Int.J.Curr.Microbiol.App.Sci (2017) *6*(6): 376-385

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 6 (2017) pp. 376-385**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.606.044

Growth and Yield of Machine Transplanted Rice (*Oryza sativa* L.) as Influenced by Age and Number of Seedlings

R.B. Negalur[1]* and A.S.Halepyati[2]

[1]AICRP on weed management, MARS, UAS Raichur, Karnataka, India
[2]College of Agriculture, UAS, Raichur, India
**Corresponding author*

Keywords

Age of seedlings, Number of seedlings per hill, Machine transplanting, Gross returns, Net returns.

Article Info

Accepted:
04 May 2017
Available Online:
10 June 2017

A B S T R A C T

Field experiment on "Effect of different age and number of seedlings on growth and yield of machine transplanted rice (*Oryza sativa* L.)" was conducted at Agricultural Research Station, Gangavathi, University of Agricultural Sciences, Raichur and Karnataka during kharif, 2012 and 2013 in clay soil. Pooled mean of two years indicated that, planting of twenty five days old seedlings recorded significantly higher plant height at harvest (95.41 cm), number of green leaves per plant at 60 DAT (87.52), number of tillers at harvest (734 m^{-2}), leaf area $plant^{-1}$ at harvest (810 cm^2), leaf area index (3.88) and grain and straw yield (5101 and 6335 kg ha^{-1}, respectively), gross and net returns (Rs. 91,141 and 45,178 ha^{-1}, respectively), and benefit cost ratio of 2.01. Similarly among the number of seedlings $hill^{-1}$, planting of three to four seedling $hill^{-1}$ recorded significantly higher plant height at harvest (97.34 cm), number of green leaves per plant at 60 DAT (90.41), number of tillers at harvest (787 m^{-2}), leaf area $plant^{-1}$ at harvest (877 cm^2), leaf area index (4.18) and grain and straw yield (5330 and 6585 kg ha^{-1}, respectively), gross and net returns (Rs. 95,190 and 49,165 ha^{-1}, respectively) and benefit cost ratio 2.10.

Introduction

Rice (*Oryza sativa* L.) is considered as the "global grain". It is the major staple food for more than half of the global population. In rice production, India ranks second as it is grown in almost all the states of the country.

Total estimated area under rice in India is 44.40 million hectares with a production of 104.32 million tonnes. West Bengal has the highest rice production, while Punjab has the highest productivity of rice among the different rice growing states of India.

Proper age of seedlings for transplanting varies with management practices, growth period, variety and growing season. In case of high yielding varieties, the seedlings should be transplanted at 4-5 leaf stage (Shastry, 1977). Twenty days old seedlings were most suitable for transplanters namely QUAT, CRRI and Yanji (Aswini *et al.*, 2009). There is a necessary to optimize the age of seedlings for minimizing root damage for proper functioning of the transplanters (Aswini *et al.*, 2009).

Number of seedlings transplanted per hill varies from country to country. While in Burma, one to four seedlings are transplanted per hill, in Sri Lanka only one seedling is used. Usually, 5 to 7 seedlings are transplanted in Philippines. Results in India indicated that the number of fertile tillers were greater with 3-4 seedlings (Hedayetullaha, 1977).

Transplanting is done manually, which is tough and involves enormous drudgery and human stress in sweltering weather. It requires about 300-350 man hours per hectare, which is approximately 25 per cent of total labour requirement for paddy cultivation. Non availability of labour has compounded the situation and paddy transplanting has emerged as the problem in the major rice growing areas of this region. This results in delay in transplanting and decrease in yield. In spite of the huge labour requirement, plant to plant and row to row spacing are not achieved as the workers transplant seedlings at far wider spacing that too randomly than recommended and hence mechanical weeding is also not possible. So also, the scarcity of labour at peak demand period results an increased cost of operation and delays the transplanting operation. Hence, transplanting of paddy seedling with a suitable mechanical transplanter seems to be most appropriate and promising avenue, as it minimizes drudgery and saves much of the labour requirement (Vasudevan *et al.,* 2014).

