International Journal of Environment, Agriculture and Biotechnology
Vol-7, Issue-2; Mar-Apr, 2022

Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Peer Reviewed

Analysis of Heritability and Correlation for Yield and Yield Attributing Traits in Single Cross Hybrids of Maize

Jigyasha Gautam[1], Aakash Adhikari[2], Pabitra Ale[1], Babita Dhungana[1], Anup Adhikari[1], Krishna Hari Dhakal[3]

[1]Nepal Polytechnic Institute, Chitwan, Nepal
[2]Himalayan College of Agricultural Sciences and Technology, Kirtipur, Kathmandu
[3]Agriculture and Forestry University, Chitwan, Nepal
Corresponding Author: jigyasagtm@gmail.com)

Received: 16 Feb 2022; Received in revised form: 22 Mar 2022; Accepted: 31 Mar 2022; Available online: 06 Apr 2022

Abstract— *It is very important to study and understand the inter-relationships among the yield and yield attributing traits as well as heritability for the increased efficiency of the breeding programs. Thus, this research is meant to examine economic and biological performance and then measure the correlation between these traits and their heritability. A field experiment was performed in a Randomized Block layout with three replications, every assigned with fifteen treatments in Bharatpur, Chitwan. Effects confirmed considerable variants among all the found quantitative data. Days to tassel initiation were positively and significantly correlated with days to silking (0.83***), days to maturity (0.85**), and days to anthesis (0.87**). Thousand seed weight was significantly and positively correlated with shelling percentage (0.34*). Grain yield was significantly and positively correlated with cob length (0.32*) and number of grains per row (0.33*) whereas highly significant and positively correlated with circumference (0.43***). Traits like days to maturity (0.3), shelling percentage (0.3), and grain yield (0.6) exhibited moderate heritability while others exhibited low heritability. RL-294/CML-226 had the highest grain yield (7.7 t/ha) and grain per row (15.2) with medium performance for other characters. RML-57/RL-174 recorded the highest rows per cob (39.7), cob length (18cm), and shelling percentage (80%) whereas the lowest days to maturity (116.7 DAS) and fluctuating performance in others. Variety RML-86/RML-146 showed better consistent performance for all the traits with the third-highest grain yield (7.1 t/ha) except for shelling percentage (which was the lowest) and days to maturity (which was the longest). This depicts that the two varieties RL-294/CML-226 and RML-86/RML-146 have good possibilities for improvement and cultivation in that area.*

Keywords— ***Positively, Significant, Performance, Grain yield, Shelling percentage, Consistent.***

I. INTRODUCTION

Maize (*Zea mays*) is a monocot cereal grain belonging to the family *Poaceae* and tribe *Maydae*. Maize is considered the queen of cereals as it possesses the highest genetic yield potential rather than other cereals (Gami et al., 2018). Along with the traditional way of use as food, feed, and fodder, maize can also be used as raw material in a variety of food and business products such as starch, sweeteners, oil, drinks, glue, Industrial alcohol, and gas ethanol. Maize is taken into consideration as stable food throughout the globe because of its high nutritional importance enriched with an abundant amount of macronutrients like starch, fiber, protein, and fat along with micronutrients like B-complex vitamins, ß-carotene, and essential minerals, i.e. magnesium, zinc, phosphorus, copper, etc. (Bathla et al., 2019). Maize cultivation and consumption has been a way of life for Nepalese farmers as it is included in most of the crop rotations practiced in Nepal. Most of the hilly farmers here solely depend on maize for cereal consumption for about 1/3rd of the year.

The majority of the repeated maize cultivators belong to the hills of Nepal and are popular for winter cultivation on plains. The area under maize production in plains when increased can serve as an economic boon to the country by reducing the amount of maize imported every year and increasing livestock and poultry production. Thus, it is very important to assign suitable varieties for winter to the specific area in plains for incline in maize yield.

Being a developing country, maize cultivation in Nepal faces different infrastructural, mechanical, and economic challenges. The productivity and achievable yield of maize in Nepal is 2.55mt/ha and 5.70mt/ha respectively (Thapa, 2021), but this figure is hard to accomplish due to various reasons. the highest rate of hybrid seed is the important trouble followed by untimely availability of inputs, seed replacement for every season, and excessive irrigation requirements (Dawadi & Maize, 2015). In Nepal, farmers started to develop hybrid maize because in the Eighties importing seeds from India as an open border among the international locations makes imports smooth (Thapa, 2013). The farmers do not have access to sufficient input supplies in a time of need. Sometimes even getting the seed of desired varieties is a very difficult task for them which compel them to cultivate any random seeds available in the locality. As such, they cannot increase their production by increasing the number of fertilizers, mechanization, and other options which results in less utilization of the production potential. Even if more cannot be accomplished, just a simple assessment of varieties suitable for the specific maize growing areas helps to increase production and productivity as well as adds to farm family income to increase their living standard.

