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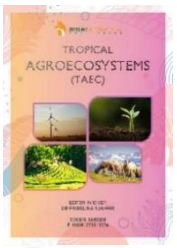

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RESEARCH ARTICLE

EFFECT OF AGE AND NUMBER OF SEEDLINGS IN PRODUCTIVITY OF RICE, DANG, NEPAL

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ABSTRACT

The growth, yield and yield attributing characters of Tilki rice variety was evaluated under different age and number of seedlings hill $^{-1}$ at Dang, Nepal during rainy season from June to September, 2019. The experiment was laid out into factorial design of two different age of seedlings as viz. 20 days and 30 days as main plot factor and four different number of seedlings hill $^{-1}$ viz. 1, 2, 3 and 4 as sub-plot factor and replicated thrice. The results revealed that highest plant height (79.69cm) at the time of harvesting , LAI (0.17), panicle length (23.55cm), number of grains per panicle (101.82), effective tiller per hill (9.9), non-effective tiller per hill (1.03), total tiller per hill (10.94), test weight (29.22gm) ,economical yield (2.09ton/ha), biological yield (5.28ton/ha) and harvest index (39.34%) were recorded by 20 days of seedlings. Regarding the number of seedlings effective tiller per hill and harvest index were non-significant. Highest plant height (79.65cm), test weight (28.88gm) and LAI (0.17) were recorded in 1 seedling per hill. Longest panicle length (24.11cm) and more number of grains per panicle (100.48) were also recorded in 1 seedlings per hill. Highest number of non-effective tiller (1.66) and total tillers per hill (11.08) in four seedlings per hill were recorded. Highest economical yield (2.21ton/ha) and biological yield (5.43ton/ha) were recorded in 2 seedlings per hill. The interaction effect of age and number of seedlings per hill showed non-significant relation with all the growth, yield and yield attributing parameters except non-effective tiller per hill and LAI.

KEYWORDS

Rice variety, Age of seedlings, Number of seedlings per hill.

1. INTRODUCTION

Rice (Oryza sativa L. var. Indica) is the most important cereal crop in agriculture and economy of Nepal. It shares about 20% to the agricultural gross domestic product (AGDP) and accounts about 53% of the total food grain production and covering more than 50% of the agricultural land area (Bista, 2018; NARC 2007). Rice is grown in 1.55 million ha of cultivable land with 71% in terai and 24.9% in inner-terai, and 4.1% in Hills and Mountains amounting 4.30 million ton of rice grain with an average productivity of 2.9 ton/ha (FAO 2010; MOAC 2008). It is the main diet of Nepalese people and meets more than 50% of their total calorific requirements (NARC 2007). 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. 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 seedlings per hill are one of major factor that influences the tillering capacity, growth and development, which ultimately influences the yield and yield contributing characters. Number of seedlings 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. Higher number of seedlings 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 seedlings may leads lower number of tiller and finally lower yield. Thus, it is necessary to determine the optimum number of seedlings 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. A group researcher also state that older seedling reduces the general performance of crop and finally reduce the yield of crop (Bozorgi et al., 2011). Hence, this experiment was under taken to identify the optimum age and number of seedlings per hill.

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2. Materials and Methods

Field experiment was conducted at Fulbari municipality of Dang district during June to November 2019 to study the effect of age and number of seedlings per hill in rice production. Geographically, it is located at Latitude 28° 07' 24.00" N and Longitude 82° 17' 26.40" E with an altitude of 725masl.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 2019). 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 factorial design keeping combination of two different age of seedlings viz. 20 days, and 30 days old seedling as main plot factor and four number of seedlings per hill i.e. 1, 2, 3 and 4 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 0.75 m^2. Dry nursery bed was prepared for raising the seedlings and 20- and 30-days old seedlings were transplanted with various number of seedlings in puddled field in 15 cm x 10 cm planting geometry. The fertilizer dose of 100:50:50 kg NPK ha-1 was applied from urea (46%N), DAP (18% N and 46% P2O5) and MOP (60% K2O). 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 doses 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 tillers per hill was recorded. For plant height, five hills were selected from each plot and tagged it for taking plant height and number of tillers 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 per hill, non-effective tillers per hill, total tillers per hill, 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 ton/ha 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.