Materials and Methods

Under Northern dry zone of Karnataka, between 15o 15' 40" North latitude and 76o 31' 40" East longitude Agricultural Research Station, Gangavathi is situated at an altitude of 419 m above mean sea level where rice is the predominant irrigated crop under Tungabhadra command area which falls under the jurisdiction of University of Agricultural Sciences, Raichur, Karnataka. Field experiment on effect of age and number of seedlings on growth and yield of machine transplanted rice was conducted during kharif, 2012 and 2013. The design used was laid in strip-plot design and soil type was medium deep black clay. The initial soil analysis of indicated electrical conductivity (2.1), soil reaction (8.2) estimated with the as outlined by Jackson (1973), available N (247.2 kg ha^{-1}) Subbaiah and Asija (1956), available P_2O_5 (50.2 kg ha^{-1}) Olsen *et al.,* (1954) and available K_2O (357.6 kg ha^{-1}) Jackson (1973) at top surface 0–20 cm soil depth.

The experiment consisted three different age of seedlings viz., A1: twenty days old seedlings, A2: twenty five days old seedlings and A3: thirty days old seedlings and three different number of seedlings per hill planted by transplanter viz., N1: 3-4 seedlings per hill, N2: 5-6 seedlings per hill and N3:7-8 seedlings per hill. The land preparation consisted of passing of cultivator twice followed by puddling with disc puddler twice and finally levelled with spike tooth harrow and three different aged seedlings raised were transplanted on the same day.

As a pre emergent herbicide butachlor 50 EC at the rate of 2.5 liter ha^{-1} was sand mixed and broadcasted over the field uniformly having thin film of water and two hand weedings taken up at 20 and 40 days after transplanting. Upto 10 days from the planting 2.5 cm depth of standing water was maintained and was increased to 5 cm until 10 days before the harvest of the crop. A fertilizer dose of (150:75:75 and 20 kg N: P_2O_5: K_2O and $ZnSO_4$/ha) was applied using Urea, Di-ammonium phosphate (DAP), Muriate of potash (MOP) and zinc sulphate, other plant protection measures were taken as and when required. At physiological maturity, the crop was harvested, dried, threshed and cleaned manually in both the years and dry weights of

both grain and straw were recorded upon sun drying for a week. Different variable costs of items like seeds, fertilizers, irrigation, plant protection chemicals, hiring charges of transplanter, fuel cost and labour charges prevailed in market during 2012 and 2013 were considered for calculating cost of cultivation.

Results and Discussion

Growth parameters

Age of seedlings

Significant response was noticed by rice crop due to planting of different aged seedlings. Pooled data indicated that significantly higher plant height (4.51 %), number of green leaves per plant (3.34 %), number of tillers (10.70 %), leaf area (17.05 %), leaf area index (16.97 %) and total dry matter production at harvest (8.71) were observed by planting of twenty five days old seedlings (Tables 1 and 2) over planting of twenty days old seedlings, but was found to be on par with planting of thirty days old seedlings.

The increased height of plants might be attributed to early establishment of twenty five days old plants and subsequently more absorption of nutrients from the soil as compared to other two ages of seedlings. These results are similar with the findings of Faruk *et al.,* (2009).

Singh and Husain (1983) also reported increased rice growth parameters with planting of 25-30 days old seedlings and mentioned that younger seedlings had lower effective tiller rate and prone to mechanical damage when compared with higher aged seedlings. Vijayalaxmi *et al.,* (2016) reported 25 days old seedlings as the optimum age as for higher DMP with highest partitioning towards panicle followed by stem and leaf.

