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Effect of Age and Number of Seedling Per Hill on Production of Rice in Sub-Tropical Region of Nepal

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Abstract: The growth, yield and yield attributing characters of Sabitri rice variety was evaluated under different age and number of seedlings hill^{-1} at Dang, Nepal during rainy season from June to September, 2018. The experiment was laid out in to split plot design of three different age of seedlings as viz. 22 days, 29 days and 36 days as main plot factor and four number of seedling hill^{-1} viz. 2, 3, 4 and 5 as sub-plot factor and replicate thrice. The results revealed that the highest plant height (122.8 cm) at the time of harvesting, longest panicle length (25.3 cm) and number of sterile grain panicle $^{-1}$ (26.0) was recorded by 22 days old seedlings. The highest number of effective tiller m^{-2} (285) and highest grain yield (4.0 t ha^{-1}) was recorded by 29 days old seedlings. Whereas thousand grain weight and harvest index were non-significant with different age of seedlings. Regarding the number of seedlings hill^{-1} highest number of effective tiller m^{-2} (296), longest panicle (24.9 cm), grain yield (4.2 t ha^{-1}) and straw yield (6.1 t ha^{-1}) was recorded from the 4 number of seedlings hill^{-1}. Highest sterile grain panicle^{-1} was recorded in 5 number of seedlings hill^{-1} and highest harvest index (41.0%) was obtained from 3 seedlings hill^{-1}. The plant height at the time of harvesting, filled grain panicle^{-1} and thousand grain weight were non-significant with number of seedlings hill^{-1}. The interaction effect of age and number of seedlings hill^{-1} showed non-significant relation with all the growth, yield and yield attributing parameters.

Keywords: Rice Variety, Age of Seedlings, Number of Seedlings Hill^{-1}

1. Introduction

Rice is the most important staple food crop of Nepal which fulfils more than 30% of the total kcal requirement of the Nepalese people [4]. It is one of the most important cereal crops of Nepalese agriculture and economy. It is grown in all agro-ecological zones from Terai plains (59 masl at Musaharnia of Dhanusa district) to high hills up to 3050 masl (Chhumchure in Jumla district) including valleys and foot hills of Nepal [11, 13]. It is grown in about 1.5 million ha of land with the production of 5.2 million tons with 3.36 t ha^{-1} productivity [9], which is much more less than other countries. Lowland rice contributes 91% where as 9% of the rice is grown upland condition (aerobic rice or upland rice or Ghaiya).

Seedling age and number of seedling per hill are one of major factor that influences the tillering capacity, growth and development, which ultimately influences the yield and yield contributing characters [12]. Number of seedling per hill is an important factor for successful of rice production as it influenced on tiller formation, solar radiation interception, total sunshine reception, nutrient uptake, photosynthesis rate and several physiological phenomena and ultimately affects the growth and development of rice plant [5]. Higher number of seedling per hill causes intra competition between the plants and sometimes causes gradual shading and lodging leads higher straw yield instead of grain yield and lower number of seedling may leads lower number of tiller and finally lower yield. Thus, it is necessary to determine the optimum number of seedling per hill to get optimum grain yield per unit area.

Similarly, age of seedling for transplanting is another important factor, affects the yield of rice because it, directly influence the tillering capacity, yield attributing characters and ultimately yield. Overaged of seedling tends the

degeneration of primary tiller buds which ultimately reduce the number of tiller production. Bozorgi et al (2011) [2] also state that older seedling reduce the general performance of crop and finally reduce the yield of crop. Hence, this experiment was under taken to identify the optimum age and number of seedling per hill.

2. Materials and Methods

Field experiment was conducted at Lamahi municipality of Dang district during June to November 2017 to study the effect of age and number of seedlings per hill in rice production. Geographically, it is located at 27°99' N latitude and 82°30' E longitude. The average maximum and minimum temperature during cropping season were 31.32°C and 23.32°C respectively and the total rainfall was 134.38 mm during rice growing period (June to September 2017). The experimental site was silty loam with pH 6.6, soil organic matter 1.46%, available N, P, K were 0.1%, 45 kg ha^{-1}, and 190.8 kg ha^{-1} respectively.

The experiment was laid out in to split plot design keeping combination of three different age of seedlings viz. 22 days, 29 days and 36 days old seedling as main plot factor and four number of seedlings per hill i.e. 2, 3, 4 and 5 seedlings per hill as sub plot factor and each replicated thrice. The individual plots and replication were separated by 0.5 m. The area of each individual plot was 9 m^2. Dry nursery bed was prepared for raising the seedlings and 22, 29 and 36 days old seedlings were transplanted with various number of seedlings in puddled field in 20 cm x 15 cm planting geometry. The fertilizer dose of 100:60:40 kg NPK ha^{-1} was applied from urea (46%N), DAP (18% N and 46% P_2O_5) and MOP (60% K_2O). Half dose of Nitrogen and full dose of P and K were applied at the time of transplanting as basal dose and remaining N was applied in two split dose at vegetative stage (40 DAT) and panicle initiation stage (60 DAT). Manual weed management was done after 25 DAT and frequent irrigation was done depending upon necessity.

