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Effect of Age of Seedling and Plant Spacing on Yield and Economics of Transplanted Rice (*Oryza sativa* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted at Shradhay Bhagwati Singh Agriculture Research Farm (Hajipur), Chandra Bhanu Gupta Krishi Snatakottar Mahavidyalaya, B.K.T., Lucknow (Uttar Pradesh) during the Kharif season of 2022. The experiment was laid out in split plot design with three replications keeping three ages of seedlings viz., 21 days of the age of old seedlings, 28 days of the age of old seedlings and 35 days of the age of old seedlings in main plots and three plants spacing 20 cm x 10 cm, 25 cm x 10 cm and 15 cm x 15 cm in subplots. Results revealed that there was significant variation among different times of transplanting with respect to growth. Growth parameters were higher in paddy transplanted at 21 days of age of old seedlings as compared to the rest of the age

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of seedlings. The yield attributes as effective tillers m^{-2}, panicle length (cm.), numbers of grains $panicle^{-1}$, grains weight $panicle^{-1}$ (g.), panicle weight (g.) and 1000 grain weight were significantly superior in paddy transplanted in 21 days of age of old seedlings. 21 days of age of old seedlings proved significantly superior in terms of grain, straw, total biological yield and harvest index when compared to the rest of the age of seedlings. The maximum N – content (%) was significantly superior in paddy transplanted in 35 days of the age of seedling in grain and straw. The N – Uptake (kg/ha.) was significantly superior in paddy transplanted in 21 days of age of seedling in grain and straw. The protein content (%) was significantly superior over in paddy transplanted at 35 days of the age of seedlings in grain and straw. The Protein – production (kg/ha.) were significantly superior in paddy transplanted at 21 days of age of seedling in grain and straw. Growth parameters such as plant height (cm.), dry matter accumulation (gm^{-2}) and leaf area index were higher in paddy transplanted with 20 cm x 10 cm but a number of tillers (m^{-2}) higher with 25 cm x 10 cm as compared to rest of the plant spacing. Plant spacing of 25 cm x 10 cm produced significantly more yield attributes and yield of rice. The maximum N – content (%) were significantly superior in paddy transplanted with 15 cm x 15 cm in grain and straw. The maximum N – Uptake (kg/ha.) was significantly superior in paddy transplanted with 25 cm x 10 cm in grain and straw as compared to the rest of the plant spacing. The maximum protein content (%) were significantly superior over in paddy transplanted with 15 cm x 15 cm in grain and straw. The Protein – production (kg/ha.) was significantly superior in paddy transplanted with 25 cm x 10 cm in grain and straw. Transplanting of paddy 28 days of age of old seedlings with 25 cm x 10 cm plant spacing had higher gross return, net return, and B:C ratio of rice crop.

Keywords: Nitrogen; zinc; growth; yield; economics rice.

1. INTRODUCTION

Rice *(Oryza sativa L.)* belongs to the Poaceae (Gramineae) family with chromosome number 2n=24. Rice is a C_3 and self-pollinated crop. Rice is a major source of energy. Its main carbohydrate is starch, which is composed of amylose & amylopectin. It constitutes 12% water, 75% - 85% starch & only 7% protein. In the World, rice area is grown on 164.19 million hectares with a total production of 497.7 million tonnes in 2019-20 & productivity has increased to 507.24 million tonnes of milled rice in the last harvesting year worldwide [1]. India ranks first in the rice area after China. India occupies the largest rice area of 46.38 million hectares and produced 130.29 million tonnes with the productivity of 28.09 q/hac. [1]. Uttar Pradesh is the largest rice-growing state after West Bengal in India, though the productivity is low. In Uttar Pradesh Rice is grown over an area of 5.68 million hectares with a production of 15.66 million tonnes and productivity of about 2.75 tonnes/ha. West Bengal has a higher productivity of 2.95 tonnes/ha. as compared to Uttar Pradesh [1]. The age of seedling is an important factor as it has a tremendous influence on the tiller dynamics, tiller production, grain formation and other yield-contributing characteristics in rice [2, 3]. Plant geometry plays an important role in yield maximization of rice [4]. Optimum plant geometry depends on various factors such as plant type, season, soil fertility level and age of seedlings. The ideal plant geometry has to be adopted for getting optimum plant stand in the field which results in higher yield. The yield potential is not fully exploited mainly due to inadequate plant population. Optimum plant density ensures the plants to grow properly with their aerial and underground parts by utilizing more solar radiation and soil nutrients [5].