The hybrid maize variety is correctly grown in the plains, inner plains, valleys, foothills, and mid-hill of Nepal (Sharma et al., 2007). But plains and inner plains are considered to have high scope for hybrid maize production during winter and spring (Dawadi & Sah, 2012) and (Sharma et al., 2004). There are altogether 59 registered hybrids, among which five were released and two were registered for release by NMRP Rampur, and 52 are multinational companies' hybrids(Dhakal et al., 2020). Hybrid maize seed advertising and marketing is prospering every year however constrained commercial hy brids are perfect for cultivation as a result of the present diverse agro-ecological regime of the count (Sharma et al., 2016). The varietal options for the farmers for hybrid seeds are very limited (Kunwar & Shrestha, 2014), which is why this research was conducted to assign the farmers all suitable hybrids for the inner plains. The seed industries are slowly establishing and developing to provide the hybrid seeds for farmers. But, the dependency over imported hybrid maize seed increased each year due to unavailability of aggressive cultivars within nation and underdeveloped seed industries (Joshi et al., 2016).

Varietal evaluation of the self-produced hybrids enables to increase in a competitive marketplace for the imported hybrid seeds and also gives a reliable option to the farmers seeking higher yield. Systematic research on maize hybrids started in 1997 after comparing 9 Indian hybrids in Rampur (Kandel, 2021). Hybrid cultivation is the best alternative option for Nepalese farmers to increase their crop productivity even with their current economic status to meet the growing demand for maize as a result of the flourishing poultry industry. To meet this, there should be a significant improvement in maize production which requires the introduction of more improved and hybrid varieties (Adhikari et al., 2018). This helps the GDP of the country to rise and also reduces the reliance on imported maize from India for food, feed, seed, and other industrial purposes. From the knowledge of the inter-relationship between yield and its contributing components the efficiency of the maize breeding programs can be improved(Mohammadi et al., 2003).

II. MATERIALS AND METHODS

Seeds of 15 single cross hybrids of maize had been obtained from the National Maize Research Program (NMRP), Rampur, and Chitwan for this experiment which was conducted in Bharatpur, Chitwan on the research farm of Nepal Polytechnic Institute. The crop was planted in late winter (early February). The average annual temperature of Bharatpur is 24 degrees Celsius and rainfall here is around 1993mm. The field experiment was conducted in a Completely Randomized Block layout with three replications. Three blocks were made with 15 experimental units in each and all 15 treatments were randomly assigned in each experimental unit of each block so that all three blocks have all treatments placed randomly. The size of each plot was 5-meter squares (2m*2.5m). The spacing between rows was 50cm and plant to plant 25cm. Each experimental unit contained 40 plants. The single cross hybrids were allotted into treatments as below:

Table 1: Allotment of single cross hybrids into treatments

Treatments	Genotype
1	RH-6
2	RH-10
3	RML-86/RML-96
4	RML-95/RML-96
5	RML-89/RML-140
6	RML-57/RML-17
7	RML-138/RML-96
8	RML-234/RML-96
9	RML-87/RL-105
10	RL-243/RML-140
11	RML-86/RML-146
12	RL-248/RML-25
13	RML-94/NL-1
14	RL-294/CML-226
15	RML-57/RL-174

The field was prepared with two harrowing followed by leveling. National Agricultural Research Council (NARC) recommended dose of 180:60:40kg NPK/ha was applied where the Nitrogen fertilizer was divided 3 times among which half of the dose was applied as basal application and the remaining half was divided equally again to be applied on 60DAS and during flowering. Five plants were sampled randomly for recording observation for each entry and 50 percent completion out of the total plants was taken for days to germination, silking, tasseling, and maturity. Plant height was taken at the time of maturity by measuring the length above from the ground to the base of the tassel. The cobs obtained after the maturity were shelled and sundried up to 15% of moisture after which the necessary measurements were recorded. The yield was recorded after the winnowing of the shelled cobs as it removes the other impurities. The shelling percentage was calculated using five sample cobs and formulae as:

$$\text{Shelling Percentage} = \frac{\text{Grain Yield (kg)} \times 100}{\text{Cob yield (kg)}}$$

Data entry and processing were carried out using the Microsoft Office Excel 2010 software and means and standard deviation for all traits were compared. The testing of the hypothesis and analysis of variance was calculated using R-software.