After 30 DAT different biometrical observation like plant height, number of tiller per hill was recorded. For plant height, ten hills were selected from the 5th and 10th row of each plot and tagged it for taking plant height and number of tiller per hill in different phase of the crop. The height of each tagged plants was measured at 15 days interval till full maturity stage. Plant height was determined by measuring the distance from the soil surface to the tip of the leaf before heading and to the tip of the panicle after heading. The mean height of ten plants is expressed as plant height of each plot. Similarly, after physiological maturity different yield and yield attributing characters like effective tilers m^{-2}, panicle length, number of grains per panicle, thousand grain weight (g), grain yield and straw yield were recorded from unit plot. The grains and straws are sun dried and converted to t ha^{-1} with 14% moisture content of grains. The biological yield and harvest index were calculated by using the following formula.

Biological yield = Grain yield + straw yield

Harvest index = (grain yield / biological yield) x 100

Collected data were analysed statistically using R-program with Agricola. Least significant difference (LSD) and Duncan multiple Range Test (DMRT), as mean separation technique was applied to identify the most efficient treatment [6].

3. Result and Discussion

3.1. Effect of Age of Seedlings on Growth, Yield and Yield Attributes of Sabitri Rice Variety

There was significant difference in plant height at the time of harvesting due to the age of seedlings (Table 1). Tallest plant height (122.8 cm) was observed in 22 day old seedling whereas shortest plant height (112.6 cm) was observed in 36 day old seedling. Seedling age had significant effect on number of effective tiller m^{-2}. The highest number of effective tiller m^{-2} (285) was observed in 29 days old seedlings whereas 36 days old seedlings produced lowest number of effective tiller m^{-2} (273) which was statistically similar to 22 day old seedling. The longest panicle (25.3 cm) was observed in 22 days old seedling whereas 29 and 36 days old seedling produced statistically similar length of panicle. These findings are conformity with the findings of Kim et al (1999) [8], Sarker et al (2012) [14]. They also found the longest panicle length and highest number of effective tiller m^{-2} in 3 week and 4 week old seedlings respectively. The result showed that maximum number of sterile grain was found in 22 days old seedling which is statistically indifferent with the 29 days old seedlings and lowest number of sterile grain per panicle was found in 36 days old seedlings. The filled grain per panicle was statistically non-significant. Shah and Yadav (2001) [15] also found the non-significant result in number of filled grain per panicle with the different age of seedlings. The highest grain yield (4.0 t ha^{-1}) and biomass yield (10.0 t ha^{-1}) was obtained from 29 days old seedling whereas 22 days old seedling produced lowest grain yield which is statistically indifference with the 36 day old seedling, The highest grain yield is due to highest number of effective tiller m^{-2}. Faruk et al (2009) [5] also reported the highest grain yield from 4 weeks of old seedlings. It is observed that 22 day old seedling recorded the highest straw yield (6.0 t ha^{-1}) and the lowest straw yield was recorded in 36 day old seedling which is statistically similar to 29 day old seedling. The result also showed that there were no any significant effect on harvest index and thousand grain due to the age of seedlings.

3.2. Effect of Number of Seedlings Per Hill on Growth, Yield and Yield Attributes of Sabitri Rice Variety

The plant height at the time of harvesting was not influenced by the number of seedlings per hill (Table 1). The

number of seedling per hill had statistically significant influence on number of effective tiller m^{-2}. The highest number of effective tiller m^{-2} (296) was observed in 4 number of seedlings per hill and lowest number of effective tillers m^{-1} were recorded in 2 seedlings per hill. Similarly, the panicle length was also statistically different with the number of seedlings per hill. Longest panicle (24.9 cm) was recorded in 4 seedlings per hill whereas 5 seedlings per hill recorded the shortest panicle length (23.5 cm). The result showed the statistically different in number of sterile grain per panicle. The lowest number of sterile grain per panicle was recorded in 2 number of seedlings per hill which was statistically par with 3 and 4 number of seedlings per hill whereas 5 number of seedlings per hill recorded the highest number of sterile grain per panicle. Similar, result was also recorded by the Frauk et al (2009) [5] who also recorded highest number of sterile grain per panicle in 5 number of seedlings per hill. The filled grain per panicle was statistically non-significant. The highest grain yield (4.2 t ha^{-1}) and biomass yield (10.3 t ha^{-1}) was observed in 4 number of seedlings per hill. The 3 number of seedlings per hill recorded the statistically indifferent yield whereas 2 number of seedlings recorded the lowest grain yield (3.2 t ha^{-1}). The result was conformity with Islam et al (2008) [7] who also found non-significant relations in filled grain per panicle with number of seedlings per hill and highest grain yield with 4 number of seedlings per hill. The result also showed that there were no any significant effect on thousand grain due to the number of seedlings per hill. The result was conformity with Bhowmik et al. (2012) [1] who also found non-significant relation in thousand grain weight with number of seedlings per hill. The harvest index was statistically influenced with the number of seedlings per hill. The highest harvest index (41.0%) was recorded in 3 number of seedlings per hill whereas lowest harvest index (37.8%) recorded in 5 number of seedlings per hill.