Number of seedling per hill

Planting of different number of seedlings per hill produced significant influence on rice growth parameters. Planting of 3-4 seedlings per hill recorded significantly higher plant height (8.99 %), number of green leaves per plant (10.91 %), number of tillers (27.55 %) (Table 1), leaf area (47.15 %), leaf are index (47.18 %) and total dry matter production at harvest (24.71 %) (Tables 1 and 2) over planting of 7-8 seedlings per hill. Planting of 5-6 seedlings per hill was the next best treatment. These findings can be corroborated with the reports of Maiti and Bhattacharya (2011) and Rasool *et al.,* (2013) who reported that planting of fewer numbers of seedlings hill^{-1} enabled the plant to produce healthy leaves and tillers which had undergone normal physiological growth and field duration, resulting in more healthy leaf area and panicles with more filled spikelets. Whereas, transplanting of 4 to 5 seedlings hill^{-1} resulted in production of weak panicles with less filled spikelets. Optimum plant density for higher DMP and grain yield would be 5 seedlings hill^{-1} which produced higher DM with highest partitioning towards panicle followed by stem and leaf (Vijayalaxmi *et al.,* 2016).

Yield

Age of seedlings

Age of seedlings had significant influence on yield and significantly higher grain yield (6.20 %) and straw yield (5.65 %) was also noticed by planting of twenty five days old seedlings over planting of twenty days old seedlings (4803 kg ha^{-1}) and straw yield (5996 kg ha^{-1}) (Table 3). This treatment was followed by planting of thirty days old seedlings. Kim *et al.,* (1999) reported that young seedlings had lower effective tiller production rate when compared with more

aged seedlings. Maximum non-bearing tillers were recorded from two weeks old seedlings and the lowest one was in four weeks old seedling and mentioned that number of unbearing tillers hill^{-1} increased by decreasing seedling age. This might be due to the production of secondary and tertiary tillers in the main field by low aged tillers which are incapable for production of panicle. Increased grain and straw yield due to planting of four weeks old seedlings was also reported by Bozorgi *et al.*, (2011). Singh and Husain (1983) also reported increased rice grain yield with planting of 25–30 days old seedlings.

Table.1 Plant height, number of green leaves and number of tillers of machine transplanted rice as influenced by age and number of seedlings

Treatments	Plant height (cm) at harvest			Number of green leaves plant^{-1} at 60 DAT			Number of tillers m^{-2} at harvest		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
Main treatments (A)									
A_1	89.44	93.13	91.29	83.00	86.37	84.69	657	668	663
A_2	93.64	97.18	95.41	85.44	89.59	87.52	732	736	734
A_3	91.71	94.76	93.24	84.44	88.37	86.41	705	717	712
S.Em.±	0.64	0.73	0.65	0.41	0.41	0.50	9.62	9.22	9.53
C.D. (P=0.05)	2.51	2.87	2.56	1.59	1.62	1.98	37.77	36.20	37.42
Sub treatments (N)									
N_1	95.67	99.00	97.34	88.44	92.37	90.41	782	793	787
N_2	91.56	95.02	93.29	84.56	88.81	86.69	698	708	703
N_3	87.58	91.04	89.31	79.89	83.14	81.52	614	619	617
S.Em.±	0.99	1.05	1.21	1.26	1.24	1.10	17.97	19.21	18.61
C.D. (P=0.05)	3.90	4.12	4.75	4.96	4.85	4.32	70.57	75.42	73.09
Interaction (A x N)									
A_1N_1	93.67	97.00	95.34	86.33	90.37	88.35	752	763	758
A_1N_2	98.20	101.87	100.04	89.67	93.70	91.69	811	818	815
A_1N_3	95.13	98.13	96.63	89.33	93.03	91.18	782	800	791
A_2N_1	90.00	93.73	91.87	84.00	88.03	86.02	672	682	677
A_2N_2	93.33	96.67	95.00	85.67	90.03	87.85	731	732	732
A_2N_3	91.33	94.67	93.00	84.00	88.37	86.19	691	712	702
A_3N_1	84.67	88.67	86.67	78.67	80.70	79.69	547	560	554
A_3N_2	89.40	93.00	91.20	81.00	85.03	83.02	653	658	656
A_3N_3	88.67	91.47	90.07	80.00	83.70	81.85	643	640	642
S.Em.±	1.39	0.99	1.24	0.47	0.69	1.34	25.53	21.15	26.28
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table.2 Leaf area per plant, leaf area index and total dry matter production of machine Transplanted rice as influenced by age and number of seedlings

