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Assessment of genetic component in maize (*Zea mays* L.) for fodder yield

Vishal Patil, Dr. Kevin Gawali, Amol Nagmote and Dr. Ashish Sarda

Vishal Patil
M.Sc. Student, Department of Genetics and Plant Breeding, School of Agricultural Sciences, G H Raisoni University, Saikheda, Madhya Pradesh, India

Dr. Kevin Gawali
Dean, Department of Genetics and Plant Breeding, School of Agricultural Sciences, G H Raisoni University, Saikheda, Madhya Pradesh, India

Amol Nagmote
Prof., Assistant Professor, Department of Genetics and Plant Breeding, School of Agricultural Sciences, G H Raisoni University, Saikheda, Madhya Pradesh, India

Dr. Ashish Sarda
Associate Professor, Department of Agricultural Statistics and Mathematics, School of Agricultural Sciences, G H Raisoni University, Saikheda, Madhya Pradesh, India

Corresponding Author:
Vishal Patil
M.Sc. Student, Department of Genetics and Plant Breeding, School of Agricultural Sciences, G H Raisoni University, Saikheda, Madhya Pradesh, India

Abstract

The investigation was carried During the Kharif season of 2021-22, at the Agricultural Research Farm of the Department of Genetics & Plant Breeding, School of Agricultural Sciences, GHRU (MP), 15 maize genotypes and checks (African tall) were planted in Randomized Completely Block Design (RCBD), with fifteen observations under study. That was Plant height, number of leaves per plant, leaf area, stem girth, inter nodal length, leaf stem ratio, brix's value, crude protein yield per plant, crude protein yield per plant per day, green fodder yield per plant per day, dry matter yield per plant, green fodder yield per plant, dry matter yield per plant, green fodder yield per plant Association and path coefficient study show that plant height, number of leaves per plant, green fodder production per plant per day, stem girth, dry matter yield per plant per day, and crude protein yield per plant per day all have a significant correlation and a larger direct influence. This implied that these personalities will improve. improve the efficacy of selection for increased fodder output in fodder maize.

Keywords: Correlation, path coefficient, genetic component, fodder yield

Introduction

Introduction Maize (*Zea mays* L.) is one of the world's most essential cereal crops for both humans and animals. It is a key component of animal feed, particularly in industrialised countries where livestock feed accounts for 78% of total maize output. Growing maize as a feed crop is regarded excellent since it grows rapidly, gives large yields, is tasty, rich in nutrients, and aids in increasing cow body weight and milk quality (Sattar *et al.*, 1994) [14]. When collected at the milk to early-dough stage, it includes 9-10% CP, 60-64 percent NDF, 38-41 percent ADF, 23-25 percent hemicellulose and 28-30 percent cellulose on a dry matter basis. when collected at the milk to early-dough stage on a dry matter basis Forage maize may be given safely at all phases of development without the risk of oxalic acid or prussic acid, as with sorghum.

Maize is a major food crop in the worldwide agricultural economy for both humans and animals. It has a great production potential and is also known as the miracle crop. After wheat and rice, it is the world's third largest cereal crop. It is utilised as cattle feed as well as for human consumption. The crop has both industrial and non-industrial use. Maize provides 10% of the world's protein and 19% of the calories from food crops. In terms of maize output, India ranks sixth. The crop is a significant component of animal feed, particularly in industrialised countries where livestock use 78 percent of total maize production. Maize is grown in practically every state in India. It encompasses around 6 million hectares. The entire area under fodder grown on an individual crop basis is 8.3 million hectares, of which maize provides around 900 hectares and green fodder output is approximately 30 to 35 tonnes per hectare (agropedia.iitk.ac.in, 2013). Madhya Pradesh is still in the early stages of fodder farming. Farmers in Madhya Pradesh allocated just 3% of their total crop area to fodder. Farmers use around 0.74 lakh hectares of fodder land for fodder crops.

For cattle, around 40 kg of green feed is required per animal per day. The country is currently suffering from a net shortfall of 35.6 percent green fodder, 10.95 percent dry crop waste, and 44 percent concentrated food components. By 2050, there will be a demand for 1012 million tonnes of green fodder and 631 million tonnes of dry fodder (IGFRI, Vision 2050). By 2050, with current rates of fodder resource expansion, there will be an 18.4 percent shortfall in green fodder and a 13.2 percent deficit in dry fodder. Green fodder supply should be expanded at a rate of 1.69 percent per year to make up the difference (IGFRI, Vision 2050).