Table 1. *Effect of age and number of seedlings $hill^{-1}$ on growth, yield and yield attributing characters of Sabitri rice.*

Treatment	Plant height at harvest (cm	Effective Tiller m^{-2}	Panicle Length (cm)	Filled Grain Panicle-1	Sterile grain panicle -1	Test Weight (g)	Grain yield (t ha-1)	Straw yield (t ha-1)	Harvest Index (%)
Age of seedling									
22	122.8^{a}	278.0^{b}	25.3^{a}	114.0	26.0^{a}	23.8	3.6^{b}	6.0^{a}	39.5
29	117.1^{b}	285.0^{a}	23.7^{b}	111.0	24.0^{a}	23.7	4.0^{a}	5.7^{b}	39.8
36	112.6^{c}	273.0^{b}	23.8^{b}	112.0	20.0^{b}	23.7	3.7^{b}	5.6^{b}	39.5
CV (%)	5.1	2.2	7.4	4.1	17.7	3.2	4.1	6.2	2.9
LSD (0.05)	3.1	8.3	1.1	NS	3.7	NS	0.2	0.3	NS
No. of seedling per hill									
2	117.4	260.0^{d}	24.4^{ab}	110.0	20.0^{b}	23.8	3.2^{c}	5.1^{b}	39.0^{bc}
3	118.3	284.0^{b}	24.2^{ab}	113.0	22.0^{b}	23.4	4.0^{a}	5.8^{a}	41.0^{a}
4	118.6	296.0^{a}	24.9^{a}	113.0	23.0^{b}	23.7	4.2^{a}	6.1^{a}	40.6^{ab}
5	115.7	275.0^{c}	23.5^{b}	110.0	28.0^{a}	24.0	3.6^{b}	5.9^{a}	37.8^{c}
CV (%)	3.1	3	5.3	5.5	18.5	3.5	5.8	5.5	4.3
LSD (0.05)	NS	8.3	1.3	NS	4.3	NS	0.2	0.3	1.7
Grand Mean	117.5	279.0	24.3	112.0	23.0	23.7	3.8	5.7	39.6

3.3. Interaction Effect of Age and Number of Seedlings $Hill^{-1}$ of Growth, Yield and Yield Attribution Characters of Sabitri Rice

The interaction effect of age and number of seedlings $hill^{-1}$ was statistically non-significant in all the growth, yield and yield attributing parameters (Table 2).

Table 2. *Interaction effect of age and number of seedlings $hill^{-1}$ on growth, yield and yield attributing characters of Sabitri rice.*

Age of seedlings (Days)	Number of seedlings $hill^{-1}$	Plant height at harvest (cm)	Effective tillers $hill^{-1}$	Panicle length (cm)	Filled grain $panicle^{-1}$
22	2	120.9	258	25.5	110
22	3	125.8	283	25.4	115
22	4	123.6	297	25.5	117
22	5	121.1	274	24.8	113
29	2	116.1	270	23.9	113
29	3	119.4	292	23.6	112
29	4	118.2	300	24.1	110
29	5	115.1	279	23	108
36	2	115.4	252	23.8	108
36	3	109.9	276	23.6	112
36	4	114.1	291	25.2	112
36	5	110.9	271	22.8	117
CV%		3.1	3	5.4	5.5
Mean		117.5	279	24.3	112
LSD (0.05)		NS	NS	NS	NS

Table 2. *Continued.*

Age of seedlings (Days)	Number of seedlings hill^{-1}	sterile grain panicle^{-1}	1000 grain weight (gm)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index
22	2	20	24	3.1	5	38.3
22	3	25	23	3.8	5.5	41.1
22	4	28	24.7	4.1	6.2	40
22	5	30	23.7	3.5	5.6	38.5
29	2	21	23.7	3.4	5.2	39.5
29	3	23	24.3	4.2	6.3	40
29	4	26	22.7	4.4	6.4	40.9
29	5	27	24	3.8	6.1	38.7
36	2	20	23.7	3.2	5	39.1
36	3	18	23	4.1	5.7	41.9
36	4	14	23.7	4	5.8	40.9
36	5	28	24.3	3.5	6.2	36.2
CV%		18.5	1.3	5.8	5.5	0.8
Mean		23	23.7	3.8	5.7	39.6
LSD (0.05)		NS	NS	NS	NS	NS

4. Conclusion

The result of the experiment showed that, although 22 days old seedling recorded the highest plant height, panicle length and straw yield, the 29 days old seedling recorded the highest grain yield which have economic value and effective tiller m^{-2} over other age of seedlings. Regarding the number of seedling hill^{-1}, 4 number of seedlings hill^{-1} showed the superior in plant height, yield and yield attributing characteristics than other age of seedlings. The interaction between the age and number of seedlings hill^{-1} showed the non-significant result in all the yield and yield attributing characteristics and plant height.

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