III. RESULTS AND DISCUSSION

Growth parameter

Plant height was observed to evaluate the growth parameter. In the experiment, highly significant variation was found from the statistical analysis for plant height among the tested single cross hybrids. Maximum plant height was exhibited by the treatment RML-86/RML-146 with 209cm and the lowest plant height was shown by the single cross hybrid RML-234/RML-96 with 152cm. The CV value for plant height was 7.519921; the LSD value among the tested single cross hybrids was 21.42786 and the mean plant height for the treatments was 170cm. The heritability value of plant height was 0.8 which indicates only 80% of the variability in the plant height is due to the genetic differences among the single cross hybrids and the other 20% is due to environmental factors.

Table 2: Growth trait for fifteen single cross hybrids of maize

Genotype	**Plant height**
RH-6	161.7def
RH-10	167.4cdef
RML-86/RML-96	188.9ab
RML-95/RML-96	168.3bcdef
RML-89/RML-140	159.3ef
RML-57/RML-17	166.0cdef
RML-138/RML-96	171.5bcdef
RML-234/RML-96	151.6f
RML-87/RL-105	160.9ef
RL-243/RML-140	152.4f
RML-86/RML-146	208.9a
RL-248/RML-25	182.6bcd
RML-94/NL-1	183.8bc
RL-294/CML-226	158.1ef
RML-57/RL-174	174.0bcde
CV	**7.5**
LSD	**21.4**
MEAN	**170.4**
Heritability	**0.2**
F-test	***

(Kandel et al., 2018) their article mentioned a mean plant of 201cm. This means the height is much higher than our result which is only 152cm. This difference might have occurred due to the difference in growing degree days and also the use of different hybrids with different genotypic components. The plant height variation among the treatments could be the result of variation in genotypic components of hybrids, photosynthetic rate, and leaf size.

PHENOLOGICAL TRAITS

Phenological traits such as days to germination, silking, tasseling, anthesis, and maturity were recorded. In our experiment, there was significant variation for days to germination among the tested single cross hybrids. A maximum day for germination was observed in the treatment RL-243/RML-140 in 16 days and a minimum day for germination was observed in the single cross hybrid RML-138/RML-96 in 14 days. The heritability value of days of germination was 0.8.

A highly significant variation for days of cob tassel initiation was observed among the tested single cross hybrids. A maximum day for tassel initiation was observed in the treatment RML-87/RML-105 in 86 days and a minimum day of tassel initiation was observed in the single cross hybrid RL-243/RML-140 in 75 days. The heritability value of days of tassel initiation was 0.8. (Ghimire & Timsina, 2015), in their research reported similar variation for days to silking which ranged from 70-91 days. The difference in days to variation among different single cross hybrids might have resulted due to the difference in the duration of the vegetative phase among the germplasms.

There occurred significant variation for days of silking among the tested single cross hybrids. A maximum day for silking was observed in the treatment RML-87/RML-105 in 88 days and a minimum day for silking was observed in the single cross hybrid RL-248/RML-25 in 79 days. The heritability value of days of silking was 0.7. (Ghimire & Timsina, 2015) found the days for silking to vary within the range of 72-92 days. This result is slightly greater than our result which might have been caused due to the different genotypic components of the germplasms used in these two studies. The difference in days of silking is also affected by the duration of the vegetative phase as well as tassel and cob initiation days among the germplasms.

Moderately significant variation was found for days of cob anthesis among the tested single cross hybrids. A maximum day for anthesis was observed in the treatment RML-87/RML-105 in 88 days and a minimum day for anthesis was observed in the single cross hybrid RL-243/RML-140 in 77 days. The heritability value of days of anthesis was 0.8. (B P Kandel et al., 2018) the recorded mean of 108 days for days to anthesis in different hybrids is a little higher than the result we got. This difference in the days to anthesis might have occurred due to the difference in growing degree days between the two types of research, ours which was conducted in spring and summer, and the other one was conducted in winter. Different treatments vary for days to anthesis due to the difference in the vegetative cycle and days to tassel initiation.

There was highly significant variation for days to maturity among the tested single cross hybrids. A maximum day for maturity was observed in the treatment RML-86/RML-146 in 127 days and a minimum day for maturity was observed in the single cross hybrid RML-57/RML-174 in 117 days. The heritability value of days of maturity was 0.6. (Ghimire & Timsina, 2015) reported the days to physiological maturity in maize ranged from 143-151days in their article. Their range of days to maturity is slightly higher than our result, which might be due to the difference in the germplasm used in these two types of research. The variation in days to physiological maturity depends upon the variation in the duration of the vegetative stage, time of tassel initiation, cob formation, silking, and anthesis as well the time for cob filling and kernel development.