2. MATERIALS AND METHODS

A field experiment was conducted at Shradhay Bhagwati Singh Agriculture Research Farm (Hajipur), Chandra Bhanu Gupta Krishi Snatkottar Mahavidyalaya, Bakshi-Ka-Talab, Lucknow University, Lucknow (U.P.) during Rabi season 2021-2022. The experimental site is situated at 26.50º North latitude and 80.50º East longitude with an altitude of 123 meters above mean sea level. The soil of the experimental field was silty-loam texture, slightly alkaline in reaction (8.00 p^H), medium in organic carbon (0.70%) and available nitrogen (270 kg/ha) phosphorus (27 kg/ha) and potassium (262 kg/ha). Nine treatments comprised of three days of age of seedling (21,28 and 35 days) and three Plant spacing (20 cm x 10 cm, 25 cm x 10 cm and 15 cm x 15 cm) were tested in Split Plot Design with three replications. Nitrogen was applied through urea respectively. Half dose of Nitrogen was applied at the time of sowing and the rest half of nitrogen was applied in three splits at the time of first irrigation and second irrigation. A common dose of Phosphorus (60 kg P_2O_5/ha) and potash (40 kg K_2O/ha) was applied at sowing time to all plots through muriate of potash. The rice variety (NDR 2065) was sown the first week of July 2022, using 40 kg/ha seed at 20 x 10, 25 x 10 and 15 x 15 cm apart rows and harvested in the last week of October 2022. The data on plant height and tillers were recorded from the area already marked by tagged. For dry matter production, three hills were randomly selected from the sampling rows (leaving aside a border row from each side) from each plot. The fresh samples were first sun-dried and then kept in an electric oven at 70ºC till the constant dry weight was attained. Yield attributes were recorded from 5 panicles selected randomly from each plot. Grain and straw yields of rice were recorded at harvest the harvest index was calculated as grain yield divided by total biological yield and multiplied by a hundred. The uptake of nutrients was calculated as nutrient content in grain and straw multiplied by respective yield. The economics of different treatments was worked out based on prevailing market prices. The data so obtained on various parameters were analysed as per standard statistical procedures. The content of N and Protein in grain and straw was determined using standard laboratory procedures.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

Plant height, number of tillers, leaf area index and dry matter accumulation of rice were affected significantly due to different days of age of seedling and Plant spacing (Table 1). Crop transplanted with 21 days of age of seedling recorded higher plant height, number of tillers, leaf area and dry matter accumulation significantly superior over rest of the Age of seedling. The maximum plant height (120.87 cm), leaf area index (6.85), number of tillers (550.44 m^{-2}) and dry matter accumulation (665.33 gm^2) were recorded significantly with 21 days of Age of seedling but being at par with 28 days of Age of seedling. This might be due to the fact that the younger seedling having a greater ability of meristematic tissue activity as compared to older seedlings resulting in more number of meristematic tissues at the base of the seedling resulting in more plant height, more tillers, more leaves and higher dry matter accumulation as compared to older seedling caused poor meristematic tissues activity resulted poor growth of plant in terms of plant height, number of tillers, dry matter accumulation and leaf area index. These results are supported by the findings of More et al. [6], Aggarwal and Singh [7], Salem et al. [8] and Patra and Haque [9].

Crop transplanted at 20 x 10 cm plant spacing recorded higher plant height, leaf area and dry matter accumulation but numbers of tillers recorded higher with 25 x 10 cm. Crop planted at 20 cm x 10 cm spacing recorded significantly higher plant height, dry matter accumulation and leaf area index as compared to 25 cm x 10 cm and 15 cm x 15 cm spacing. The higher value of all growth parameters under 20 cm x 10 cm spacing might be due to the initial high plant population caused by heavy competition among plants results in more plant height, dry matter accumulation and leaf area index. However, the initial lower plant population/unit area under 25 cm x 10 cm and 15 cm x 15 cm produced more tillers due to lower inter and intra-row competition with 25 cm x 10 cm. Similar results were reported by Patra and Nayak [10], Kewat et al. [11], Verma et al. [12], Nayak et al. [13] and Pol [14].