There is an urgent need to develop complementary characters under selection, correlation, route analysis and main component analysis, which are being used effectively to determine the rate of different production components in fodder maize to select the best genotype in order to realise the potential of maize fodder. As a result, a reasonable method to improving fodder maize fodder output is required. Given these criteria for attaining these goals, the current study was conducted to assess the level of relationship and evaluate direct and indirect impacts.

Materials and Methods

The study was conducted during the Kharif season of 2021-22 at the Agricultural Research Farm of the Department of Genetics & Plant Breeding, School of Agricultural Sciences, GHRU (MP), with 15 maize genotypes and checks (African tall) planted in Randomized Block Design (RBD) and fifteen observations under study, namely, days to 50% tasseling, days to 50% silking, plant height, number of leaves per plant, leaf area, stem girth, inter nodal le According to Johnson *et al*., the correlation coefficient at the phenotypic level was computed from the variance and covariance (1955). The path coefficients analysis was used to calculate the direct and indirect effects of various contributing traits on green fodder yield and dry matter yield (Dewey and Lu, 1959) [5].

1. Experimental site

The current study was conducted in the Agricultural Research Farm of the Department of Genetics and Plant Breeding, School of Agricultural Sciences, GHRU, Saikheda, during the kharif season of 2021.

2. Experimental location and climate

The experiment was carried out at GH Raisoni University, Saikheda, which is located at 21°31'11"N 78°45'54"E. The experimental field is located in the Dhoda Borgaon district of Chhindwara, Madhya Pradesh, India. The site is elevated over 478 m mean sea level on average. This region is located in the state's climatic zone's central plain zone.

3. Experimental material

The experimental material consists of 15 Maize genotypes, one of which is a control (African Tall). These genotypes were produced in three replications using randomised block design (RBD). The soil at the experimental site was loamy with a pH range of 6.5 to 7.8. The ground was prepped by harrowing twice and planking once. On August 20, 2020, the genotypes were seeded on raised beds. The row to row and plant to plant spacing was preserved at 60×30cm 2.

4. Correlation coefficient analysis

The correlation coefficient is the reciprocal connection of variables that does not indicate a cause and effect relationship. Simple correlation coefficients were calculated at the genotypic and phenotypic levels between two characteristics using the equations provided by Al-Jibouri *et al*. (1958).

Genotypic correlation between traits x and y:

$$Rxy\ (g) = \frac{\sigma^2 g\ (xy)}{\sqrt{\sigma g^2\ x\ \sigma g^2 y}}$$

Phenotypic correlation between traits x and y:

$$Rxy\ (p) = \frac{\sigma^2 p\ (xy)}{\sqrt{\sigma p^2\ x\ \sigma p^2 y}}$$

5. Path analysis

Path Co-efficient analysis is nothing more than a standardised partial regression Co-efficient. Wright established the notion of Path analysis, which divides Correlation into measurements of direct and indirect impacts of independent factors or dependent variables (1921).

However, Dewey and Lu initially utilised this approach for plant selection (1959). Path analysis was performed by estimating the Correlation Coefficient in all feasible combinations of dependent variables. The path coefficient was calculated by solving the equation in matrix form.

Results and Discussion

Correlation analysis

Correlation studies are extremely important in breeding programmes. The correlation index was initially proposed by Galton (1988) to describe the degree of relationship between two variables. The degree of linkage influences the success of the selecting process as well. The correlations that are reported in this study have been investigated in this study (Table 1 & 2) Plant height has a highly substantial and positive link with inter nodal length, green fodder yield per plant per day, crude protein yield per plant per day, crude protein yield per plant, dry matter yield per plant, dry matter yield per plant per day, and dry matter yield per plant per day. Plant height also had a strong negative link with brix value and a weak negative correlation with stem girth. The number of leaves per plant is significant and correlates favourably with inter nodal length. It also has a highly significant and negative link with dry matter yield per plant, followed by a strong negative correlation with crude protein yield per plant, crude protein yield per plant per day, and leaf stem ratio. The leaf stem ratio had a highly significant and positive correlation with the dry matter yield per plant per day, which was followed by a significant positive correlation with the crude protein yield per plant, green fodder yield per plant per day, crude protein yield per plant per day and dry matter yield per plant.