Table 3: Phenological traits for fifteen single cross hybrids of maize (1)

Genotype	Days of germination	Days of tasseling	Days of silking
RH-6	15.3ab	81.7bc	83.7bc
RH-10	14.0c	79.0cde	81.7cd
RML-86/RML-96	14.0c	81.7bc	83.7bc
RML-95/RML-96	14.7bc	80.3cde	83.7bc
RML-89/RML-140	14.0c	81.0cd	83.0bcd
RML-57/RML-17	14.7bc	81.0cd	83.0bcd
RML-138/RML-96	14.0c	79.7cde	84.3abc
RML-234/RML-96	16.0a	79.0cde	81.7cd
RML-87/RL-105	15.3ab	86.3a	88.3a

RL-243/RML-140	16.0a	75.0f	79.0d
RML-86/RML-146	14.0c	85.0ab	87.0ab
RL-248/RML-25	14.7bc	77.0ef	79.0d
RML-94/NL-1	14.0c	82.3bc	83.0bcd
RL-294/CML-226	14.0c	81.7c	83.0bcd
RML-57/RL-174	14.7bc	77.7def	81.7cd
CV	**4.6**	**2.7**	**3.3**
LSD	**1.1**	**3.6**	**4.6**
MEAN	**14.6**	**80.6**	**83.0**
Heritability	**0.2**	**0.2**	**0.1**
F-test	**	***	*

Note: Mean separated by DMRT and columns represented with the same letter (s) are non-significant at a 5% level of significance, CV= Coefficient of Variation, LSD= Least Significant Difference at 0.05 level of significance, and SD= Standard Deviation

Table 3: Phenological traits for fifteen single cross hybrids of maize (2)

Genotype	Days of anthesis	Days of maturity
RH-6	85.0abc	121.3bcd
RH-10	84.3bc	122.7bcd
RML-86/RML-96	85.0abc	125.3ab
RML-95/RML-96	84.3bc	122.7bcd
RML-89/RML-140	83.7c	123.3bc
RML-57/RML-17	84.3bc	118.7ef
RML-138/RML-96	83.7c	123.3bc
RML-234/RML-96	82.3c	122.7bcd
RML-87/RL-105	88.3a	124.7abc
RL-243/RML-140	77.7d	125.3ab
RML-86/RML-146	87.7ab	127.3a
RL-248/RML-25	81.7c	119.3def
RML-94/NL-1	85.0abc	125.3ab
RL-294/CML-226	83.7c	127.3a
RML-57/RL-174	82.3c	116.7f
CV	**2.6**	**1.9**
LSD	**3.7**	**3.9**
MEAN	**83.9**	**123.1**
Heritability	**0.2**	**0.3**
F-test	**	***

Note: Mean separated by DMRT and columns represented with the same letter (s) are non-significant at a 5% level of significance, CV= Coefficient of Variation, LSD= Least Significant Difference at 0.05 level of significance, and SD= Standard Deviation

YIELD COMPONENTS

Different yield components such as row per cob, grain per row, cob length, circumference, shelling percentage, thousand seed weight, and grain yield were studied. There was moderately significant variation for grain per row among the tested single cross hybrids. A maximum grain per row was exhibited by the treatment RML-57/RL-174with 40 and the lowest grain per row was shown by the single cross hybrid RML-234/RML-96 with 30. The heritability value of grain per row was 0.8. (Kandel et al., 2018) reported mean grain per row of 28cm which is a little less than our result. The use of different hybrids with varying genotypic components might have resulted in this. Variation in grain per row among the treatments might be the result of the difference in photosynthetic rate and also genetic components among them.

In our experiment, there was significant variation for row per cob among the tested single cross hybrids. A maximum row per cob was exhibited by the treatment RL-294/CML-226 with 15 grains and the lowest row per cob was shown by the single cross hybrid RML-94/NL-1 with 13 grains. The heritability value of row per cob was 0.7. (Kandel et al., 2018) reported mean row per cob of 13rows which is similar to our result. Variation in a row per cob among the treatments might be the result of the difference in photosynthetic rate and also genetic components among them.

Significant variation was observed for row per cob among the tested single cross hybrids. A maximum row per cob was exhibited by the treatment RL-294/CML-226 with 15 grains and the lowest row per cob was shown by the single cross hybrid RML-94/NL-1 with 13 grains. The heritability value of row per cob was 0.7. (Kandel et al., 2018) reported mean row per cob of 13rows which is similar to our result. Variation in a row per cob among the treatments might be the result of the difference in photosynthetic rate and also genetic components among them.

Cob length exhibited significant variation among the tested single cross hybrids. Maximum cob length was exhibited by the treatment RH-10 with 19cm and cob length was shown by the single cross hybrid RML-95/RML-96 with 16cm. The heritability value of cob length was 0.6. (Kandel et al., 2018) also recorded the mean cob length of 17cm in their research of performance check of hybrids in Rampur, Chitwan. The variation of cob length among the treatments could have been the result of the difference in the duration of reproductive stage, photosynthetic rate, number of grains per row, and also the genetic components.