3.2 Yield Attributes

The data on various yield attributes like effective tillers/m^2, panicle length, no. of grains/panicle, grains weight/panicle, panicle weight and 1000 grain weight were recorded at harvesting of crop. The data recorded on different yield attributes were analysed statistically and presented in Table 2. A perusal of the data presented in Table 3 revealed that age of seedlings and plant spacing affected the all yield attributes statistically. Crop planted with 21 days old seedlings produced significantly maximum no. of effective tillers (549.32/m^2) over 28 and 35 days age old seedling. Planting of 21 days age old seedling and 28 days age old seedling were found at par but produced significantly maximum Panicle length, No. of grains/panicle, Grains weight/panicle, Panicle weight and 1000 grain weight over 35 days age old seedling. This can be attributed to the fact that the trauma of root damage received during uprooting and transplanting of the seedlings was comparatively less under young seedlings (21 days old) than the older seedlings. Thus, younger seedling having higher capacity to produce more tillers as compared to older seedling and this was due to better partitioning or translocation of photosynthates from source to sink under (21 days old seedlings) than (28 days old seedlings) and (35 days old seedlings) particularly during grain development. The highest test weight was recorded by 21 days old seedlings. The increase in test weight under younger age of seedling might also be due to higher number of filled grains per panicle coupled with high panicle length. Pramanik and Bera [15], Chaudhari et al. [16] and Vishwakarma et al. [17], Singh and Singh [18] reported similar results.

Table 1. Growth attributes of rice as affected by age of seedling and Plant spacing

Treatments	Plant height (cm)	Number of tillers/m^2	Dry matter accumulation (gm^2)	Leaf area index
Age of seedling (Days)				
A_1 - 21	120.87	550.44	665.33	6.85
A_2 - 28	117.38	514.66	653.11	6.10
A_3 - 35	110.50	475.00	637.22	5.80
Sem ±	1.32	0.90	1.47	0.01
CD at 5%	3.65	3.63	5.95	0.05
Plant spacing (cm.)				
Sp_1 - 20 x 10	120.78	478.66	660.55	6.90
Sp_2 - 25 x 10	113.37	550.11	609.00	6.55
Sp_3 - 15 x 15	116.60	543.86	627.23	6.78
Sem ±	1.16	2.24	1.97	0.02
CD at 5%	3.12	6.88	6.16	0.06

Table 2. Yield attributing characters of rice as affected by age of seedling and Plant spacing

Treatments	Effective tillers m^{-2}	Panicle length(cm)	No. of Grainspanicle^{-1}	Grain weight panicle^{-1} (g)	Panicle weight (g)	1000 grain weight (g)
Age of seedling (Days)						
A_1 - 21	549.32	26.88	158.11	2.27	3.26	19.55
A_2 - 28	513.65	26.74	159.33	2.17	3.17	19.22
A_3 - 35	470.19	24.43	151.55	1.46	2.96	18.77
Sem ±	2.23	0.41	2.84	0.12	0.65	0.84
CD at 5%	4.48	1.18	7.83	0.26	1.53	NS
Plant spacing (cm.)						
Sp_1 - 20 x 10	529.83	26.94	160.88	2.13	2.97	19.02
Sp_2 - 25 x 10	548.38	27.40	165.22	2.66	3.33	19.55
Sp_3 - 15 x 15	525.72	22.72	147.88	2.56	3.10	19.12
Sem ±	1.42	0.52	3.69	0.18	0.18	0.21
CD at 5%	2.97	1.27	8.37	0.47	0.47	0.57

Table 3. Yield characters of rice as affected by age of seedling and plant spacing