Treatments	Leaf area plant^{-1} (cm^2) at harvest			Leaf area index at harvest			TDMP at harvest (g plant^{-1})		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
Main treatments (A)									
A_1	680	703	692	3.24	3.35	3.30	70.65	76.71	73.68
A_2	805	814	810	3.83	3.88	3.86	76.93	83.27	80.10
A_3	745	760	753	3.55	3.62	3.59	73.86	79.19	76.53
S.Em.±	17.40	15.80	17.69	0.08	0.08	0.08	0.84	0.85	0.87
C.D. (P=0.05)	68.34	62.04	67.47	0.32	0.30	0.33	3.29	3.34	3.43
Sub treatments (N)									
N_1	873	880	877	4.16	4.19	4.18	82.02	89.08	85.55
N_2	768	795	782	3.66	3.79	3.73	73.11	79.20	76.16
N_3	589	603	596	2.80	2.87	2.84	66.31	70.89	68.60
S.Em.±	25.69	25.89	26.32	0.12	0.12	0.13	1.54	1.71	1.77
C.D. (P=0.05)	100.88	101.64	103.33	0.48	0.49	0.49	6.06	6.70	6.96
Interaction (A x N)									
A_1N_1	839	852	846	4.00	4.05	4.03	78.10	85.27	81.69
A_1N_2	907	920	914	4.32	4.38	4.35	85.87	93.78	89.83
A_1N_3	873	866	870	4.15	4.13	4.14	82.09	88.20	85.15
A_2N_1	734	774	754	3.50	3.69	3.60	70.40	76.22	73.31
A_2N_2	810	824	818	3.86	3.93	3.90	75.23	82.62	78.93
A_2N_3	761	786	774	3.62	3.74	3.68	73.69	78.77	76.23
A_3N_1	468	483	476	2.23	2.30	2.27	63.44	68.65	66.05
A_3N_2	698	698	698	3.32	3.32	3.32	69.69	73.42	71.56
A_3 N_3	601	628	615	2.86	2.99	2.93	65.79	70.60	68.20
S.Em.±	33.61	35.23	29.07	0.16	0.17	0.14	2.33	1.41	1.74
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table.3 Grain yield, straw yield and harvest index of machine transplanted rice as influenced by age and number of seedlings

Treatments	Grain yield (kg/ha)			Straw yield (kg/ha)			Harvest index		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
Main treatments (A)									
A1	4753	4853	4803	5930	6061	5996	0.45	0.45	0.45
A2	5080	5122	5101	6245	6425	6335	0.45	0.44	0.45
A3	4841	4936	4889	6049	6195	6122	0.44	0.45	0.45
S.Em.±	61	52	57	60	66	63	0.00	0.00	0.00
C.D. (P=0.05)	241	202	226	234	261	247	NS	NS	NS
Sub treatments (N)									
N_1	5295	5365	5330	6515	6655	6585	0.45	0.45	0.45
N_2	4834	4903	4869	6048	6208	6128	0.44	0.44	0.44
N_3	4546	4643	4595	5661	5818	5740	0.45	0.45	0.45
S.Em.±	67	67	67	86	85	85	0.00	0.00	0.00
C.D. (P=0.05)	263	262	263	337	334	332	NS	NS	NS
Interaction (A x N)									
A_1N_1	5067	5166	5117	6368	6513	6441	0.44	0.44	0.44
A_1N_2	5597	5635	5616	6692	6853	6773	0.46	0.45	0.46
A_1N_3	5220	5295	5258	6485	6599	6542	0.45	0.45	0.45
A_2N_1	4715	4819	4767	5953	6023	5988	0.44	0.45	0.45
A_2N_2	4972	4970	4971	6138	6390	6264	0.45	0.44	0.45
A_2N_3	4816	4920	4868	6052	6210	6131	0.44	0.44	0.44
A_3N_1	4478	4574	4526	5468	5647	5558	0.45	0.45	0.45
A_3N_2	4671	4762	4717	5904	6032	5968	0.44	0.44	0.44
A_3 N_3	4488	4594	4541	5610	5775	5693	0.44	0.45	0.45
S.Em.±	106	103	100	188	116	142	0.01	0.01	0.01
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table.4 Gross returns, net returns and benefit cost ratio of machine transplanted rice as influenced by age and number of seedlings

