

# EFFECT OF AGE OF SEEDLING AND PLANT SPACING ON YIELD AND ECONOMICS OF TRANSPLANTED RICE (*Oryza sativa* L.)

## ABSTRACT

An experiment was conducted at ShradhayBhagwati Singh Agriculture Research Farm (Hajipur), Chandra Bhanu Gupta krishiSnatakottarMahavidyalaya, 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 age of old seedlings, 28 days of age of old seedlings and 35 days of age of old seedlings in main plots and three plant spacing 20 cm x 10 cm, 25 cm x 10 cm and 15 cm x 15 cm in sub plots. Result revealed that there was significant variation among different time of transplanting in respect of growth. Growth parameters were higher in paddy transplanted in 21 days of age of old seedlings as compared to rest of the age of seedlings. The yield attributes as effective tillers m<sup>-2</sup>, panicle length (cm.), numbers of grains panicle<sup>-1</sup>, grains weight panicle<sup>-1</sup> (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 rest of age of seedling. The maximum N – content (%) were significantly superior in paddy transplanted in 35 days of age of seedling in grain and straw. The N – Uptake (kg/ha.) were significantly superior in paddy transplanted in 21 days of age of seedling in grain and straw. The protein content (%) were significantly superior over in paddy transplanted in 35 days of age of seedling in grain and straw. The Protein – production (kg/ha.) were significantly superior in paddy transplanted in 21 days of age of seedling in grain and straw. Growth parameters as plant height (cm.), dry matter accumulation (gm<sup>-2</sup>) and leaf area index were higher in paddy transplanted with 20 cm x 10 cm but number of tillers (m<sup>-2</sup>) 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.) were significantly superior in paddy transplanted with 25 cm x 10 cm in grain and straw as compared to 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.) were 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.

Comment [DCS1]: Reduce the words

**KEYWORDS:** Nitrogen, Zinc, Growth, Yield, Economics Rice.

## INTRODUCTION

Rice (*Oryza sativa* L.) belongs to Poaceae (Gramineae) family with chromosome number 2n=24. Rice is a C<sub>3</sub> and self-pollinated crop. Rice is a major source of energy. It's main carbohydrate is starch, which is composed of amylose & amylopectin. It constitutes 12% water, 75% - 85% starch & only 7% protein. In World, rice area is grown on 164.19 million hectare with total production 497.7 million tonnes in 2019-20 & productivity has increased to 507.24 million tonnes of milled rice in the last harvesting year of worldwide (Agricultural statistics at a glance, 2021). India ranks first in rice area after China. India occupy the largest rice area of 46.38 million hectares and produced 130.29 million tonnes with productivity of 28.09 q/hac. (Agricultural statistics at a glance,

2021).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 the production of 15.66 million tonnes and productivity of about 2.75 tonnes/ha. West Bengal has the higher productivity of 2.95 tonnes/ha. as compared to Uttar Pradesh (Agricultural statistics at a glance, 2021).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 (Bassi *et al.*, 1994; and Pasuquin *et al.*, 2008).Plant geometry plays an important role in yield maximization of rice (Siddiqui *et al.*, 1999). 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 (Miah *et al.*, 1990).

**Comment [DCS2]:** Please revisit the content by incorporation importance of work, scope, future way forward etc. and objectives

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## METHODS AND MATERIALS

A field experiment was conduct at ShradhayBhagwati Singh Agriculture Research Farm (Hajipur), Chandra Bhanu Gupta Krishi SnatkottarMahavidyalaya, Bakshi-Ka-Talab, Lucknow University, Lucknow (U.P.) during Rabi season 2021-2022. The experimental site is situated at 26.50° North latitude and 80.50° East longitude with an altitude of 123 meters above mean sea level. The soil of experimental field was silty-loam texture, slightly alkaline in reaction (8.00 p<sup>H</sup>), 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 were applied through urea respectively. The half dose of Nitrogen was applied at the time of sowing and rest half does of nitrogen was applied in three splits at the time of first irrigation and second irrigation. A common dose of Phosphorus (60 kg P<sub>2</sub>O<sub>5</sub>/ha) and potash (40 kg K<sub>2</sub>O/ha) was applied at sowing time to all plots through muriate of potash. The rice variety (NDR 2065) was sown 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 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 border row form each side) from each plot.The fresh samples were first sun dried and then kept in electric oven at 70°C till the constant dry weight attained. Yield attributes were recorded from 5panicles 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 hundred. The uptake of nutrients was calculated as nutrient content in grain and straw multiplied by respective yield. Economics of different treatments was worked out on the basis of 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.

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## RESULTS AND DISCUSSION

### 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 (Table1). 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<sup>-2</sup>) and dry matter accumulation (665.33 gm<sup>2</sup>) was 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 facts that the younger seedling having the greater ability of meristematic tissues activity as compared to older seedling resulted more number of meristematic tissues at the base of the seedling resulted more plant height, more number of tillers, more number of 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. (2007), Aggarwal and Singh (2015), Salem et al. (2011) and Patra and Haque (2011).]

**Comment [DCS9]:** Discuss the result thoroughly

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 initial high plant population caused heavy competition among plant resulted in more plant height, dry matter accumulation and leaf area index. However, 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 (2001), Kewat et al. (2002), Verma et al. (2002), Nayak et al. (2003) and Pol (2003).

#### **YIELD ATTRIBUTES**

The data on various yield attributes like effective tillers/m<sup>2</sup>, 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. A perusal of the data presented in table 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<sup>2</sup>) 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 (2013), Chaudhari et al. (2015) and Vishwakarma et al. (2015), Singh and Singh (2009) reported similar results.]