Treatments	Grain yield (Q./ha.)	Straw yield (Q./ha.)	Total biological yield (Q./ha.)	Harvest index (%)
Age of seedling (Days)				
A_1 - 21	42.42	62.69	104.48	42.85
A_2 - 28	41.78	59.38	101.80	40.66
A_3 - 35	36.38	50.37	86.76	32.76
Sem ±	0.36	1.17	0.86	0.67
CD at 5%	1.45	3.45	3.46	2.71
Plant spacing (cm.)				
Sp_1 - 20 x 10	39.06	55.48	94.55	41.34
Sp_2 - 25 x 10	42.90	61.62	104.53	42.63
Sp_3 - 15 x 15	38.61	55.34	93.96	32.17
Sem ±	0.41	0.57	0.98	0.77
CD at 5%	1.27	1.80	3.07	2.27

Table 4. Nitrogen content and it's uptake as affected by age of seedling and plant spacing

Treatments	N – content (%)		N – uptake (kg/ha)	
	Grain	Straw	Grain	Straw
Age of seedling (Days)				
A_1 - 21	1.49	0.46	63.20	28.83
A_2 - 28	1.50	0.47	62.67	27.90
A_3 - 35	1.51	0.48	54.93	24.17
Sem ±	0.005	0.005	0.63	0.86
CD at 5%	NS	NS	2.53	3.50
Plant spacing (cm.)				
Sp_1 - 20 x 10	1.51	0.46	58.98	25.52
Sp_2 - 25 x 10	1.50	0.46	64.35	28.34
Sp_3 - 15 x 15	1.51	0.47	58.30	26.00
Sem ±	0.004	0.004	0.70	0.99
CD at 5%	NS	NS	2.20	3.10

Table 5. Protein content and it's uptake as affected by age of seedling and plant spacing

Treatments	Protein – content (%)		Protein uptake (kg/ha)	
	Grain	Straw	Grain	Straw
Age of seedling (Days)				
A_1 - 21	8.52	2.87	361.41	179.92
A_2 - 28	8.58	2.93	358.47	173.98
A_3 - 35	8.63	3.00	313.95	151.11
Sem ±	0.028	0.029	3.62	4.98
CD at 5%	NS	NS	14.60	20.11
Plant spacing (cm.)				
Sp_1 - 20 x 10	8.63	2.87	337.08	159.22
Sp_2 - 25 x 10	8.58	2.87	368.08	176.84
Sp_3 - 15 x 15	8.63	2.93	333.20	162.14
Sem ±	0.020	0.027	4.02	5.68
CD at 5%	NS	NS	12.55	17.70

Table 6. Economics of various treatment combination

Treatments	Cost of cultivation(Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B : C ratio (Rs/Re invested)
A_1P_1	43417	111412	67995	1.56
A_1P_2	40617	117940	77323	1.90
A_1P_3	41667	96384	54717	1.31
A_2P_1	43667	105408	61741	1.41
A_2P_2	40867	121496	80629	1.97
A_2P_3	41917	99024	57107	1.36
A_3P_1	43917	84120	40203	0.91
A_3P_2	41117	99928	58811	1.43
A_3P_3	42167	102680	60513	1.43

Rice planted with 25 x 10 cm. spacing recorded significantly maximum effective tillers over rest of the plant spacing. However, significantly lowest number of effective tillers was observed with plant spacing of 15 x 15 cm. crop planted with 25 x 10 cm. spacing being at par with 20 x 10 cm. plant spacing but recorded significantly higher panicle length (27.40 cm.), no. of grain/panicle (165.22 cm.), grain weight/panicle (2.66 g.) as compared to crop planted with 15 x 15 cm. spacing. However, grain weight/panicle, panicle weight and 1000 grain weight were significantly higher with 25 x 10 cm. spacing over 20 x 10 cm. spacing however, it was on par with 15 x 15 cm. plant spacing. Greater availability of the photosynthates and its translocation under P_2 (25 cm x 10 cm) as compared to 20 cm x 10 cm or 15 cm x 15 cm resulted in higher values of yield attributes These findings are in confirmation with those reported by Pol et al. [19], Rasool et al. [20] and Pawar [21].