Green fodder yield per plant per day correlated substantially with dry matter yield per plant, followed by crude protein yield per plant, crude protein yield per plant per day, and dry matter yield per plant per day. It was also shown that fodder production had a significantly substantial and inverse relationship with brix value. Dry matter yield per plant per day exhibited a very strong significant and positive link with crude protein yield per plant per day, which was followed by crude protein yield per plant and dry matter yield per plant per day. It was also discovered that the dry matter yield per plant had a substantial and inverse relationship with the brix value. Dry matter yield per plant per day demonstrated a highly significant and positive link with crude protein yield per plant per day, crude protein yield per plant, green fodder yield per plant and brix's value. The crude protein yield per plant has a very strong and positive association with the crude protein yield per plant per day and the green fodder yield per plant. There was, however, a significantly significant negative connection with brix value. The connection between crude protein production per plant per day and green fodder yield per plant was extremely significant and favourable. It also demonstrated an extremely substantial negative association with the brix value.

Path coefficient

By dividing the correlation, path coefficient analysis allows separation of the direct influence and its indirect effects via other characteristics (Wright, 1921) [19]. As a result, the current inquiry focused on this critical goal. The phenotypic and genotypic correlation were evaluated based on the data recorded on the genotype in the current study to identify the direct and indirect influence of yield and yield contributing features. Green fodder production per plant was used as the dependent variable in a path coefficient analysis. Path coefficient analysis was performed in the current study (Table 3 & 4) with green fodder production per plant as the dependent variable.

The results showed that crude protein production per plant per day had a significant positive direct influence on green fodder yield per plant. Crude protein yield per plant per day exerted the most influence, followed by days to 50% tasseling, stem girth, green fodder yield per plant per day, and dry matter yield per plant per day. Leaf area and dry matter output per plant have a little beneficial direct influence. Crude protein output per plant has a significant negative direct influence, ranging from days to 50% silking. The leaf stem ratio has a moderately detrimental effect. Other factors that had no influence were plant height, number of leaves per plant, and inter nodal length.

Jain and Patel (2012) [8] for leaf area, number of leaves per plant, days to 50 per cent flowering and plant height, Jain and Patel (2013) [8] for green fodder yield per plant and dry matter yield, Singh *et al*., (2016) [16] for leaf area had direct effect on fodder yield. While, its negative direct effects were observed by Borad *et al*., (2007) [3] for plant height, inter nodal length and leaf stem ratio. On the basis of correlation and path coefficient analysis it is revealed that stem girth, green fodder yield per plant per day, dry matter yield per plant per day and crude protein yield per plant per day and crude protein yield per plant per day had significant correlation and higher direct effect. This indicated that these characters will enhance the effectiveness of selection for higher fodder yield in Maize. However, contradictory result was reported by Kumar and Singh (2004) [11] for days to 50 per cent silking, Srivas and Singh (2004) [17] for plant height, leaf area and number of leaves per plant, Borad *et al*., (2007) [3] for inter nodal length and leaf stem ratio. While, Shelake *et al*., (2005) [15] observed that crude protein yield had highest negative direct effect.

Table 1: Estimates of genotypic correlation coefficients among yield and its attributing traits in fodder Maize

Characters	Days to 50% tasseling	Days to 50% silking	Plant Height(cm)	Number of leaves per plant	Leaf area (cm2)	Internodal length	Stem girth (cm)	Leaf stem ratio	GFY/Plant /day	DMY/plant	DMY/plant /day (g)	CPY/plant (g)	CPY/plant /day (g)	Brix value (%)	GFY/plant (g)
Days to 50% tasseling	1.0000	-0.0301	-0.0091	-0.2286*	-0.4335**	-0.2675*	-0.1669	-0.2221*	-0.4225**	0.5222**	-0.4892**	0.4968**	0.4248**	-0.2910*	0.4704**
Days to 50% silking		1.0000	-0.4048**	-0.1558	0.0565	0.5225**	-0.1042	-0.0003	-0.0758	-0.0490	0.0585	0.3553**	-0.3478**	-0.4303**	-0.5619**
Plant Height (cm)			1.0000	0.6054**	-0.015	-0.0577	-0.2497*	-0.2239*	-0.0688	0.4759**	0.4485**	0.1800	0.6785**	0.4537**	0.1963
Number of leaves per plant				1.0000	0.0399	-0.0040	-0.2498*	-0.2077*	-0.1060	0.5640**	0.5219**	0.3658**	0.6710**	0.5124**	0.5905**
Leaf area (cm^2)					1.0000	0.3282**	0.6402**	0.4163**	-0.2356*	0.8370**	0.1642	-0.0679	0.6242**	-0.4006**	-0.6263**
Internodal length						1.0000	0.4484**	0.6080**	0.1337	-0.0988	0.6691**	0.9912**	-0.0144	0.2871*	0.3269**
Stem girth(cm)							1.0000	0.5333**	0.4505**	-0.2165*	0.2450*	0.1372	-0.0326	0.0480	0.1160
Leaf stem ratio								1.0000	0.5007**	-0.0233	0.3224*	0.4035**	-0.0411	0.2511*	0.2270*
GFY/Plant/day									1.0000	0.4852**	0.4302**	0.6460**	0.5111**	0.4858**	0.6643**
DMY/plant										1.0000	0.3576**	0.5316**	0.8022**	0.8163**	0.8016**
DMY/plant/day (g)											1.0000	0.9852**	0.3761**	0.4632**	0.4414**
CPY/plant (g)												1.0000	0.3277**	0.4006**	0.1963
CPY/plant/day (g)													1.0000	0.6033**	0.5316**
Brix value (%)														1.0000	0.6672**
GFY/plant (g)															1.0000

