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Research Article

EFFECT OF AGE OF SEEDLINGS AND NUMBER OF SEEDLINGS PER HILL ON GROWTH AND YIELD OF MANIPUR BLACK SCENTED RICE (*Oryza sativa* L.) CULTIVAR CHAKHAO POIREITON

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Abstract- Field experiment was conducted during Kharif, 2015 at Agronomy research farm, COA, CAU, Imphal. The soil of experimental field was clay, acidic in reaction (pH 5.6), high in organic carbon (1.19), available potash (313kg/ha) and medium in available nitrogen (440kg/ha), available phosphorous (17kg/ha). The experiment was carried out with 4 levels of age (A) of seedlings (A15, A25, A35 and A45 day's old seedlings) and 4 levels of number of seedlings/hill (S_1, S_2, S_3 and S_4 seedlings/hill). The different levels of age of seedling and number of seedling/hill has influenced significantly on growth parameters, and yield contributing characters as well as grain yield. The maximum number of effective tillers/hill (12.33) was obtained from the treatment A_1S_4. The maximum grain yield (2333kg/ha) was recorded in the treatment transplanted 15 days old seedling and 2 seedlings/hill. The higher grain yield was recorded in young seedling due to early establishment of seedling and efficient in nutrient uptake as well as the availability of suitable growing conditions in the early stage too. From the economic point of view, the highest gross return (Rs 1,08,945/ha), net return (Rs 69,536/ha) and Cost: Benefit ratio (1.76) were recorded from the treatment A1S2 (transplanting of 15 days old and 2 seedlings/hill).

Keywords- Scented rice, Age, Seedling, Effective tillers, Growth, Yield.

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Introduction

Rice is the principal food crop of the North Eastern Region of India occupying an area of about 3.5 million hectare with an average productivity of 1.77 tonnes/ hectare which is much below the national average. The black scented rice of Manipur cultivar 'Chakhao poireiton' is considered to be both food and medicine. The black colour of Manipur rice is due to the presence of anthocyanins, which act as a powerful antioxidant and Vitamin B, niacin, vitamin E, calcium, magnesium, iron and zinc, high in fibre and have got a sweet and slightly nutty taste. Such type of aromatic and medicinal rice is also known as 'Forbidden rice' in some parts of the world. In Manipur, rice is cultivated in an area of 172.83 thousand hectares with a production of 387.17 thousand tonnes and with an average yield of 2415.51 kg /ha in the year 2013-14 [1]. Among the different agro-techniques, transplanting aged seedlings and optimum number of seedling/hill are the two most important agronomic practices for getting the higher grain yield of black scented rice, under both sufficient and limited resource conditions. Number of seedlings per hill plays a most important role in relation to maximise grain yield of scented rice and also for common rice varieties. If less number of seedlings per hill is used, the potential yield cannot be realize, If more seedlings is used it might not be cost effective. It becomes imperative therefore to find out the optimum number of seedlings required per hill for producing more shoots, number of effective tillers per hill, number of filled grains per panicle and ultimately maximum yield of both high quality and quantity. Tillering and growth of rice proceed normally when optimum aged seedlings are transplanted at the right time. The optimum numbers of tillers determines the number of panicles, grains and grain yield per unit land area [2]. Number of seedlings/hill is another important factor that it can play important roles in boosting yield of rice. Because it influences the tiller formation, solar radiation interception, nutrient uptake, rate of photosynthesis and other physiological phenomena and ultimately affect the growth and development of rice plant.