3.3 Yield Studies

Crop planted with 21 days old seedling produced significantly maximum Grain yield (42.42 Q./ha.), Straw yield (62.69 Q./ha), Total biological yield (104.48 Q./ha.) and Harvest index (42.85%) over 28 and 35 days age old seedling. The lowest Grain yield, Straw yield, Total biological yield and Harvest index was recorded with 35 days age old seedling. The difference between 21 days old seedling and 28 days old seedling was found non-significant for Grain yield, Straw yield, Total biological yield and harvest index. The higher availability of nutrients under 21 days old seedling as compared to 28 days old seedling and 35 days old seedling enhanced the synthesis of photosynthates and its translocation to sink (yield attributes) resulted in higher values of all yield attributes and finally high grain, straw, biological yield and harvest index are obtained. On the other hands poor growth of crop under age of seedling resulted poor synthesis of photosynthetic and its translocation to sink caused significant reduction of number of tillers and yield attributes which finally resulted poor yields. Upadhyay et al. [22], Rao et al. [23], Mostafa [24], Ali et al. [25], Pramanik and Bera [15], Chaudhari et al. [16], Vishwakarma et al. [17] and Singh et al. [26] reported similar results.

Rice planted with 25 x 10 cm. spacing recorded significantly maximum Grain yield, Straw yield, Total biological yield and Harvest index over rest of the plant spacing. However, non-significantly lowest Grain yield, Straw yield, Total biological yield and Harvest index was observed with plant spacing of 15 x 15 cm. as compared to 20 x 10 cm. plant spacing. This was due to lower intra and inter row competition and higher availability of nutrients to crop enhanced the growth and synthesis of more photosynthesis and its translocation to sink resulted higher values of yield attributes and finally the yield of crop. Contrary to this, higher plant population and more intra and inter row competition among plant caused poor supply of nutrients to crop thus resulted poor growth and low synthesis of photosynthetic and its translocation to plant reproductive parts caused significant reduction in yield attributes and yield of crop. On the other hands, low plant population under 15 cm x 15 cm failed to compensate to total yield. Similar results were reported by Patra and Nayak [27, Gunsi and Pal [28], Mahato et al. [29], Salahuddin et al. [30] and Rasool et al. [31].

3.4 Nitrogen Content and Uptake

The content (%) of N and uptake (kg/ha) of N in Grain and Straw was not affected statistically due to age of seedling and plant spacing. Increasing age of seedling from 21 to 35 days increased N – content (%) and N – uptake (kg/ha.) in grain and straw. The maximum content (%) of N (1.51%) and (0.48%) in grain and straw was recorded with transplanting of 35 days old seedling. The maximum uptake (kg/ha) of N (63.20 kg/ha and 28.83 kg/ha) in grain and straw was recorded with transplanting of 21 days old seedling. The difference between 21 days old seedling and 28 days old seedling was found non-significant for N – uptake (kg/ha.) in grain and straw.

Crop planted with 15 cm x 15 cm. spacing recorded the maximum N – content (%) (1.51 % and 0.47 %) in grain and straw, respectively. Crop planted with 25 cm x 10 cm spacing recorded the maximum N – uptake (64.35 kg/ha and 28.34 kg/ha) in grain and straw, respectively. The difference between 20 cm x 10 cm. and 15 cm x 15 cm. was found non-significant for N – uptake in grain and straw.

3.5 Protein Content and Uptake

The protein content (%) of protein and production (kg/ha) of protein in Grain and Straw was affected statistically due to age of seedling and plant spacing. Increasing age of seedling from 21 to 35 days increased protein content (%) and its production (kg/ha.) in grain and straw. The maximum protein content (%) (8.63 % and 3.00 %) in grain and straw, respectively was recorded with transplanting of 35 days old seedling. The maximum protein production (kg/ha) (361.41 kg/ha and 179.92 kg/ha) in grain and straw, respectively was recorded with transplanting of 21 days old seedling. The difference between 28 days old seedling and 21 days old seedling was found non-significant for protein production (kg/ha.) in grain and straw. The production of protein in grain and straw was on par for grain with 28 and 35 days old seedling.

Crop planted with 15 cm x 15 cm spacing recorded the maximum protein content (%) (8.63 % and 2.93 %) in grain and straw, respectively. Crop planted with 25 cm x 10 cm. spacing recorded the maximum protein production (kg/ha) (368.08 kg/ha and 176.84 kg/ha.) in grain and straw, respectively. The difference between 20 cm x 10 cm and 15 cm x 15 cm. was found non-significant for protein production in grain and straw.