Treatments	Gross returns (` ha^{-1})			Net returns (` ha^{-1})			B : C		
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled
Main treatments (A)									
A1	89116	82499	85808	47331	33283	40307	2.13	1.68	1.91
A2	95187	87094	91141	52921	37435	45178	2.26	1.76	2.01
A3	90773	83939	87356	48537	34205	41371	2.15	1.69	1.92
S.Em.±	702	702	702	716	716	716	0.02	0.01	0.01
C.D. (P=0.05)	2756	2756	2756	2812	2812	2812	0.09	0.04	0.04
Sub treatments (N)									
N1	99211	91168	95190	56891	41439	49165	2.35	1.84	2.10
N2	90645	83415	87030	48580	33907	41244	2.16	1.69	1.93
N3	85220	78950	82085	43317	29576	36447	2.03	1.60	1.82
S.Em.±	946	946	946	977	977	977	0.03	0.03	0.02
C.D. (P=0.05)	3715	3715	3715	3835	3835	3835	0.12	0.012	0.06
Interaction (A x N)									
A1N1	95021	87867	91444	53059	38489	45774	2.26	1.78	2.02
A1N2	104761	95637	100199	62212	45743	53977	2.47	1.92	2.20
A1N3	97851	89999	93925	55403	40084	47744	2.30	1.81	2.06
A2N1	88442	81928	85185	46677	32729	39703	2.12	1.67	1.90
A2N2	93179	84627	88903	50971	35031	43001	2.21	1.71	1.96
A2N3	90313	83688	87000	48092	33962	41026	2.14	1.69	1.92
A3N1	83885	77702	80793	42256	28629	35442	2.01	1.58	1.80
A3N2	87620	81018	84319	45580	31530	38555	2.09	1.64	1.87
A3 N3	84156	78130	81143	42115	28570	35342	2.00	1.58	1.79
S.Em.±	1599	1599	1599	1774	1774	1774	0.06	0.08	0.05
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Fig.1 Grain and Straw yield of machine transplanted rice as influenced by Age and number of seedlings