Materials and Method

The experiment was entitled "Effect of age of seedling and number of seedling per hill on growth and yield of Manipur black scented rice (*Oryza sativa* L.) Cultivar *chakhao poireiton*" was carried out at Agronomy Research farm, COA, CAU, Imphal (Manipur) during *Kharif* season 2015. Which is situated 24.51^0 N latitude and 93.56^0 E longitudes at an elevation of 750 m above mean sea level. The experimental field soil was clay and acidic (pH 5.6) in reaction. Manipur comes under the sub-tropical climatic region of the country. The mean monthly meteorological data of weather parameters viz., rainfall, relative humidity, temperature for the experimental period from June to December, 2015 were obtained from Meteorological Observatory ICAR Manipur centre, Imphal -795004. The average annual rainfall of Imphal valley is 1450.9 mm. Mean monthly minimum and maximum relative humidity ranged from 55.4 to 90.8 per cent. The highest temperature (29.7 ºC) was recorded during the month of September, 2015 and minimum temperature (5.8 ºC) in the month of December, 2015. The total rainfall during the experimentation period from June to December 2015 was 1298.90 mm. Experimental design Factorial Randomized Block Design (FRBD), Number of replication 3, Seed treatment with Dhanustin @ 5 g/kg seed, Seed rate at 60 kg/ha, Spacing 10 cm x 10 cm, Plot size was 4 m x 3 m, Cultivar *Chakhao poireiton*, Gross area 791 m^2, Recommended dose of N: P: K was 60: 40: 40 kg/ha. There were 4 levels of age of seedling (15,25,35,45 days) and 4 levels of number of seedling(1,2,3,4) per hill. The selected seed was soaked in water over night. The sprouted seeds were broadcast on raised nursery bed of about 1m x 15

m size on 15 June, 2015. The seedlings were uprooted carefully on the same day of transplanting. Transplanting of seedling was done as per treatment (15, 25, 35 and 45 day's old seedling with 1, 2, 3 and 4 seedlings/hill) in the main plots. Statistical analysis of data obtained from the experiment were statistically analysed, adopting the procedure of analysis of variance wherever variance ratio is significant, critical difference is reported at 5 % level of probability.

Results and Discussion

The result that the age of seedling and number of seedling/hill significantly influenced plant height, number of tillers, effective tillers, panicle length, grains panicle/panicle, unfilled spikelet's/panicle, test weight, harvest index and grain and straw yield. Interaction effect of both the factors on growth and yield parameters was also significant except test wt. and panicle length.

Results: The maximum plant height (199.57 cm) was recorded at 90 day after transplanting from the transplanting of 15 days old seedling with 4 seedling /hill. Higher number of tillers/hill (12.73) was obtained from the transplanting of 25 days old seedling with 4 seedling/hill. The highest number of effective tillers per hill (12.33) was recorded at harvest in A_1S_4 (transplanted with 15 days old seedling and 4 seedlings per hill).The interaction had significant effect on the length of panicle (27.95 cm) was recorded in A_1S_2 (15 days old seedling and 2 seedlings per hill) treatment. The lowest unfilled spikelets was recorded (5.73) in A_1S_1 (15 days old seedling and 1 seedling/hill). The highest interaction on maximum number of filled grains (119.57) was recorded in treatment A_1S_1. The increase in age of seedling and number of seedling per hill also had a negative effect on the number of filled grains per panicle. Age of seedling and number of seedling/hill had no significant effect on the thousand grains weight (g).The maximum grain yield (2333 kg/ha) was recorded in the treatment A_1S_2. The straw yield was found to be maximum (4255kg/ha) in the treatment A_1S_4. The maximum harvest index (44.99) was recorded in the treatment A_3S_2 (transplanting of 35 days old seedling with 2 seedling per hill).The highest gross return (Rs 1,08,945/ha), net return (Rs 69,536/ha) and cost: benefit ratio (1.76) were recorded from the treatment A_1S_2.

Table-1 *Effect of age and number of seedling per hill on growth parameters at 90 DAT and yield parameters of black scented rice at harvest*