3.6 Economics

The highest gross return (1,21,496 Rs./ha.), net return (80,629 Rs./ha.) and B : C ratio (₹ 1.97) was recorded under 28 days old seedling (A_2) along with plant spacing 25 x 10 cm. (P_2) treatment followed by planting of 21 days old seedling at 25 x 10 cm. Plant spacing with gross income (117940 Rs./ha.), net income (77323 Rs./ha.) and benefit cost ratio (₹ 1.90). Whereas, lowest gross return (84120 Rs./ha.), net return (40203 Rs./ha) and benefit cost ratio (₹ 0.91) was recorded with 35 days old seedling (A_3) along with plant spacing 20 x 10 cm.(P_1).

The higher gross income, net income and benefit cost ratio with A_2P_2 was mainly because of higher grain and straw yield and lower cost of cultivation as compared to rest of the combination. However, A_3P_1 resulted lowest income because of poor yield owing to age of seedling planted.

4. CONCLUSION

The different age of seedlings at transplanting, 21 days of age of old seedlings recorded higher growth and yield of rice. The plant spacing of 25 cm x 10 cm recorded higher yield of rice crop. Crop transplanted at 21 days of Age of seedling and Plant spacing with 25 x 10 cm recorded higher yield of rice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Agricultural Statistics at a glance. Directorate of Economics and Statistics, Ministry of Agricultural and Farmers Welfare, (Govt. of India); 2021.
2. Bassi GA. Rang and Joshi DP. Effect of seedling age on flowering of cytoplasmic male sterile and restorer lines of rice. International Rice Research Notes (Philippines). 1994;19(1): 4.
3. Pasuquin E,Lafarge T, TubanaB. Transplanting young seedlings in irrigated ricefields: Early and high tiller production enhanced grain yield. Field Crops Research. 2008;105 (1- 2):141-155.
4. Siddiqui MRH. Lakpale R. Tripathi RS. Effect of spacing and fertilizer on medium duration rice varieties. Indian Journal of Agronomy. 1999;44(2):310-312.
5. Miah MHN, Karim MA, Rahman MS, Islam MS. Performance of Nizersail mutants under different row spacing. Bangladesh J. Train. Dev. 1990;3(2):31- 34.
6. More MR, Pawar LG, Chavan SA. Misal RM. Effect of methods of raising seedlings and seedling age and transplanting on growth and yield of rice. In: Second Nat. Sym. on System of Rice Intensification (SRI). Oct 3-5. Agartala, Tripura. 2007;44-45.
7. Aggarwal N. Singh A. Crop performance, nutrient uptake vis-a-vis weed suppressive ability of mechanically transplanted rice (*Oryza sativa*) as influenced by age of seedlings and planting density. Indian Journal of Agronomy, 2015;60(2):255-260.
8. Salem AKM, ElKhoby WM, Abou-Khalifa AB. Ceesay M. Effect of nitrogen fertilizer and seedling age on inbred and hybrid rice varieties. AmericanEurasian J. Agric. Enviro. Sci. 2011;11(5):640-646.
9. Patra PS. Haque S. Effect of seedling age on tillering pattern and yield of rice (*Oryza sativa* L.) under system of rice intensification. J. Agric. Biol. Sci. 2011;6(11):33-35.
10. Patra, A.K. and Nayak B.C. 2001. Effect of spacing on rice varieties of various duration under irrigated condition. Indian J. Agron., 46(3): 449-452.
11. Kewat ML, Agrawal SB, Agrawal KK. Sharma RS. Effect of divergent plant spacings and age of seedlings on yield and economics of hybrid rice (*Oryza sativa*). Indian J. Agron., 2002;47(3):367-371.
12. Verma AK, Pandey N. Tripathi S. Effect of transplanting spacing and number of seedlings on productive tillers, spikelet sterility, grain yield and harvest index of hybrid rice. IRRN., 2002;27(1):51-52.
13. Nayak BC, Dalei BB. Chodhury BK. Response of hybrid rice to date of planting, spacing and seedling rate during wet season. Indian J. Agron., 2003;48(3):172-174.
14. Pol PP. Effect of integrated nutrient management and plant densities on yield

