Agronomy Journal of Nepal. 7(1):88-93
ISSN: 2091-0649 (Print)
DOI: https://doi.org/10.3126/ajn.v7i1.62154

Impact of Age of Seeding and Varieties on Yield and Yield Attributing Characters of Rice in Central Terai Region of Nepal

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Received: May 30, 2023
Revised: June 11, 2023
Published: July 10, 2023

The authors declare that there is no conflict of interest.

ABSTRACT

The objective of this study was to evaluate the response of age of seedling and varieties on yield and yield attributing characters of rice. A field experiment was conducted at Directorate of Agriculture research, Parwanipur in two main season from 2018-2019. The experiment was designed in split plot with two factors; seedling age 20, 30, 40, 50 days and varieties Chaite-5, Radha-14 and Bahuguni-1 as main and sub-factors, respectively. The result was analyzed using Zen-stat ver.15. The results revealed there were no significant impact of all varieties in term of yield in pooled condition (Chaite-5, Bahuguni-1 and Radha-14 yielded 5376 kg ha^{-1}, 4943 kg ha^{-1}, 4357 kg ha^{-1}, respectively), whereas age of seedling significantly influenced the yield and yield attributing characters in both years and in pooled condition. The yield of rice was significantly higher for twenty days aged seedling (6080 kg ha^{-1}) in 2018 and 4628 kg ha^{-1} in 2019 and 5354 kg ha^{-1} in pooled and followed by consecutive old aged seedling. In conclusion, twenty days aged seedling would be the best option for the optimum production in Central Terai Region of Nepal.

Keywords: seedlings, varieties, yield, rice, age

How to cite this article:

Sah MK, A Shrestha, P Shah and A Mishra. 2023. Impact of Age of Seeding and Varieties on Yield and Yield Attributing Characters of Rice in Central Terai Region of Nepal. Agronomy Journal of Nepal. 7(1):88-93. DOI: https://doi.org/10.3126/ajn.v7i1.62154

INTRODUCTION

Rice is most adoptable and stable food crops of Nepal (MoALD 2021), play vital role in contribution to food security(Mohidem et al 2022). The demand of food is increasing day by day and possesses equally challenges to increase the production of rice crop due to climate change(Lampayan et al 2015) and other infrastructure constraint (Kushwaha et al 2016). To enhance the yield, there is option of using fertilizer and herbicides that determines the monetary input but, non-monetary input can be use of appropriate age of seedling considering the climatic condition during the time of transplanting (Shah andYadav 1970).

The important factor that to be consider for attaining the uniform population and regulating growth and yield of rice crop is age of seedling at the time of transplanting (Tzudir and Kumari 2021). The transplanted in right age

enhances effective tiller and crop growth with significant differentiation (Reuben et al 2016). However, if transplanting is delayed or more aged seedling (i.e. more than 25 days old seedling) results the poor seedling establishment and production of fewer tillers cause low (Li et al 2020). The delay in transplanting the rice is common due to rain-fed lowland field of central Terai region of Nepal (VLW Bara report 2022) and not aware as well as no facilities of forecasting weather condition. The farmers prepare the rice seedling nursery depend on the onset of rains, unknown pattern of rainfall, they are compel to plant either early seedling or old aged seedling (Shah and Yadav 1970, VLW Bara report 2022). Early plantation of seedling during heavy rainfall and flooding condition, there is less possibilities of survive of seedling due to anerobic condition and cause of root rot due to fungal development and also combination and hot weather with water stagnant for more than a week (Dhungana et al 2020). So, appropriate age of seedling should be known for sustainable development of rice yield in Terai Region.

Although there is dissimilar effect of age of seedling of rice in different season. In Terai of Nepal, rice is grown in three seasons viz: rainy, spring and winter. The seedling age has no effect in winter season due to slow and long growth but there is significant role of age of seedling of both season (Kushwaha et al 2016). The delay transplantation have detrimental impact in rice yield formation due to short vegetative growth stage and poor tiller occurrence and decreased dry matter accumulation (Li et al 2020a, Liu et al 2017). (Lampayan et al 2015) illustrated that the younger the seedling age could improve the grain yield that also attributes the higher 1000-grain weight due to longer flowering and grain filling time and have longer vegetative growth period. However, instance still younger seedling has high chance of mortality and requires intensive agronomic management to avoid yield loss (Pasuquin et al 2008). These report fully support about the impact of seedling age of rice during the transplantation. But clear evidence and actual data has been provided on case of central Terai region of Nepal, so this experiment was required to conduct in the experiment plot of Directorate of Agriculture Research, Madhesh Province with objective to determine the appropriate age of seedling of rice in two year 2018 and 2019 during rainy season.