Treatments	Plant height(cm)	No. of tillers/hill	No. of effective tillers	Unfilled spikelet	Filled grains/ panicle	Test weight(g)	Panicle length (cm)	Straw yield (kg/ha)	Grain yield (kg/ha)	Harvest Index (%)
A1S1	189.70	10.17	8.80	5.73	103.20	24.49	24.48	3047	1572	34.03
A1S2	194.30	11.20	10.40	8.47	119.57	30.22	27.95	3125	2333	42.74
A1S3	190.20	13.17	11.93	8.27	115.03	31.62	26.47	3464	2000	36.61
A1S4	199.57	12.37	12.33	13.00	90.63	27.72	23.61	4255	1878	30.62
A2S1	188.77	9.77	9.13	8.47	107.7	30.32	26.16	2383	1594	40.08
A2S2	194.57	11.33	10.60	6.27	89.93	28.13	23.69	2692	1839	40.59
A2S3	189.13	12.97	11.73	9.00	96.83	30.04	24.19	3181	2000	38.61
A2S4	198.57	12.73	11.47	12.00	88.83	26.91	25.29	3553	1617	31.28
A3S1	186.90	9.87	8.67	10.07	104.27	31.26	25.82	2394	978	42.78
A3S2	193.07	11.30	10.93	10.13	95.93	29.20	24.26	2214	1322	44.99
A3S3	189.50	12.87	11.87	9.53	84.77	28.26	23.39	2714	1611	39.86
A3S4	195.70	12.60	11.27	14.33	93.13	26.62	25.53	2281	1406	39.14
A4S1	185.37	9.80	9.0	11.00	94.37	25.94	23.10	1308	1239	34.10
A4S2	191.03	11.20	9.80	13.73	97.83	27.38	23.58	1617	1322	37.38
A4S3	187.90	12.70	11.73	14.00	90.67	26.09	22.94	2431	1267	31.83
A4S4	194.93	12.63	10.93	11.07	91.87	25.27	20.49	2186	1078	32.09
SEm±	0.36	0.11	0.05	0.24	0.29	0.21	0.22	42	28.20	1.51
CD(p=0.05)	1.04	0.35	0.14	0.69	0.84	NS	0.64	121.30	81.44	4.36

Discussion:

1. Plant height: The effect of age of seedling on plant height irrespective of the stage of growth revealed significant differences. This is in conformity with the report of El-rewainy *et al.* (2007)[3]. But in contrast the maximum plant height (193.67 cm) was observed from the transplanting of 15 day old seedling at the time of maturity. The taller plant in early planting might be due to availability of more time for growth period with optimum photoperiod and temperature for the growth of the crop plants which may result in more nitrogen absorption for the synthesis of protoplasm responsible for rapid cell division which may increase the plant in shape and size. Similar finding were also reported by Naidu *et al.* (2013) [4] and Nayak *et al.* (2003)[5].The number of seedling per hill increased the plant height but not at an increasing rate. This is in conformity with the findings of Shah *et al.* (1987)[6]. More number of plants and leaf area to sunlight during the growth period resulting in better photosynthesis and consequently resulting in higher plant height. The highest order of interaction was revealed from 35 days old seedling and 4 seedlings/hill giving the highest plant height.

2. Number of tillers per hill: Tiller production was significantly influenced by the difference in age of seedling. The number of tiller production per hill decreased with increase in age of seedling. The effect of seedling age on tillering revealed that the young seedlings will have the higher ability to enhance production. Ali *et al.*(2013)[7] and Ashraf *et al.* (1999)[8].As there was increase in the number of seedling per hill, tiller number also increased. This result is in conformity with the findings of Nayak *et al.* (2003) [5]. Also the number of tiller production increased with increased number of seedlings per hill from one to three, as showed by Cai *et al.* (1991)[9]. The mortality of the tillers was more in 4 seedlings/hill which might be due to more under and above ground competition for space, plant nutrient, air and light for performing normal physiological activities of the plant. The interaction effect of age of seedling and number of seedling per hill influenced the production of tillers per hill.

3. Number of effective tillers per hill at harvest: The number of effective tillers was significantly influenced by age of seedling. The 15 days old seedlings revealed superiority over the other age of seedlings in respect of effective tiller production shown by Ali *et al.* (2013)[7]. The productive tillers might be higher in early planting due to better development of early formed tillers up to reproductive phase of the crop while in case of late planting, less unavailability of sufficient amount of photosynthates as source of energy might result in the mortality of tillers and number of productive tillers could be reduced. Nayak *et al.* (2003)[5] also reported significant reduction in total tillers production with delay in planting.