Moderately significant variation for circumference among the tested single cross hybrids was found. Maximum circumference was observed in the treatment RL-243/RML-140 with 16cm and the lowest circumference was shown by the single cross hybrid RML-57/RL-174 with 14cm. The heritability value of circumference was 0.9. (Neupane et al., 2019) also recorded a similar result of a mean of 15cm for the circumference among maize hybrids in his result. The variation of circumference among the single-cross hybrids could have resulted due to the difference in grain per row, grain size, cob length, and genotypic components.

A highly significant variation for shelling percentage was observed among the tested single cross hybrids. Maximum shelling percentage was exhibited by the treatment RML-57/Rl-174 with 80% and the lowest shelling percentage was shown by the single cross hybrid RML-86/RML-146 with 70%. The heritability value of the shelling percentage was 0.9. (Neupane et al., 2019), in their article reported an average shelling percentage of 72% among the maize hybrids. This result is slightly lower than ours. The difference in grain size, number of rows per cob, number of cob per row, cob diameter, and also genotype of the hybrids might have contributed to the difference in shelling percentage among the genotypes.

In our experiment, there was a highly significant variation for thousand seed weights among the tested single cross hybrids. Maximum thousand seed weight was exhibited by the treatment RH-10 with 375gm and the lowest thousand seed weight was shown by the single cross hybrid RML-89/RML-140 with 255gm. The heritability value of thousand seed weight was 0.9.

There was a highly significant variation in grain yield among the tested single cross hybrids. Maximum grain yield was observed in the treatment RL-294/CML-226 with 7.7t/ha and minimum grain yield was observed in the single cross hybrid RH-6 with 2.1t/ha. The heritability value of grain yield was 0.6. (Kandel et al., 2018) the reported grand mean of 9.4t/ha for grain yield. This is higher than the result we derived. The use of different hybrids with varying genotypic components might have resulted in this. The germination percentage, number of cobs per plant, cob length, circumference, grains per cob, and the genotypic components of different treatments could be the cause for variation in grain yield.

Table 5: Yield attributing traits of single-cross hybrids of maize

Genotype	Rows per cob	Grain per row	Cob length
RH-6	32.9cdef	13.9abcd	15.8cd
RH-10	33.7cdef	13.9abcd	18.9a
RML-86/RML-96	32.2ef	15.2a	17.7abc
RML-95/RML-96	30.9f	14.5ab	15.6d
RML-89/RML-140	33.1cdef	13.7abcd	16.0bcd
RML-57/RML-17	38.3ab	14.1abcd	17.3abcd
RML-138/RML-96	32.3def	14.9a	15.7cd
RML-234/RML-96	30.5f	14.4abc	16.2bcd
RML-87/RL-105	35.7abcde	12.9bcd	16.3bcd
RL-243/RML-140	37.1abc	14.7a	17.6abcd
RML-86/RML-146	35.4abcde	14.8a	16.7bcd
RL-248/RML-25	33.5cdef	14.3abcd	16.4bcd
RML-94/NL-1	36.5abcd	12.7d	16.6bcd
RL-294/CML-226	34.5bcdef	15.2a	16.8bcd
RML-57/RL-174	39.7a	12.8cd	18.0ab
CV	**7.5**	**6.8**	**7.3**
LSD	**4.3**	**1.6**	**2.1**
MEAN	**34.4**	**14.1**	**16.8**
Heritability	**0.2**	**0.1**	**0.1**
F-test	**	*	.

Note: Mean separated by DMRT and columns represented with the same letter (s) are non-significant at a 5% level of significance, CV= Coefficient of Variation, LSD= Least Significant Difference at 0.05 level of significance, and SD= Standard Deviation

Table 6: Yield attributing traits of single-cross hybrids of maize

Genotype	Rows per cob	Grain per row	Cob length
RH-6	32.9cdef	13.9abcd	15.8cd
RH-10	33.7cdef	13.9abcd	18.9a
RML-86/RML-96	32.2ef	15.2a	17.7abc
RML-95/RML-96	30.9f	14.5ab	15.6d
RML-89/RML-140	33.1cdef	13.7abcd	16.0bcd
RML-57/RML-17	38.3ab	14.1abcd	17.3abcd
RML-138/RML-96	32.3def	14.9a	15.7cd
RML-234/RML-96	30.5f	14.4abc	16.2bcd
RML-87/RL-105	35.7abcde	12.9bcd	16.3bcd
RL-243/RML-140	37.1abc	14.7a	17.6abcd
RML-86/RML-146	35.4abcde	14.8a	16.7bcd
RL-248/RML-25	33.5cdef	14.3abcd	16.4bcd

RML-94/NL-1	36.5abcd	12.7d	16.6bcd
RL-294/CML-226	34.5bcdef	15.2a	16.8bcd
RML-57/RL-174	39.7a	12.8cd	18.0ab
CV	**7.5**	**6.8**	**7.3**
LSD	**4.3**	**1.6**	**2.1**
MEAN	**34.4**	**14.1**	**16.8**
Heritability	**0.2**	**0.1**	**0.1**
F-test	**	*	.