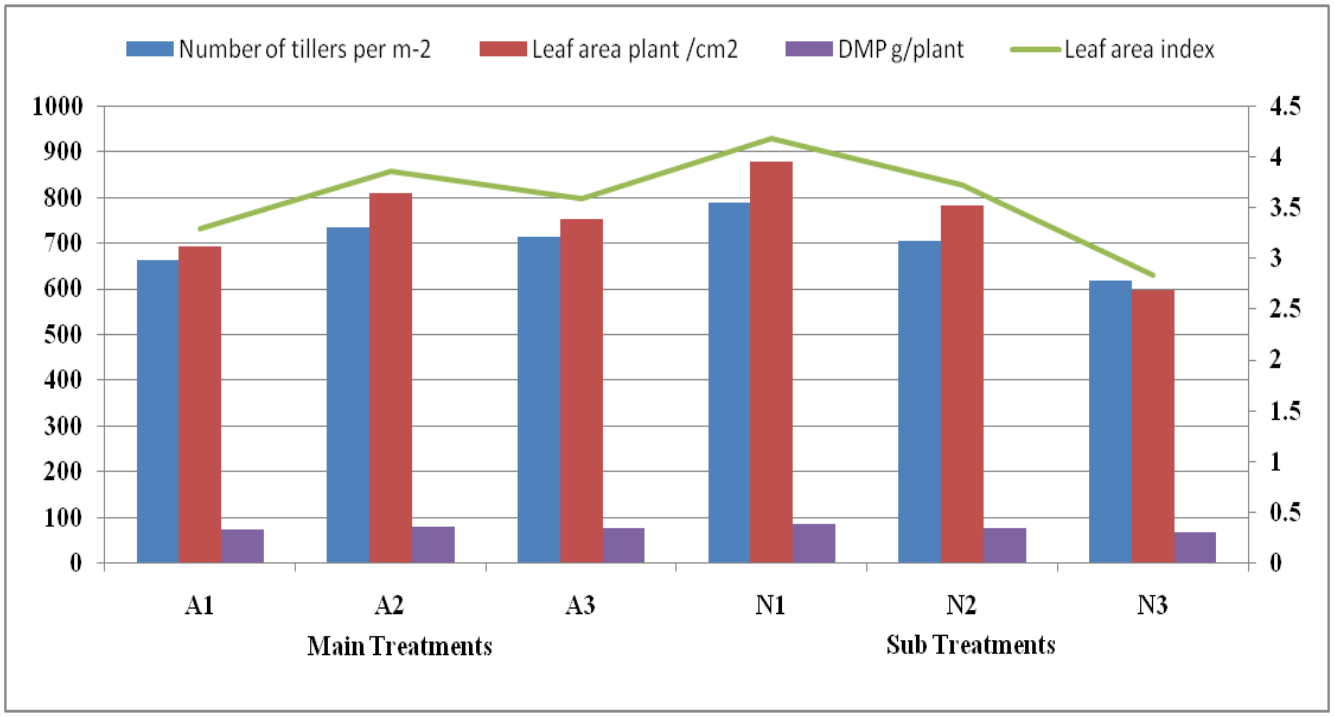
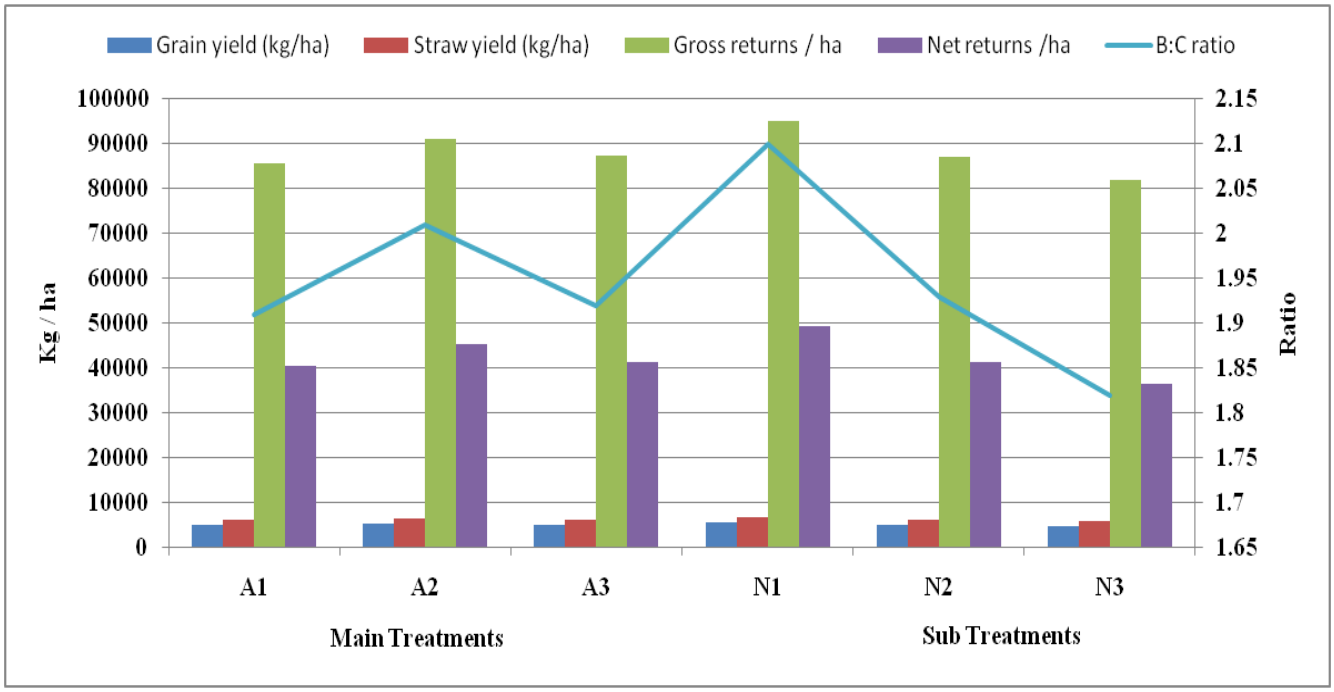