MATERIALS AND METHOD

The experiments were conducted during the rainy season of 2018 at RARS Parwanipur , Bara in split plot design having four age of seedling as main plot (20 days, 30 days, 40 days and 50 days old seedling) and three rice varieties (Chaite-5, Radha-14 and Bahugunidhan-1) as sub plot with three replications. Individual plot size was 15 m^2 , spacing were 20 cm row to row and plant to plant 20cm and fertilizer dose was100:30:30 $NP_2O_5K_2O$ kg ha^{-1} . Days of 50% flowering and 80% maturity were evaluated with following (Zadoks et al 1974). Yields and yield components: rice plants from the replications were harvested during physiological maturity to determine their grain yield parameters (Bahuguna et al 2017). For five hills, plants that had average panicles were sampled. The number of spikelet's per panicle and the seed setting rate were individually calculated. The grains were dried at 70°C to a constant weight, and the dry grain weight was subsequently measured. The theoretical grain yield was then adjusted to a moisture content of 13.5%. Data processing and analyses were conducted using Microsoft Excel 2007 Software for Windows. An analysis of variance was performed using Genstat Ver 2015 statistical software for Windows to test the differences among the treatments. The means of the treatments were compared according to a least significant difference (LSD) test at the 0.05 probability level ($P<0.05$).

RESULT AND DISCUSSION

Table 1: Impact of seedling age in Biometric character of Rice during 2018 and 2019 in Rainy Season

Treatment	Plant Height (cm)			Panicle Length (cm)		
Age of seedling during Transplanting (A)						
	2018	**2019**	**Pooled**	**2018**	**2019**	**Pooled**
20	115.91	111.6	113.8	26.15	26.3	26.225
30	112.13	99.9	106.0	25.33	23.62	24.475
40	103.28	96.5	99.9	24.5	23.72	24.11
50	101.51	85.4	93.5	25.66	22.81	24.235
P-value	<.001	<.001	<.001	0.115	<.001	<.001
LSD (0.5)	2.066	2.08	2.1	1.375	0.68	1.0275
Varieties (B)						
Chaite-5	111.66	101.5	106.6	24.42	23.53	23.975
Radha-14	107.86	94.01	100.9	26.21	24.53	25.37
Bahuguni-1	105.11	99.58	102.3	25.59	24.28	24.935
P-value	0.002	<.001	<.001	0.003	0.004	0.0035
LSD (0.5)	3.244	2.69	3.0	0.912	0.55	0.731
A×B	Ns	Ns	Ns	Ns	Ns	Ns
CV %	3.5	3	3.3	4.1	2.7	3.4
Grand mean	108.21	98.6	103.4	25.41	24.11	24.76

Plant Height

At 1% level of significance, the age of seedling influenced the rice plant height in both two year and in pooled as listed in Table 1. The plant height was higher in young seedling i.e 20 days old and subsequently decreased with increased in old aged. The plant height ranged from 85 cm to 115 cm. The tested varieties showed significant difference in their height that range from 99 cm to 111 cm. Variety Chaite-5 was comparatively taller than Radha-14 and Bahuguni-1.

Panicle length

The arrangement and allocation of grains depend upon the panicle architecture and panicle length. There was significant influence of panicle length due to age of seedling of rice. Table 1 showed that the young aged seedling constituted prominently higher length of panicle in all both year and pooled as compared to other aged, and decreased trend of panicle length with increase aged. The smallest panicle length was observed in 50 days old seedling. The variation of length occurred up to 14 % in young to old seedling. But varieties did not significant impact in terms of panicle length.

Table 2: Impact of age of seedling and varieties in Phenological character of rice during 2018 and 2019 under rainy reason.

Treatments	Days of Heading			Days of maturity			Vegetative period (Days)	Reproductive period (Days)
	2018	2019	Pooled	2018	2019	Pooled		
Age of seedling (A)								
20	89	94	91.5	123	123	123	91.5	31.5
30	103	103	103	125	130	127.5	103	24.5
40	106	109	107.5	125	136	130.5	107.5	23
50	116.3	116	116.15	139	143	141	116.15	24.85
P-value	0.002	<.001	<.001	0.02	<.001	0.02	<.001	<.001
LSD (0.5)	1.36	1.27	1.315	9.8	2	5.9	1.315	4.585
Varieties (B)								
Chaite-5	93	94	93.5	121	121	121	93.5	27.5
Radha-14	99	112	105.5	131	138	134.5	105.5	29
Bahuguni-1	102	111	106.5	131	139	135	106.5	28.5
P-value	0.032	<.001	<.001	<.001	<.001	<.001	<.001	0.055
LSD (0.5)	6.56	0.93	0.81	4.18	1.54	2.86	0.81	2.05
A×B	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
CV %	7.7	1.8	4.2	3.8	1.3	2.55	1.17	1.38
Grand mean	98.2	106	102.1	127.8	132.5	130.15	102.1	28.05