Transplanting 3 seedlings per hill gave more number of effective tillers per hill. This is in conformity with the findings of Verma *et al.* (2002) [10]). They concluded that the crop transplanted with two seedlings per hill produced significantly higher productive tillers than the crop transplanted with one seedling per hill. Similar results were also reported by Srinivasula (1997)[11].The interaction effect of age of seedling and number of seedling per hill brought significant change in the number of effective tillers per hill. The maximum number of effective tillers per hill were recorded in A_1S_4 (15 days old seedling and 4 seedlings per hill) treatment.

4. Length of panicle (cm):The longest panicle length (25.73 cm) was recorded in 15 days old seedling and the lowest (22.53 cm) was associated with transplanted 45 days old seedling. The longest panicle produced by early planting might be due to availability of more time for better development of plant parts which might result in the better development of yield attributing characters. Similar results have been reported by Singh *et al.* (2004)[12].The different levels of number of seedling per

hill influenced the length of panicle. The lower number of seedling per hill gave the longest (24.99 cm) panicle and the increase in number of seedling per hill decreased the length of panicle. It might be due to competition of soil, nutrient and light which are necessary for growth and development of rice plant. The interaction between age of seedling and number of seedling per hill also had significant effect on the length of panicle. The length of panicle increased with the decrease in the age of seeding and number of seedling per hill.

5. Number of unfilled spikelet/ panicle: The number of unfilled spikelets per panicle was significantly influenced by age of seedling. The increased age of seedling increased in number of unfilled spikelets per panicle. The 15 days old seedlings were gave the lowest number of unfilled spikelets per panicle in comparison to 45 days old seedling. The number of seedling per hill also influenced the number of unfilled spikelets per panicle. More number of seedlings per hill increased the number of unfilled spikelets per panicle. The interaction between age of seedling and number of seedling per hill affected the number of unfilled spikelets per panicle. The highest numbers of unfilled spikelets were recorded due to 45 days old seedling and 4 seedlings per hill.

6. Number of filled grains/panicle: The number of filled grains per panicle was significantly affected by the age of seedling. The aged seedling more than 25 days did not show significant effect on the number of filled grains per panicle. The more number of filled grains were recorded in 25 days old seedling. This was also confirmed by Ali *et al.* (2013)[7] who reported that 30 days old seedling gave the higher number of filled grains per panicle. The higher number of filled grains per panicle could be attributed to better establishment of seedlings, early tillering and synchronised flowering due to suitable age of seedling transplanted. The number of seedling per hill also had significant effect on the number of filled grains per panicle but the transplanting 1 seedling per hill gave the higher (102.33) number of filled grains per panicle. The interaction effect of age of seedling and number of seedling per hill also had significant effect on the number of filled grains per panicle. More number of filled grains were recorded in transplanted 25 days old seedling and 2 seedlings per hill. The number of filled grains was determined by the suitable age of seedling because younger seedlings were established well than the later one. The number of seedling per hill also contributed to number of filled grains because transplanting more number of seedling per hill increased the inter and intra plant competition which resulted in decreased number of filled grains per panicle and increased number of sterile spikelets which reduced the number of filled grains per panicle.

7. Test weight (g): Different age of seedling and number of seedling per hill had no significant effect on the test weight. The maximum (29.89) test weight was recorded in 25 days old seedling. The number of seedling per hill also had no significant effect on the test weight (1000 gains weight) but higher test weight was recorded in 1 seedling per hill. The interaction effect of age of seedling and number of seedling per hill also had no significant effect on test weight. The test weight recorded in different treatments was not significantly different from each other. Under most conditions the 1000 grains weight of field crops is very stable varietal character. (Soga and Nozaki, 1975)[13], thus showing little response to different treatments.