3. Result and Discussion

3.1 Effect of age of seedlings, number of seedlings per hill and their interaction on Biometric characters

Treatment	Plant height(cm)	LAI
Age of seedling		
X	79.69167^{a}	0.170833^{a}
Y	67.73333^{b}	0.143333^{b}
LSD (0.05)	4.744096***	0.010312***
No. of seedling		
S_1	79.65^{a}	0.178333^{a}
S_2	74.71667^{ab}	0.15^{bc}
S_3	70.96667^{b}	0.141667^{c}
S_4	69.51667^{b}	0.158333^{b}
LSD(0.05)	6.709165*	0.014583***
Interaction		
$X \times S_1$	86.56667	0.1833333^{ab}
$X \times S_2$	80.60000	0.1666666^{b}
$X \times S_3$	76.16667	0.1433333^{c}
$X \times S_4$	75.43333	0.1900000^{a}
$Y \times S_1$	72.73333	0.01733333^{ab}
$Y \times S_2$	68.83333	0.1333333^{c}
$Y \times S_3$	65.76667	0.1400000^{c}
$Y \times S_4$	63.60000	0.1266667^{c}
S.Em.(±)	5.418075	0.011777
LSD(0.05)	NS	0.0203141**
CV (%)	7.35028	7.497098
Grand mean	73.7125	0.157083

Note: Data subjected to square root transformation; figures in parentheses are transformed value. CV: Coefficient of variation, LSD: Least significant difference, S.Em: Standard error. Mean separated by LSD and columns represented with same letter are non-significant at 5% level of significance, * significant, *** highly significant, NS-non significant

3.2 Effect on plant height

There was high significant difference in plant height at the time of harvesting due to the age of seedlings. Tallest plant height (79.69 cm) was observed in 20-day old seedling whereas shortest plant height (67.73 cm) was observed in 30-day old seedling. The transplanting of young aged seedling gets sufficient time to root establishment with less transplanting shock at this stage which ultimately resulted better nutrient uptake which stimulate cell division and causing stem elongation. Some researchers observed that 10-days old seedlings had more vigorous stem elongation and higher tillering ability compared with 15 and 40-days old seedlings (Kim et al., 1999). A study reported that young seedlings (7 or 14 days old) performed better than 21 days old seedlings (Gani et al., 2002).

The effect of number of seedlings on plant height was found to be significant. The tallest plant height (79.65cm) observed when 1 seedling per hill was transplanted while the shortest, i.e. 69.51 cm was found when transplanted with 4 seedlings per hill. Gupta found that transplanting of 1 seedling per hill significantly increased plant height, than the higher number of seedlings per hill (Gupta, 1996). The plant transplanted with 3 and 4 seedlings showed at par plant height The plant height when transplanted with 2 seedlings per hill was found to be at par with 3 seedlings per hill, 4 seedlings per hill as well as with 1 seedling per hill. The different interactions of age and number of seedlings showed non-significant differences on plant height.

3.3 Effect on LAI

The effect of age of seedlings on LAI was found to be statistically highly significant. The plant transplanted at 20 days after sowing had greater (0.17) leaf area index than when transplanted at 30 DAS (0.14). Hussain et al. (2012) also observed that, 14 age of seedlings produced more LAI and dry matter as compare to 21 days old seedlings. LAI was observed greater (0.178) in the plant that was transplanted with 1 seedling per hill and lesser (0.014) in the plant transplanted with 4 seedlings per hill which concludes there was high significant differences in LAI value when seedlings were transplanted with different numbers per hill. Also, LAI was at par in the plant transplanted with 3 and 4 seedlings per hill. When transplanted with 2 seedlings per hill, LAI result was at par to the plant transplanted with 1 seedling per hill and also to 3 seedlings per hill. The interaction result showed that LAI value was greater (0.19) in the plant which was transplanted with 20 days old seedling and 4 seedlings per hill while the lowest was in the plant which was transplanted with 30 days old seedling and 4 seedlings per hill (0.12).

