traits except panicle length and test weight, which remained unaffected due to different spacings. Hybrid rice seedlings planted at a closest spacing (20 cm × 10 cm), had recorded significantly minimum number of ear-bearing tillers (7.7/hill) and number of sound grains (756/hill) coupled with maximum chaffy grains (16%) among all

the plant spacings and these traits improved remarkably with increase in plant spacings, being maximum under widest spacing 20 cm × 20 cm, followed by 20 cm × 15 cm. Efficient utilization of resources and less intra-space competition among widely spaced plants may be assigned the reason for superiority in these yield attributes of hybrid rice. These results are in accordance with the findings of Padmavati *et al.* (1998). Transplanting of varying age of seedlings also caused significant variation in almost all yield-attributing traits except 1,000-grain weight. Transplanting of 21- and 28-day-old seedlings produced indentically superior yield attributes to 14-day-old seedlings. Thin and lanky seedlings of 14 days took more time for establishment after transplanting, perhaps due to inefficient utilization of growth resources as a result of tardy root and shoot growth. Consequently, it recorded significantly inferior traits, mainly effective tillers (7.4/hill) and filled grains (623/hill), panicle length (18.3 cm) besides maximum chaffy grains (15%).

Grain and straw yield

Grain and straw yields significantly varied due to different plant spacings. Maximum grain (63 q/ha) and straw (162 q/ha) yields were recorded under closest spacing 20 cm × 10 cm, 15 cm × 15 cm and both proved significantly superior to wider plant spacings 20 cm ×15 cm and 20 cm × 20 cm which produced 16 to 18 and 25 to 33% less grain and straw yields, respectively, than a closest spacing 20 cm × 10 cm (Table 2). The advantage of having superior yield-attributing traits mainly effective tillers and healthy grains/hill under wider spacings (20 cm × 20 cm and 20 cm × 15 cm) was nullified due to lower plant population per unit area than that of closer spacings which had more plant population. Shrivastava and Tripathi (1998) also reported similar results.

Transplanting of 21- and 28-day-old

Table 1. Seedlings mortality and yield-attributing traits of hybrid rice as affected by plant spacings and age of seedlings (mean data of 2 years)

Treatment	Seedling mortality (%)	Effective tillers/hill	Panicle length (cm)	Filled grains/hill	Chaffy grains (%)	1,000-grain weight (g)
Plant spacing						
20 cm × 20 cm	3.1	9.5	21.6	1,045	11	23
20 cm × 15 cm	2.5	9.0	21.8	873	12	23
20 cm × 10 cm	1.3	7.7	20.0	756	16	22
15 cm × 15 cm	1.5	8.7	20.1	802	14	22
CD (P=0.05)	1.1	0.6	NS	57	0.8	NS
Age of seedlings						
14 days old	4.0	7.4	18.3	623	15	22
21 days old	1.4	9.3	21.1	896	13	23
28 days old	0.9	9.4	24.1	1,032	12	23
CD (P=0.05)	0.9	0.6	1.4	45	0.7	NS

seedlings recorded 43 and 70 and 38 and 70% higher grain and straw yields, respectively, over 14-day-old seedlings. The better initial growth coupled with superior yield attributes (effective tillers/hill, healthy grains/hill and panicle length) besides less chaffy grains might be ascribed the reasons for higher grain and straw yields under 21- and 18-day-old seedlings. These results also confirm the findings of Padmaja and Reddy (1998).

Economics

Cost of cultivation showed marked variation due to plant spacings. Maximum cost (Rs 15085/ha) was incurred under the closest spacing (20 cm × 10 cm) which was reduced correspondingly with further widening in plant spacings. The highest plant population under closest spacing could be assigned the reason for maximum cost over other spacings. However, the age of seedlings did not cause much variation in cost of cultivation and it ranged from Rs 14,051 to 14,151/ha under 14, 21 and 28-day-old seedlings respectively. The non-significant variation in the cost of cultivation among different age of seedlings could be ascribed to similar requirement of agro-inputs except irrigation water which caused the variation of Rs 50 to 100/ha.

Maximum gross and net monetary returns, as well as benefit : cost ratio were obtained under 20 cm × 10 cm spacing, followed by 15 cm × 15 cm and these values were decreased with further widening in plant spacings (Table 2). The higher grain and straw yields attributed to better economic returns under closer spacings. Transplanting of 21- and 28-day-old seedlings registered higher gross and net monetary returns along with benefit : cost ratio and proved superior to 14-day-old seedlings. The higher grain and straw yields

Table 2. Grain and straw yields, and economics of hybrid rice as affected by plant spacings and age of seedlings (mean data of 2 years)

Treatment	Yield (q/ha)		Cost of cultivation (Rs/ha)	Gross monetary returns (Rs/ha)	Net monetary returns (Rs/ha)	Benefit : cost ratio
	Grain	Straw				
Plant spacings						
20 cm × 20 cm	47	108	13,015	31,250	18,235	2.4
20 cm × 15 cm	53	133	13,685	45,880	22,115	2.6
20 cm × 10 cm	63	162	15,085	42,750	27,665	2.8
15 cm × 15 cm	60	142	14,618	40,100	25,482	2.7
CD (P=0.05)	6.1	4.0				
Age of seedlings						
14 days old	40	100	14,051	27,000	12,949	1.9
21 days old	57	138	14,101	38,250	24,149	2.7
28 days old	68	170	14,151	45,900	31,749	3.2
CD (P=0.05)	2.9	3.9				

are the reason for handsome returns with transplanting of 21- and 28-day-old seedlings.

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