**Comment [DCS10]:** Discuss the result thoroughly

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<sub>2</sub> (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. (2005), Rasool et al. (2013) and Pawar (2017).

**Comment [DCS11]:** Discuss the result thoroughly

**Table 1: Growth attributes of rice as affected by Age of seedling and Plant spacing**

Treatments	Plant height (cm)	Number of tillers/m <sup>2</sup>	Dry matter accumulation (gm <sup>2</sup> )	Leaf area index
Age of seedling (Days)				
A <sub>1</sub> - 21	120.87	550.44	665.33	6.85
A <sub>2</sub> - 28	117.38	514.66	653.11	6.10
A <sub>3</sub> - 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 <sub>1</sub> - 20 x 10	120.78	478.66	660.55	6.90
Sp <sub>2</sub> - 25 x 10	113.37	550.11	609.00	6.55
Sp <sub>3</sub> - 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

**Comment [DCS12]:** Can be transform the value and calculate CV? Pl consult any statistician.

**Table 2: Yield attributing characters of rice as affected by Age of seedling and Plant spacing**

Treatments	Effective tillers m <sup>-2</sup>	Panicle length (cm)	No. of Grains panicle <sup>-1</sup>	Grain weight panicle <sup>-1</sup> (g)	Panicle weight (g)	1000 grain weight (g)
Age of seedling (Days)						
A <sub>1</sub> - 21	549.32	26.88	158.11	2.27	3.26	19.55
A <sub>2</sub> - 28	513.65	26.74	159.33	2.17	3.17	19.22
A <sub>3</sub> - 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 <sub>1</sub> - 20 x 10	529.83	26.94	160.88	2.13	2.97	19.02
Sp <sub>2</sub> - 25 x 10	548.38	27.40	165.22	2.66	3.33	19.55
Sp <sub>3</sub> - 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

**Comment [DCS13]:** Can be transform the value and calculate CV? Pl consult any statistician.

## 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. (2003), Rao et al. (2010), Mostafa (2012), Ali et al. (2013), Pramanik and Bera (2013), Chaudhari et al. (2015), Vishwakarma et al. (2015) and Singh *et al.* (2013) 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 (2001), Gunki and Pal (2004), Mahato et al. (2007), Salahuddin et al. (2009) and Rasool et al. (2013).

#### **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.

#### **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.

### 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<sub>2</sub>) along with plant spacing 25 x 10 cm. (P<sub>2</sub>) 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<sub>3</sub>) along with plant spacing 20 x 10 cm.(P<sub>1</sub>).

The higher gross income, net income and benefit cost ratio with A<sub>2</sub>P<sub>2</sub> was mainly because of higher grain and straw yield and lower cost of cultivation as compared to rest of the combination. However, A<sub>3</sub>P<sub>1</sub> resulted lowest income because of poor yield owing to age of seedling planted.

Treatments	Grain yield (Q./ha.)	Straw yield (Q./ha.)	Total biological yield (Q./ha.)	Harvest index (%)
<b>Age of seedling (Days)</b>				
A <sub>1</sub> - 21	42.42	62.69	104.48	42.85
A <sub>2</sub> - 28	41.78	59.38	101.80	40.66
A <sub>3</sub> - 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
<b>Plant spacing (cm.)</b>				
Sp <sub>1</sub> - 20 x 10	39.06	55.48	94.55	41.34
Sp <sub>2</sub> - 25 x 10	42.90	61.62	104.53	42.63
Sp <sub>3</sub> - 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

**Comment [DCS14]:** Can be transform the value and calculate CV? Pl consult any statistician.

Treatments	N – content (%)		N – uptake (kg/ha)	
	Grain	Straw	Grain	Straw
<b>Age of seedling (Days)</b>				

A <sub>1</sub> - 21	1.49	0.46	63.20	28.83
A <sub>2</sub> - 28	1.50	0.47	62.67	27.90
A <sub>3</sub> - 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 <sub>1</sub> - 20 x 10	1.51	0.46	58.98	25.52
Sp <sub>2</sub> - 25 x 10	1.50	0.46	64.35	28.34
Sp <sub>3</sub> - 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

**Comment [DCS15]:** Can be transform the value and calculate CV? Pl consult any statistician

**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 <sub>1</sub> - 21	8.52	2.87	361.41	179.92
A <sub>2</sub> - 28	8.58	2.93	358.47	173.98
A <sub>3</sub> - 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 <sub>1</sub> - 20 x 10	8.63	2.87	337.08	159.22
Sp <sub>2</sub> - 25 x 10	8.58	2.87	368.08	176.84
Sp <sub>3</sub> - 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

**Comment [DCS16]:** Can be transform the value and calculate CV? Pl consult any statistician

**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 <sub>1</sub> P <sub>1</sub>	43417	111412	67995	1.56
A <sub>1</sub> P <sub>2</sub>	40617	117940	77323	1.90
A <sub>1</sub> P <sub>3</sub>	41667	96384	54717	1.31

A <sub>2</sub> P <sub>1</sub>	43667	105408	61741	1.41
A <sub>2</sub> P <sub>2</sub>	40867	121496	80629	1.97
A <sub>2</sub> P <sub>3</sub>	41917	99024	57107	1.36
A <sub>3</sub> P <sub>1</sub>	43917	84120	40203	0.91
A <sub>3</sub> P <sub>2</sub>	41117	99928	58811	1.43
A <sub>3</sub> P <sub>3</sub>	42167	102680	60513	1.43

## 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.

Comment [DCS17]: Repeated

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**Comment [DCS18]:** Rewrite as per author's guideline

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