3.4 Effect of age of seedlings, number of seedlings per hill and their interaction on yield attributing characters

Treatment	Panicle length(cm)	No. of grains/panicle	Effective tiller/hill	Non-effective tiller/hill	Total tillers/hill	Test weight (gm)
Age of seedling						
X	23.5575^{a}	101.825^{a}	9.9^{a}	1.033333^{a}	10.94167^{a}	29.22917^{a}
Y	22.37^{b}	89^{b}	9.3^{b}	0.841667^{b}	10.225^{b}	25.68167^{b}
LSD (0.05)	0.710796**	3.115285***	0.22374***	0.07613***	0.214585***	0.796801***
No. of seedling						
S_1	24.11667^{a}	100.4833^{a}	9.45	0.433333^{d}	9.9^{c}	28.88833^{a}
S_2	23.185^{ab}	94.06667^{b}	9.816667	0.666667^{c}	10.65^{b}	27.10667^{b}
S_3	22.63167^{bc}	92.71667^{b}	9.666667	1.033333^{b}	10.7^{b}	26.50167^{b}
S_4	21.92167^{c}	94.38333^{b}	9.466667	1.616667^{a}	11.08333^{a}	27.325^{b}
LSD (0.05)	1.005217**	4.405678**	NS	0.107664***	0.303469***	1.126847**
Interaction						
X×S_1	24.69667	104.83333	9.7000000	0.3666667^{f}	10.10000	29.77000
X×S_2	24.01333	102.43333	10.233333	0.8000000^{d}	11.03333	28.98000
X×S_3	22.41000	98.46667	9.900000	1.2000000^{d}	11.10000	28.59667
X×S_4	23.11000	101.5667	9.766667	1.7666667^{a}	11.53333	29.57000
Y×S_1	23.53667	96.13333	9.200000	0.5000000^{ef}	9.70000	28.00667
Y×S_2	22.35667	85.70000	9.400000	0.5333333^{e}	10.26667	25.23333
Y×S_3	21.43333	86.96667	9.433333	0.8666667^{d}	10.30000	24.40667
Y×S_4	22.15333	87.20000	9.166667	1.4666667^{b}	10.63333	25.08000
S. Em (±)	0.811776	3.557864	0.255534	0.086946	0.24507	0.91
LSD (0.05)	NS	NS	NS	0.1512734***	NS	NS
CV (%)	3.535033	3.728928	2.661812	9.274189	2.315626	3.314466
Grand mean	22.96375	95.4125	9.6	0.9375	10.58333	27.45542

Note: Data subjected to square root transformation; figures in parentheses are transformed value. CV: Coefficient of variation, LSD: Least significant difference, Sem: Standard error. Mean separated by LSD and columns represented with same letter are non-significant at 5% level of significance,* significant, *** highly significant, NS-non significant

3.5 Effect on panicle length

According to the data from the Table, panicle length showed significant differences when transplanted with different aged seedlings. Panicle length was longest, i.e. 23.55cm in 20 days old seedling transplanted plant and shortest, i.e. 22.37 cm in 30 days old transplanted plant. 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 (Singh et al., 2004).

Significant difference was found in the plants transplanted with different number of seedlings per hill. The longest panicle length, i.e.24.11cm was found in 1 seedling per hill transplanted plant while the shortest panicle length, i.e. 21.92cm was found in 4 seedlings per hill transplanted plant. The lower number of seedlings per hill gave the longest 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 panicle length of 2 seedling transplanted plant was at par with 1 seedling transplanted plant and that of 3 with 4. Non- significant result was found on panicle length due to the interaction (A×N).

3.6 Effect on number of grains /panicles

No. of grains per panicle was also highly significantly different when transplanted with different aged old seedlings. The number of filled grains was determined by the suitable age of seedling because younger seedlings were established well than the later one. Plant with 20 days old seedling had greater no. of grains per panicle, i.e. 101.82 and the plant with 30 days old seedlings had lesser no. of grains per panicle, i.e. 89.