maximization of hybrid rice —Sahyadri under lateritic soil condition, A Thesis submitted to Dr. B.S.K.K.V., Dapoli; 2003.
15. Pramanik K. Bera AK. Effect of seedling age and nitrogen fertilizer on growth, chlorophyll content, yield and economics of hybrid rice (*Oryza sativa L*.). Intl. J. Agron. Plant Production. 2013;4(S):3489-3499.
16. Chaudhari PR, Patel AP, Patel VP, Desai LJ, Patel JV, Chaudhari DR, Tandel DH. Effect of age of seedlings and fertilizer management on yield, nutrient content and uptake of rice (*Oryza sativa L*.). The Bioscan. 2015;10(1):351353.
17. Vishwakarma A. Effect of date of transplanting and age of seedling on growth, yield and quality of rice (*Oryza sativa L*.) hybrids under System of Rice Intensification. Ph.D. Thesis Banaras Hindu University, Varanasi (Unpublished) India (UP); 2015.
18. Singh UP, Singh Y. Effect of seedling age and number on yield of boro rice. Oryza. 2009;46(2):156-157.
19. Pol PP, Dixit AJ. Thorat ST. Effect of integrated nutrient management and plant densities on yield attributes and yield of Sahayadri hybrid rice. J. Maharashtra Agric. Univ. 2005;30(3):357- 359.
20. Rasool F, Habib R. Bhat MI. Agronomic evaluation of rice (*Oryza sativa L*.) for plant spacing and seedlings per hill under temperate conditions. African J.Agric. Res. 2013;8(37):46504653.
21. Pawar. Study the response of hybrid rice *(Oryza sativa L*.) to the age of seedlings at transplanting, spacing and levels of fertilizer under South Konkan condition on lateritic soil having low to moderate soil fertility status. Ph.D. Thesis submitted to Dr. B.S.K.K.V., Dapoli, Ratnagiri, India (MS); 2017.
22. Upadhyay VB, Mathew R, Vishwakarma SK. Shukla VK. Effect of number of seedlings per hill and age of seedlings on productivity and economics of transplanted rice. JNKVV Research Journal. 2003;37(1):27- 29.
23. Rao UA, Dakshina Murthy KM. Sridhar TV. Growth and yield of rice as influenced by age of seedlings and integrated N management for late planted situation. Internat. J. agric. Sci. 2010;6 (2):481-484.
24. Mostafa T. The effect of system of rice intensification (sri) on productivity of rice. M.Sc. (Thesis) Mansoura University, Faculty of Agriculture Agronomy Department; 2012.
25. Ali MS, Hasan MA, Sikder S, Islam MR. Hafiz MHR. Effect of seedling age and water management on the performance of Boro rice (*Oryza sativa L*.) variety brri dhan28. The Agriculturists. 2013;11(2):28-37.
26. Singh K, Singh SR, Singh JK, Rathore RS, Singh SP. Roy R. Effect of age of seedling and spacing on yield, economics, soil health and digestibility of rice (*Oryza sativa L*.) genotypes under system of rice intensification. Indian J. Agric. Sci. 2013 83: 5.
27. Patra AK, Nayak BC. Effect of spacing on rice varieties of various duration under irrigated condition. Indian J. Agron. 2001;46(3):449-452.
28. Gunsi SK, Pal SK. Effect of integrated nitrogen application and spacing on yield of rice (*Oryza sativa L*.) in foothill soil of West Bengal. Oryza. 2004;31(1): 130-133.
29. Mahato P, Gunri SK., Chanda K, Ghosh M. Effect of varying levels of fertilizer and spacing on medium duration rice (*Oryza sativa L*.) in Tarai Zone of West Bengal. Karnataka J. Agric. Sci. 2007;20(2):363-365.
30. Salahuddin KM, Chowhdury SH, Munira S, Islam MM. Parvin S. Response of nitrogen and plant spacing of transplanted aman rice. Bangladesh J. Agril. Res. 2009;34(2):279285.
31. Rasool F, Habib R. Bhat MI. Agronomic evaluation of rice (*Oryza sativa L*.) for plant spacing and seedlings per hill under temperate conditions. African J.Agric. Res., 2013;8(37):46504653.

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