8. Grain yield (kg/ha): Age of seedling is one of the most important factors for obtaining higher grain yield. The result of the study revealed significant differences among the age of seedling. The young seedling A_1 (15 days old seedling) showed significant superiority to other treatments in grain yield (1946 kg/ha). There was linear decrease in grain yield with increase in age of seedling. This is also confirmed by Ali *et al.* (2013)[7]. The younger seedlings establishes quickly in the main field and start growing at a faster rate compared to conventional seedlings, which remain in nursery bed resulting mutual competition with one another for 4-5 weeks before transplanting. Transplanting more aged seedling results in lower rice yield because older seedlings suffer from stem and root injury during pulling. This is in confirmed by Ashraf *et al.* (1999)[8]. The higher grain yield with early planting might be due to significant increase in effective tillers per hill as well as number of grains per panicle and 1000-grain weight. Transplanting with old seedling might have exposed the crop to relatively more adverse environmental condition in terms of water stagnation at the tillering phase, low temperature at the reproductive phase which might have pulled down the yield as compared to transplanting with young age seedling. The grain yield was significantly affected by number of seedling per hill. Transplanting 2 seedlings per hill showed significant superiority over the other treatments. Increase in grain yield might be due to production of more number of tillers per hill and more number of filled grains/panicle and finally increased in the grain yield. Similar observation was also reported by Gupta (1996)[14]. The interaction effect between age of seedling and number of seedling per hill brought about significant effect on higher grain yield. Transplanting 15 days old seedling with 2 seedlings per hill given the higher (2333 kg/ha) grain yield. Sawa *et al.* (1988)[15] noticed that rice transplanted with 2 seedlings per hill produced maximum grain yield. The similar results were also reported by Srivastav and Tripathi (1998)[16].

9. Straw yield (kg/ha): The straw yield per hectare was highest in 15 days old seedling and gradually decreased with the more aged seedling. The higher straw yield due to young seedling was due to less stem and root injury and easily establishment of seedlings. Also the young seedlings grow luxuriantly with better vegetative growth because higher rate of photosynthesis. Seedling age at transplanting is an important factor for uniform stand of rice and its growth and yield. The straw yield decreased due to less vegetative growth in older seedlings. Significantly different yield of straw was produced by the different number of seedling per hill. The highest (3238 kg/ha) straw yield was produced with the transplanting 4 seedlings per hill and the lowest by transplanted 1 seedling per hill. The increase in number of seedling per hill increased the straw yield because production of more number of tillers per hill and higher vegetative growth and development. All the yield contributing characters were significantly influenced by number of seedlings. It is a general concept that the more number of plants per hectare produced more straw yield and it is also dependent upon the climatic and soil factors as well as agronomic practices. But under a good management system with increased plant population, the biomass yield increased. The interaction between ages of seedling and number of seedling per hill significantly influenced the production of straw yield. The highest (4255 kg/ha) straw yield was produced by transplanting 15 days old seedling and 4 seedlings per hill.

10. Harvest index (%): Harvest index was influenced significantly by the different age of seedling. The age of seedling from 15-35 days old had significant effect on harvest index. The highest harvest index (41.69) was recorded in transplanting 35 days old seedling and the lowest (33.85) was recorded in transplanting 45 days old seedling. The results revealed that seedling age of 15 to 25 days produced significantly higher grain and straw yield, similar result was also reported by Ashraf *et al.* (1999)[8]. The number of seedlings per hill influenced the harvest index. The higher harvest index was recorded in transplanting 2 seedlings per hill and the lowest (33.40) was recorded in transplanted 4 seedlings per hill. It indicated that using optimum seedling per hill reduced competition among plants as compared to 3 or 4 seedlings per hill. The use of excess seedling per hill resulted in intra plant competition which decreased the dry matter production. The optimum seedling per hill ensures the plant to grow their aerial and underground parts through efficient utilisation of solar radiation, water and nutrients. The interactions between age of seedling and number of seedling per hill on harvest index had significant effect. The higher harvest index was recorded due to a combination of 35 days old seedling and 2 seedlings per hill.

Conclusion

The transplanting 15 days old seedling and 2 seedlings per hill given the highest economic return, gross return as well as higher B:C ratio. The reason of higher economic return is to production of higher grain yield and straw yield both. The transplanting young seedling will established early and utilize all the resources efficiently and given the higher dry matter per unit area.

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Abbreviations:

A = Age of seedling
% = Percent
/ = Per
DAT = day after transplanting
FRBD = factorial randomized block design
ha = hectare
kg/ha = kilogram per hectare
S = number of seedling/hill

Ethical approval:

This article does not contain any studies with human participants or animals performed by any of the authors. This is my original research work of post-graduation.

Conflict of Interest: None declared

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