Fig.2 Economics of machine transplanted rice as influenced by age and number of seedlings



Number of seedling per hill

Planting of different number of seedlings per hill noticed significant influence on yield and yield parameters. Planting of 3-4 seedlings per hill produced significantly higher grain yield (16.00 %) and straw (14.72 %) as compared to planting of 7-8 seedlings per hill (4595 kg ha^{-1}) and straw yield (5740 kg ha^{-1}) (Table 3). However, it was followed by planting of 5-6 seedlings per hill (4868 kg ha^{-1}) and straw yield (6128 kg ha^{-1}). This may be due to healthy and efficient individual plant growth at lesser seedling density. The higher yield with low seedling density might be due to higher percentage of productive total tillers and more interception of light. Also, grain filling which is the process of remobilization from stored reserves, particularly from stem, leaves, and from current photosynthesis. So, it may be inferred that the effectiveness of grain filling is decided by the conditions of particular tiller. Hence, planting of fewer seedlings resulted in higher grain yield (Rasool *et al.*, 2013). Such increase in yield contributing parameters with fewer number of seedlings per hill were also reported by Bozorgi *et al.*, (2011) and Maiti and Bhattacharya (2011).

Economics

Age of seedlings

Planting of twenty five days old seedlings recorded significantly higher gross returns (Rs. 91,141), net returns (Rs. 45,178) and B: C (2.01) as compared to planting of twenty days old seedlings which recorded gross returns (Rs. 85,808), net returns (Rs. 40,307) and B: C (1.91) and it was followed by planting of thirty days old seedlings (Table 4). The increased net returns in case of planting of twenty five days old seedlings was obviously due to the higher grain and straw yield.

Number of seedling per hill

Planting of 3-4 seedlings per hill recorded significantly higher gross returns (Rs. 95,190), net returns (Rs. 49,165) and B: C (2.10) as compared planting of 7-8 seedlings per hill gross returns (Rs. 82,085), net returns (Rs. 36,447) and B: C (1.82) (Table 4) and this may be attributed to the higher grain and straw yield obtained in this particular treatment compared to other planting geometry under study.

From the investigation it may be concluded that, planting of twenty five days old seedlings was found to be the best seedling age over 20 and 30 days for transplanting by self-propelled mechanical transplanter. Planting of 3-4 seedlings per hill was optimum for transplanting with self-propelled mechanical transplanter when compared to 5-6 and 7-8 seedlings per hill.