The statistical data showed significant differences in no. of grains per panicle as affected by transplanting seedlings with different no. per hill. 1 seedling per hill transplanted plant had greater no. of grains per plant, i.e. 100.48 and 3 seedlings per hill transplanted plant showed lesser no. of grains per panicle, i.e. 92.71 while 2 and 4 seedlings per hill transplanted plant had at par grains as that of 3 seedlings transplanted plant. The number of seedlings 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 spikelet which reduced the number of filled grains per panicle. The interaction showed non-significant differences on number of grains per panicle

3.7 Effect on total tillers per hill

The age of seedling during transplanting showed high significant differences in total tillers per hill later. The greater tillers (10.94) were observed in the plant with 20 days old seedling and lesser (10.22) in the 30 days old seedling. The high significant difference was shown by the different number of seedlings transplanted per hill on total tillers per hill. Greater number of tillers, i.e. 11.08 was shown by 4 seedlings and lower number of tillers, i.e.9.9 was shown by 1 seedling. As there was increase in the number of seedlings per hill, tiller number also increased (Nayak et al., 2003). Also, the number of tiller production increased with increased number of seedlings per hill from one to three, as showed (Cai et al., 1991). The 2 seedlings per hill and 3 seedlings per hill had similar tiller numbers with 1 seedling per hill. Not any significant differences were found on total tillers per hill due to the interaction.

3.8 Effect on effective tillers per hill

There was greater effective tiller per hill in the plant of 20 days old seedling, i.e. 9.9 while lesser effective tiller per hill in the plant of 30 days old seedling, i.e. 9.3. A group researcher also reported significant reduction in total tillers production with delay in planting (Nayak et al., 2003). The 15 days old seedlings revealed superiority over the other age of seedlings in respect of effective tiller production shown (Ali et al., 2013). 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, 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. Not any significant differences were found on effective tillers per hill with transplantation of different number of seedlings per hill and with the interaction of age and number of seedlings per hill.

3.9 Effect on non-effective tillers per hill

There was greater non-effective tillers in 20 days old seedling transplanted plant (1.03) while lower in 30days old transplanted plant (0.84). Greater non-effective tillers was shown by plant transplanted with 4 seedlings per hill, i.e. 1.61 while the lowest was shown by 1 seedling per hill, i.e. 0.43 followed by 2 seedlings per hill (0.67) and then by 3 seedlings per hill (1.03). Non-effective tillers was found to be greater (1.76) in transplanting with combination of 20 days old seedling and 4 seedlings per hill and lesser (0.36) in transplanting with combination of 20 days old seedling and 1 seedling per hill.

3.10 Effect on test weight

Test weight was found to be greater (29.22gm) in 20days old transplanted seedling than 30 days old transplanted seedling (25.68gm). Maximum test weight was obtained from plant transplanted with1 seedling per hill (28.88gm) followed by 4 seedlings per hill (27.32gm), 2 seedling per hill (27.1gm) and minimum from 3 seedlings per hill (26.5gm). There was non-significant differences in the test weight with the interaction of age and number of seedlings.

3.11 Effect of age of seedling, number of seedlings per hill and their interaction on yield

Treatment	Economic yield(t/ha)	Biological yield(t/ha)	Harvesting index (%)
Age of seedling			
X	2.090833[a]	5.28[a]	39.34667
Y	1.641667[b]	4.450833[b]	36.495
LSD(0.05)	0.240923**	0.466123***	NS
No. of seedlings			
S1	1.906667[a]	5.038333[a]	37.51
S2	2.211667[a]	5.436667[a]	40.50833
S3	2.043333[a]	5.181667[a]	39.1
S4	1.303333[b]	3.805[b]	34.565
LSD(0.05)	0.340717***	0.466123***	NS
Interactions			
X×S1	2.230000	5.530000	40.27000
X×S2	2.450000	5.873333	41.55000
X×S3	2.390000	5.763333	41.46667
X×S4	1.293333	3.953333	34.10000
Y×S1	1.583333	4.546667	34.75000
Y×S2	1.973333	5.000000	39.46667
Y×S3	1.696667	4.600000	36.73333
y×S4	1.313333	3.656667	35.03000
S.Em.(±)	0.27515	0.376423	3.620614
LSD(0.05)	NS	NS	NS
CV (%)	14.74349	7.736716	9.547824
Grand mean	1.86625	4.865417	37.92083