Total Pooled Reproductive Period

The appropriate portioning of the vegetative and growth period results to higher grain production of rice (Cho et al 2017). The flowering time and extend of its period is influenced by nutrients, ambient temperature, drought, salinity, exogenously applied hormones and chemicals, and pathogenic microbes. Plants either begin flowering to produce seeds for the next generation or else delay flowering by slowing their metabolism in the response of these stress. These responses vary depending upon the dose of the stimulus, the plant developmental stage, or even the cultivar that is used. Table 3 depict that due to the seedling age variation, there was vast difference in their period of reproductive phase. Young seedling extended the reproductive phase for more number days up to 31 days while other showed shorten reproductive period ranges from 23-24 days. It means, old stage seedling may gone through stress of ambient temperature and matured in less time (Cho et al 2017). The transition to flowering is an important event in the plant life cycle and is modulated by several environmental factors including photoperiod, light quality, vernalization, and growth temperature, as well as biotic and abiotic stresses (Amasino 2010, Balasubramanian et al 2006). So, old aged seedling has suffer above stress due to long vegetative growth and reduce the reproductive cycle. Similarly, the young age seedling fulfill the required light and temperature and have early flowering while delayed seedling takes more time in recovering from transplanting sucks and requires more days to flower, meantime, other factor causes to ripe early(Dhungana et al 2020, Kushwaha et al 2016, Tzudir and Kumari 2021)

Total Vegetative period

Crop spent most of the time in vegetative stage and then pronounced reproductive phase that turns to yield formation. If plant spent more time in vegetative, it certainly had less time for reproductive stage that concern to low grain per panicle and panicle length and result to low grain yield (Liu et al., 2017). Table 3 result revealed that transplanting different aged seedling had variation in vegetative period. 20 days old seedling transplanted

spent approximately 91 days in vegetative period and then transfer to reproductive while, old aged seeding had spent longer period of time above 100 day to 116 days. The vegetative period of rice may be varied with varieties as they have their own criteria for growth phase. In terms of the whole growth period, the old seedlings grew for a longer period than did the young seedlings. The whole growth period of the 27-day-old transplanted seedlings was 13 days longer than that of the 13-day-old seedlings (Li et al 2020)

Days of 50% flowering/Heading

There was significant variation in flowering time of rice due to influence of age of seedling and varieties. The flowering time may vary along with the varieties due to their varietal character to be distinguished, so similar result of flowering time was noticed as per varieties. Early flowering was seen in Chaite-5 rice (93 days) as compared to other who extent their flowering period up to 112 days. Young seedling promoted earlier flowering of rice as followed by subsequent age of seedling. 20 days age seedling have flowering in overall 91 days after transplanting while other aged extended their flowering time from 103 days to 116 days that enforce them to late flowering.

Days of maturity

Young seedling plantation of rice matured earlier i.e. 3- 20 days than consequent age of seedling. At 1% and 2% level of significance, the impact of seedling age influenced the mature time. Early and delay transplanting of seedling had prominent impact in their maturing time, while there was also vast different in days of maturity due to varietal difference.

Table 3: Impact of Age of seedling and varieties in Yield and yield attributes of rice during 2018 and 2019 under rainy season.

Treatments	Effective tillers per m^2			Grains/ panicle			Grain yield (kg/ha)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
Age of seedling (A)									
20	294	301	297.5	157.4	184.5	170.95	6080	4628	5354
30	281.3	290	285.65	123.8	108.9	116.35	5165	4407	4786
40	274.3	294	284.15	118.4	95	106.7	4280	4036	4158
50	273	239	256	108.4	87.2	97.8	2061	2973	2517
P-value	0.045	0.03	0.04	0.021	0.02	0.02	0.031	<.001	0.03
LSD (0.05)	18.3	18	9.154	23.3	24.3	28.8	697.4	404.3	550.85
Varieties (B)									
Chaite-5	250.3	257	253.65	180.6	132.5	156.55	5841	4452	5146.5
Radha-14	254.4	318	286.2	105.8	62.2	84	5070	3732	4401
Bahuguni-1	352.3	268	310.15	94.6	86.9	90.75	6028	3857	4942.5
P-value	<.001	<.001	<.001	<.001	<.001	<.001	0.143	0.002	0.0725
LSD (0.05)	22.37	17.85	20.11	24.91	23.3	24.105	1025.5	375.9	700.7
A×B	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
CV %	9	7.3	8.15	22.7	28.7	25.7	21	10.8	15.9
Grand mean	285.7	281	283.35	127	93.9	110.45	5646	4011	4828.5