Note: Mean separated by DMRT and columns represented with the same letter (s) are non-significant at a 5% level of significance, CV= Coefficient of Variation, LSD= Least Significant Difference at 0.05 level of significance, and SD= Standard Deviation

Table 7: Statistical parameters and testing of hypothesis for 15 quantitative traits of 15 single cross hybrids of maize

Traits	**Range (min-max)**	**Mean**	**SEm**	**LSD0.05**	**SD**	**CV%**	**Significance**
Germination percentage	61-88	78.16667	58.39286	12.78058	9.4	9.775934	*
Days to germination (days)	14-16	14.62222	0.4507937	1.122948	0.9	4.5917121	**
Days to cob formation (days)	83-105	79.97778	6.736508	4.340983	2.6	3.245249	Ns
Days to tassel initiation (days)	75-86	80.55556	4.71746	3.63266	3.3	2.696241	***
Days to silking (days)	79-88	83.04444	7.688889	4.637698	3.3	3.339037	*
Days to anthesis (days)	77-88	83.93333	4.838095	3.678814	3.0	2.620612	**
Days to maturity (days)	117-127	123.0667	5.314286	3.85561	3.6	1.873191	***
Rows per cob	30-40	34.4133	6.63847	4.309281	1.1	7.486994	**
Grain per row	13-15	14.133	0.9179048	1.602395	3.5	6.778822	*
Plant height (cm)	152-209	170.3707	164.1407	21.42786	18.4	7.519921	***
Cob length (cm)	16-19	16.77311	1.515709	2.059105	1.4	7.33997	.
Circumference (cm)	14-16	14.59178	0.3969089	1.5053698	0.9	4.317548	**
Shelling percentage (%)	70-80	75.65022	1.85035	2.275198	2.9	1.798202	***
Thousand seed weight (gm)	255-375	293.6444	77.16032	14.69155	35.18	2.991405	***
Grain Yield (t/ha)	2.0-7.7	5.7	20.8330	0.8811411	1.4	9.344735	***

Note: Mean separated by DMRT and columns represented with the same letter (s) are non-significant at 5% level of significance, CV= Coefficient of Variation, LSD= Least Significant Difference at 0.05 level of significance, and SD= Standard Deviation, SeM= Mean sum of square

Correlation among quantitative traits

Table 8: Pearson's correlation coefficient among fourteen quantitative traits in single cross hybrids of maize

	DAG	**GP**	**DTT**	**DTS**	**DTA**	**DTM**	**PH**	**SP**	**GPR**	**RPC**	**CL**	**C**	**TSWT**	**GY**
DAG		-0.51***	-0.2	-0.18	-0.24	-0.11	-0.31	0.03	0.02	0.1	0.03	0.21	-0.02	-0.07
GP			0.05	0.02	0.03	0.03	0.26	0.16	0.05	0.06	-0.07	-0.06	-0.13	0.03

DTT	0.83***	0.87***	0.53**	0.13	-0.13	0.01	0.03	-0.16	-0.22	-0.23	-0.05
DTS		0.83***	0.61***	0	-0.07	0.14	-0.02	-0.2	-0.19	-0.17	-0.01
DTA			0.49**	0.16	-0.04	-0.02	0.02	-0.05	-0.25	-0.24	-0.14
DTM				0.27	0.14	0.37**	-0.16	-0.06	0.38**	0.39***	0.25
PH					0.1	0.15	0.12	0.18	0.18	0.3	0.18
SP						-0.14	0.03	0.21	0.1	0.34*	-0.01
GPR							-0.17	0.05	0.46	0.14	0.33*
RPC								0.65***	0	-0.34*	0.22
CL									0.36**	0	0.32*
C										0.49***	0.43***
TSWT											0.09*
GY											

DTG- Days to Germination, GP- Germination Percentage, DTT= Days to Tassel Initiation, DTS- Days to Silking, DTA- Days to Anthesis, DTM- Days to Maturity, PH- Plant Height, SP- Shelling Percentage, GPR- Grain Per Row, RPC- Row Per Cob, CL- Cob length, C- Circumference, TSWT- Thousand Seed Weight, GY- Grain Yield, ***p=0.001>, **p= 0.01-0.001, *p=0.04-0.01

Correlation between all quantitative traits was analyzed using R-software. Days to germination and plant height were significantly and negatively (-0.31*) associated with each other whereas days to germination and germination percentage were negatively and high significantly (-0.5***) associated with each other. Moreover, days to germination were negatively and non-significantly correlated with days to cob formation (-0.03ns), days to tassel initiation (-0.2ns), days to silking (-0.18ns), days to anthesis (-0.24ns), days to maturity (-0.11ns) and plant height (-0.31ns).