Note: Data subjected to square root transformation; figures in parentheses are transformed value. CV: Coefficient of variation, LSD: Least significant difference, Sem: Standard error. Mean separated by LSD and columns represented with same letter are non-significant at 5% level of significance* significant, *** highly significant, NS-non significant

3.12 Effect on economic yield

As per the table, 20 days old seedling transplanted plant had greater economic yield, i.e. 2.09t/ha than 30 days old seedling transplanted plant, i.e. 1.64t/ha. A group researcher also reported the highest grain yield from 4 weeks of old seedlings (Faruk et al., 2009). 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. According to the data presented in the table, more economic yield (2.2t/ha) was obtained from the plant transplanted with 2 seedlings per hill while less yield was obtained from plant transplanted with 4 seedlings per hill (1.30t/ha).

This result is also observed by who observed that the highest grain yield (497 g/m2) were observed in the treatment having combination of two seedling/hill (Ahmad and Hasanuzzaman, 2012). Transplanting 2 seedlings per hill showed significant superiority over the other treatments. Increase in grain yield might be due to production of a greater number of tillers per hill and a greater number of filled grains/panicle and

finally increased in the grain yield. Similar observation was also reported (Gupta, 1996). And, 1 and 3 seedlings transplanted plant gave at par economic yield to that of 2 seedlings. Economic yield showed no significant differences with the interaction of age and number of seedlings per hill.

3.13 Effect on biological yield

There was greater biological yield in 20 days old seedling transplanted plant (5.28t/ha) while lower in 30 days old transplanted plant (4.45t/ha). 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. A group researcher also reported the highest grain yield from 4 weeks of old seedlings (Faruk et al., 2009). 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. High significant difference was seen in biological yield as affected by number of seedlings being transplanted. The plant transplanted with 2 seedlings per hill gave more biological yield (5.43t/ha) followed by 3 seedlings (5.18t/ha) per hill, 1 seedling per hill (5.03t/ha) and least by 4 seedlings per hill (3.805t/ha). Biological yield showed no significant differences with the interaction of age and number of seedlings per hill.

3.14 Effect on Harvest Index

Harvest index had non-significant differences when rice was transplanted with different aged seedlings, with different number of seedlings per hill and also with their interaction.

3.15 Regression analysis of economic yield on yield attributes

Dependence of grain yield on yield attributes, viz. test weight, number of grains per panicle, tillers per hill, effective tiller and panicle length was evident from significant positive correlation with regression functions, accounting for R^2=0.1339, R^2=0.1474, R^2=0.0084, R^2=0.403, R^2=0.172 explained variability in grain yield, respectively (from figure 1 to 5). Expectedly, grain yield showed a negative correlation with the regression function between grain yield and non-effective tiller, accounting for R^2=0.1972 (figure 6).