References

Anonymous, 2011, Ministry of Agriculture, Govt. of India. http:// www.indiastat.com.

Aswini GK, Swain S and Debaraj B 2009. Effect of seedling age on performance of rice transplanter. Agricultural Mechanization in Asia, Africa and Latin America, 40(3): 41-46.

Behera BK 2000. Investigation on puddle soil characteristics in relation to performance of self-propelled rice transplanter. Un-published Ph.D. Thesis G. B. Pant University of Agriculture and Technology, Pantnagar, UP.

Bozorgi HR, Amin Faji, Khasravi Danesh, Abdolkarim K, Ebrahim A and Freshieh T 2011. Effect of plant density on yield and yield component of rice. World Applied Sci. J., 12 (11):2053-2057.

Faruk MO, Rahman MA and Hassan MA 2009. Effect of seedling age and

number of seedling per hill on the yield and yield contributing characters of Dhan 33. Int. J. Sustain. Crop Prod., 4(1):58-61.

Hedayetullaha S 1977. A study on the effect of cultural factor in transplanted paddy on the behaviour of some plant characteristics influencing yield. Indian J. Agric. Sci., 17: 39-80.

Jackson M L 1973. Soil Chemical Analysis, (Ed.). Prentice-Hall of India, Pvt. Ltd., New Delhi, pp. 121-125.

Kim SS, Kim BK, Choi MG, Back MH, Choi WY and Lee SY 1999. Effect of seedling age on

Growth and yield of machine transplanted rice in southern plain region. Korean J.

Crop Sci. 44(2): 122-128

Maiti PK and Bhattacharya B 2011. Effect of seedling rate and number of seedlings per hill on the growth and yield of hybrid rice (*Oryza sativa* L.) grown in dry (boro) season. Crop Res., 42 (1, 2 & 3): 18-22.

Naidu GJ, Rao KT, Rao AU and Reddy DS 2013. Age of seedling and planting pattern on grain yield, protein content, NPK uptake and post-harvest nutrient status of rice under SRI. J. Acad. Indust. Res., 2 (6): 334-337.

Olsen SR, Cole CL, Watanabe FS and Deaw DA 1954. Estimation of available phosphorous in soils by extraction with sodium bicarbonate. United States Departments of Agriculture circular, p.939.

Rasool F, Habib R and Bhat MI 2013. Agronomic evaluation of rice (*Oryza sativa* L.) for plant spacing and seedlings per hill under temperate conditions. Pak. J. Agric. Sci. 9(2): 169-172.

Shastry SVS 1977. Research note. AICRP on rice research project. Int. Rice Com. Newslet., 26(2): 11.

Singh G and Husain UK 1983. Modification and testing of a manual rice transplanter. AMA, 14(2): 25-30.

Subbaiah BV and Asija GL 1956. Rapid procedure for determination of available nitrogen in soils. Current. Sci., 31: 196.

Vasudevan SN, Basangouda, Mathad RC, Doddagoudar SR and Shakuntala NM 2014. Standardization of Seedling Characteristics for Paddy Transplanter. Journal of Advanced Agricultural Technologies 1(2), 141-146.

Vijayalaxmi, G., Sreenivas, G., Leela Rani, P. and Ram Prakash, T., 2016. Influence of Plant Densities and Age of Seedlings on Dry Matter Partitioning and Grain Yield Potential of Transplanted Rice (*Oryza sativa* L.). International Journal of Current Research in Biosciences and Plant Biology, 3(4): 51-55.

How to cite this article:

Negalur, R.B. and Halepyati, A.S. 2017. Growth and Yield of Machine Transplanted Rice (*Oryza sativa* L.) as Influenced by Age and Number of Seedlings. *Int.J.Curr.Microbiol.App.Sci.* 6(6): 376-385. doi: https://doi.org/10.20546/ijcmas.2017.606.044