Days to cob formation were strong undoubtedly and significantly correlated with days to tassel initiation (0.78***) and days to silking (0.86***) whereas considerable and sturdy related to days to anthesis (0.79**) and days to maturity (0.85**). Days to tassel initiation had fairly tremendous and became robust positively correlated with days to silking (0.83 ***) and days to maturity (0.85**) while extensive and positively correlated with days to anthesis (zero.87**). Days to silking became distinctly vast and positively associated with days to anthesis (0.83**) and days to maturity (0.53***). Days to anthesis and days to maturity have been fairly substantial mild positively correlated with each other (0.6**).

Thousand seed weight changed into exceedingly huge and correlated with days to adulthood (0.39***) and circumference (0.49***) while extensive and undoubtedly correlated with shelling percentage (0.34*). Likewise, it changed into full-size and negatively related to row in step with cob (-0.34*).

Grain yield becomes large and undoubtedly correlated with cob period (0.32*) and number of grain in keeping with row (0.33*) while particularly good sized and correlated with circumference (0.43***). Likewise, grain yield changed into non-large and undoubtedly correlated with days to maturity (0.25ns), plant peak (0.18ns), range of row according to cob (0.22ns), and thousand seed weight (0.09ns). Grain yield changed into non-extensive and negatively correlated with days to germination (-0.07ns), days to cob formation (-0.06ns), days to tasseling (-0.01ns), days to anthesis (-0.14ns) and non-significant but positive correlation with days to maturity (0.25).

Characters like plant height and days to silking (which was significant and negative in (Ghimire 2015)), circumference and row per cob (which was found positive and incredibly substantial in (Ghimire 2015) as well as thousand seed weight and cob length were not associated at all (r=0.00).

Grain yield ha-1 showed a positive correlation with plant height, ear height, ear length, ear girth, number of kernel rows per ear, number of kernel per row, ear weight and five hundred kernel weight (Ghimire & Timsina, 2015), just like our result. This approach that grain yield in keeping with hectare will increase with the boom in the price of plant top, ear height, ear length, ear girth, range of kernel rows in step with ear, a wide variety of kernel according to row, ear weight and five hundred kernel weight. Further, days to 50% silking, days to 50% tasseling and days to maturity confirmed a terrible correlation with grain yield ha-1(Ghimire & Timsina, 2015), that's much like our result except for days to maturity.

Thousand kernel weight exhibited a pretty huge and powerful correlation (r=0.753**) with cob circumference (Bonea & Bonciu, 2019) much like our result. Plant height showed a negative correlation with days to tasseling and days to silking (Bonia & Bonciu, 2019) which is not much like our result.

IV. CONCLUSION

Traits like days to germination, days to tassel initiation, days to silking, days to anthesis, plant height, grain per row, a row per cob, circumference, shelling percentage and thousand seed weight exhibited high heritability whereas traits like days to maturity, cob length and grain yield exhibited moderate heritability. Heritability of different traits and characterization of 14 maize genotypes in this study helps to describe the various traits along with their ability to transfer to their off-springs which will be very useful to the plant breeders for the crop improvement program.

The positive correlation among the traits signifies that with one unit increment in a trait another positively correlated trait also increases like days to tassel initiation and days to anthesis which have the highest positive correlation in our research. Among the tested single cross hybrids, RL-294/CML-226, RL-243/RML-140, RML-86/RML-146 and RML-138/RML-96 produced higher yields as compared to other genotypes. The superior parental lines are RML-86, RML-96, RML-146, RL-294 and CML-226. Variety RML-86/RML-146 showed comparatively better performance in most of the traits except for shelling percentage. Hence, these varieties of single cross hybrid of maize can be used for further studies for its possibilities and potential in Bharatpur, Chitwan. Single cross hybrids RML-234/RML-96 and RL-294/CML-226 had the smallest plant height but better yield production which implies they are possibly suitable hybrids for cultivation in Bharatpur, Chitwan.

ACKNOWLEDGEMENT

This research and thesis completion would not have been such a smooth process had it not been for constant support, help and encouragement from so many people around me. The research would not have been as exciting and as knowledgeable as it was without our friends and family who made sure to be present at every time possible. I am obliged to all of them for making sure to help me in any possible way, be it with their presence, knowledge, or moral support during the whole research period. We are thankful to Purbanchal Univesity for including research and thesis submission as a part of our curriculum and for providing us with a research fund. We hold utmost gratitude to all the faculty members and staff of NPI for their continuous support during my entire student life at NPI. We would like to have a special mention to the scientists of the National Maize Research Program, Rampur Mr. Mahendra Tripathi and Ms. Jharana Upadhya for providing the seeds of fifteen single cross hybrids of maize.