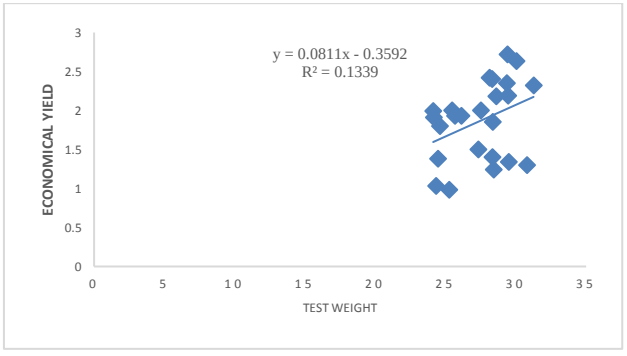

Figure 1: Regression analysis of economic yield with test weight

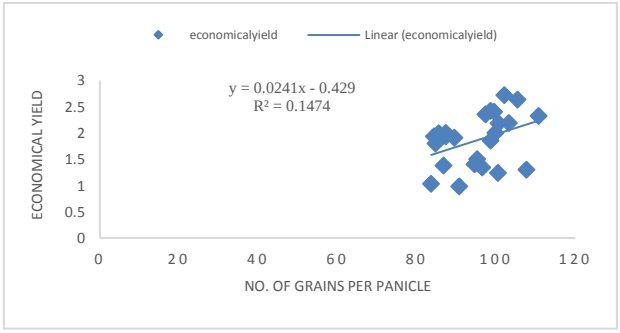

Figure 2: Regression analysis of economic yield with no. of grains per panicle

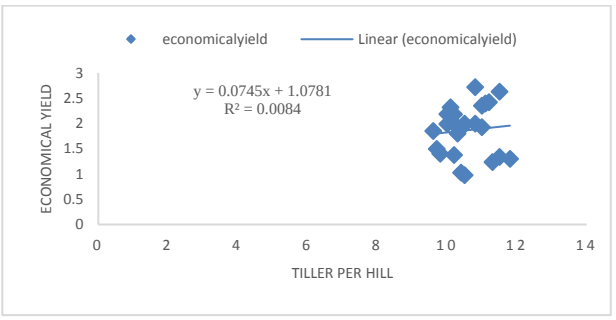

Figure 3: Regression analysis of economic yield with tillers per hill

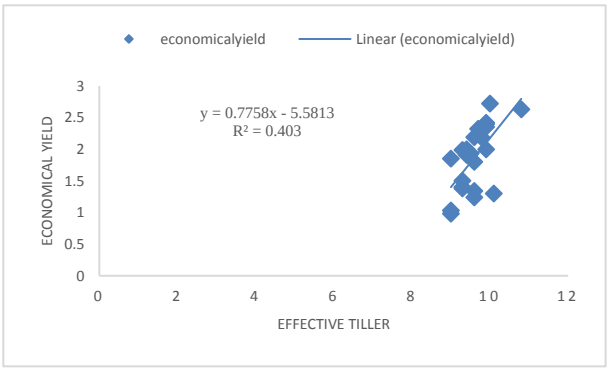

Figure 4: Regression analysis of economic yield with effective tiller

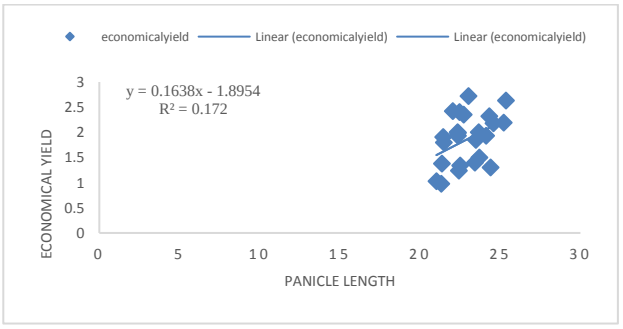

Figure 5: Regression analysis of economic yield with panicle length

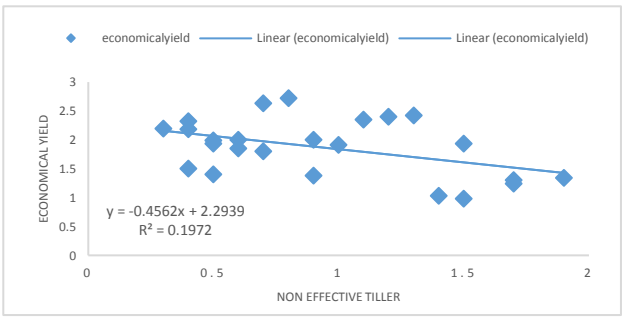

Figure 6: Regression analysis of economic yield with non-effective tiller

4. Conclusion

In all the parameters, 20 day's old seedlings showed significantly greater value than 30 day's old seedlings. So from the results obtained from our experiment, the local Tilki variety under Dang condition could give the best yield when the seedlings of 20 day's old is transplanted. Regarding the effect of number of seedlings significant differences was found in all parameters except effective tillers per hill and harvest index. The rice cultivation with different number of seedlings per hill registered greater economic yield from transplanting 2 seedlings per hill compared to 1, 3 and 4 seedlings per hill. The overall parameters on an average showed their good result when 2 seedlings in one hill was transplanted. Due to the interaction, non-significant differences were found on all the parameters except LAI and non-effective tiller. LAI was found to be greater in 20 day's old seedlings transplanted with 4 seedlings whereas lowest in 30 day's old

seedling transplanted with 4 seedlings. Significant differences was found in non-effective tiller. 20 day's old seedling transplanted with 4 seedlings produced greater non-effective tiller while 20 day's old with 1 seedling per hill produced lowest.

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