Effective tillers per m^2

Table 3 showed that effective tillers was significantly affected by the age of seedling while tiller producing capacity of individual varieties was also varied. Comparatively, Bahuguni-1 has high tiller producing capacity (310-352.3) which was followed by Radha-14 (254-286) and least by Chaite-5 (180-250). The difference in the tiller producing ability of individual is the varietal character of rice (Shrestha et al 2021, Zhao et al 2020) but it may varies with other factor limitation too (Zhao et al 2020). At 5% level of significance, 20 days young seedling produced higher tiller number ranges from 294 t0 300 per m^2 and consequently decline in number with increase age of seedling. Older seedling had lower effective tiller per m^2, it may due to seedling transplanted at 20 days are more vigorous and quick in tiller production and leaf number in early stage and have high resource efficiency to convert them into different stage at appropriate time (Pasuquin et al 2008). The delayed planting of seedling causes the deleterious effect in root mechanism and rice plant requires approximately 10-15 days to recover and have less time for tiller production (Liu et al 2015)

Grain per Panicle

This traits is very important in linking to yield performance of rice. Grain per panicle depends upon the panicle length and the arrangement of spikelet in them (Balasubramanian et al 2006, Zhao et al 2020). The grain filling is also related to how longer the reproductive phase has been extended (Balasubramanian et al 2006) and

counter of different stress (Amasino 2010). In Table 3, it depicts that number grain in a panicle was influenced by different seedling age and along with the varieties. Grain in a panicle was varied with varieties due its varietal characteristic (Shrestha 2016, Shrestha et al 2021) where Chaite-5 had higher grain in individual panicle as compared to other rice varieties. The production of grain in panicle was significantly higher in young aged seedling and number decreased with increase in seedling age. Shorter vegetative growth and longer period of reproductive phase in Table 3 showed that the grain should be more in young seedling, show as the result. The 20 days seedling established fast in field and uses the resources efficiently and gone through appropriate growth phase and finally enhanced number of effective tillers and grain per panicle as compared to other (Dhungana et al 2020, Kushwaha et al 2016, Liu et al 2015).

Yield (kg/ha)

Grain yield was significantly affected by age of seedling while there is no significant different among varieties except during 2019, which was quite significant. The yield of rice due to 20 days seedling during 2018 and 2019 were 6080 kg $ha^{-1}$and 4628 kg ha^{-1} respectively and pooled mean was 5354 kg ha^{-1}. There was decrease in yield of rice with subsequent increase of seedling age. The least yield was produced by 50 days old seedling during 2018 and 2018 were 2061 kg $ha^{-1}$and 2973 kg ha^{-1} respectively and pooled mean was 2517 kg ha^{-1}. Influence of age of seedling in different growth stage and how much they have extend of individual period and converted into yield formation (Tzudir and Kumari 2021), procure the number of effective tillers that produces longer panicle length and higher grain per panicle results higher yield (Durga et al 2015, Kushwaha et al 2016, Liu et al 2015).

CONCLUSION

In the context of unaware of rainfall pattern and unknown of appropriate management practice to enhance the yield of rice, deciding right age of seedling of rice could be non-costlier technology. Too young seedling cannot stand with waterlogged condition and too late seedling suffer more root injurious and takes 10-15 extra days for recovery, so at mean time, use of 20 days seedling had positive impact in influencing the yield of rice in Central Terai Region of Nepal. The choice of variety is based on the locality, purposes and people preference. The tested varieties equally contributed in yield and suitable for Terai areas. Use of 20 days of seedling of any varieties is more beneficial to enhance the yield of rice over different condition. Further, large plot demonstration and farmer field trials should be conducted for validation of these findings in farmer's field.

ACKNOWLEDGEMENT

Authors would like to thank NARC management for allowing budget to conduct the research activity. All the staffs of DoAR, Parwanipur are highly appreciated for their dedication for timely execution for work.

AUTHORS' CONTRIBUTION

MK Sah was responsible for project development, field layout, research execution and manuscript writing. Mr. P Sah gave valuable inputs beginning from project proposal to data analysis and other authors helped with data analysis and paper write-up.

CONFLICTS OF INTEREST

The authors declare no conflict of interests or personal relationships that could have appeared to influence the work reported in this paper.

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