REFERENCES

[1] Adhikari, S. P., Shrestha, K. P., & Shrestha, S. R. (2018). Analysis of Socio-economic Factors and Profitability of Hybrid Maize Production in Eastern Terai of Nepal. *South Asian Journal of Social Studies and Economics*, 1–7.

[2] Bathla, S., Jaidka, M., & Kaur, R. (2019). Nutritive Value. *Maize-Production and Use*.

[3] Bonea, D., & Bonciu, E. (2019). Relationships between yield and associated traits of maize hybrids under drought stress and non-drought environments. *Agronomy Series of Scientific Research/Lucrari Stiintifice Seria Agronomie*, *61*(2).

[4] Dawadi, D., & Maize, I. (2015). *Prospects , Potentials and Problems of Hybrid Maize Production In Chitwan District : A Survey*. *July*.

[5] Dawadi, D. R., & Sah, S. K. (2012). *Growth and yield of hybrid maize (Zea mays L.) in relation to planting density and nitrogen levels during winter season in Nepal*.

[6] Dhakal, S., Adhikari, B. B., & Kandel, B. P. (2020). Performance of drought tolerant rice varieties in different altitudes at Duradada, Lamjung, Nepal. *Journal of Agriculture and Natural Resources*, *3*(1), 290–300. https://doi.org/10.3126/janr.v3i1.27199

[7] Gami, R. A., Soni, N. V, Chaudhary, S. M., Solanki, S. D., & Patel, P. C. (2018). Genetic studies of the kernel yield and attributing traits of single cross hybrid in yellow maize (*Zea mays L.*). *International Journal of Plant & Soil Science*, 1–7.

[8] Ghimire, B., & Timsina, D. (2015). Analysis of yield and

yield attributing traits of maize genotypes in Chitwan, Nepal. *World Journal of Agricultural Research*, *3*(5), 153–162.

[9] Joshi, B. K., Sapkota, S., Poudyal, K., Singh, D., Ghimire, K. H., & Paudel, M. N. (2016). Bibliography of Agricultural Plant Genetic Resources in Nepal. *National Agriculture Genetic Resources Center, Nepal Agricultural Research Council, Khumaltar, Kathmandu*.

[10] Kandel, B P, Adhikari, N. R., Adhikari, B. B., & Tripathi, M. (2018). Performance of hybrid maize in Chitwan Nepal. *Bangladesh J. Plant Breed Genet*, *31*(1), 43–51.

[11] Kandel, B P. (2021). Status, prospect and problems of hybrid maize (*Zea mays L.*) in Nepal: a brief review. *Genetic Resources and Crop Evolution*, *68*(1), 1–10.

[12] Kunwar, C. B., & Shrestha, J. (2014). Evaluating performance of maize hybrids in terai region of Nepal. *World Journal of Agricultural Research*, *2*(1), 22–25.

[13] Mohammadi, S. A., Prasanna, B. M., & Singh, N. N. (2003). Sequential path model for determining interrelationships among grain yield and related characters in maize. *Crop Science*, *43*(5), 1690–1697.

[14] Neupane, S., Karn, R., Khanal, P., Karki, S., & Sah, S. K. (2019). Performance of Maize Hybrids in Spring Season at Sonpur, Dang, Nepal. *Field Crop*, *2*.

[15] Sharma, D., Chaudhary, D., & Yadav, R. (2004). Hybrid maize development for highly potential production system of Nepal. *Proc. of the 24th National Summer Crop Research Workshop on Maize Research and Production in Nepal Organized by NMRP, NARC*, 216–219.

[16] Sharma, D., Paudel, D. C., Pandey, B. R., & Yadav, R. (2007). Hybrid maize research and development for food and feed security in Nepal. *Proceedings of the 25th National Summer Crops Research Workshop on Maize Research and Production in Nepal Held on June*, 21–23.

[17] Sharma, H. P., Dhakal, K. H., Kharel, R., & Shrestha, J. (2016). Estimation of heterosis in yield and yield attributing traits in single cross hybrids of maize. *Journal of Maize Research and Development*, *2*(1), 123–132.

[18] Thapa, M. (2013). Regulatory framework of GMOs and hybrid seeds in Nepal. *Agronomy Journal of Nepal*, *3*, 128–137.

[19] Thapa, R. (2021). A Detail Eview On Status And Prospect Of Maize Production In Nepal. *Food and Agri Economics Review (FAER)*, *1*(1), 52–56.