Significant at 5% level = *Significant at 1% level = **

Table 2: Estimates of phenotypic correlation coefficients among yield and its attributing traits in fodder Maize

Characters	Days to 50% tasseling	Days to 50% silking	Plant Height (cm)	Number of leaves per plant	Leaf area (cm^2)	Internodal length	Stem girth (cm)	Leaf stem ratio	GFY/Plant /day	DMY/plant	DMY/plant /day (g)	CPY/plant (g)	CPY/plant /day (g)	Brix value (%)	GFY/plant (g)
Days to 50% tasseling	1.0000	-0.0639	-0.2420*	-0.1682	-0.1747	-0.2814*	-0.2092*	-0.1820	-0.3701**	0.1530	-0.2623*	0.2233*	0.2762*	-0.0518	0.2827*
Days to 50% silking		1.0000	-0.1372	-0.1188	0.1761	0.0214	0.0142	-0.0662	-0.0561	0.0586	0.0122	0.4608**	-0.2685**	-0.1877	-0.1261
Plant Height (cm)			1.0000	0.8967**	0.0932	-0.0745	-0.2145*	-0.1431	-0.0009	0.3846**	0.4111*	0.1906	0.4201**	0.4623**	0.4432**
Number of leaves per plant				1.0000	0.0589	-0.0222	-0.1786	-0.1215	0.0574	0.4048**	0.3919**	0.1312	0.4269**	0.4186**	0.3806**
Leaf area (cm^2)					1.0000	0.1272	0.3414**	0.3468**	-0.1991	-0.4633**	0.1410	0.0721	-0.3298**	-0.2756*	-0.1511
Internodal length						1.0000	0.1765	0.2499*	0.0797	-0.0598	0.5479**	0.3155**	-0.1288	0.1084	0.0808
Stem girth (cm)							1.0000	0.8122**	0.2825*	-0.1386	-0.0543	0.2118*	-0.0954	0.0790	0.0283
Leaf stem ratio								1.0000	0.3649**	-0.0807	0.0431	0.2866*	-0.0533	0.0694	0.0865
GFY/Plant/day									1.0000	0.3373**	0.3862*	0.2765*	0.4482**	0.4589**	0.3528**
DMY/plant										1.0000	0.4362**	0.4433**	0.5444**	0.5108**	0.5309**
DMY/plant/day (g)											1.0000	0.3477**	0.3071**	0.3237**	0.3436**
CPY/plant (g)												1.0000	0.1833	0.1844	0.2929*
CPY/plant/day (g)													1.0000	0.8026**	0.8651**
Brix value (%)														1.0000	0.8189**
GFY/plant (g)															1.0000

Significant at 5% level = *Significant at 1% level = **

Table 3: Genotypic path coefficients showing direct and indirect effects of different characters on green fodder yield per plant (g) in fodder Maize

Characters	Days to 50% tasseling	Days to 50% silking	Plant Height (cm)	Number of leaves per plant	Leaf area (cm^2)	Internodal length	Stem girth (cm)	Leaf stem ratio	GFY/Plant /day	DMY/plant	DMY/plant /day (g)	CPY/plant (g)	CPY/plant /day (g)	Brix value (%)	GFY/plant (g)
Days to 50% tasseling	0.2176	-0.0006	-0.0002	-0.0046	-0.0087	-0.0054	-0.0033	-0.0045	-0.0850	0.0105	0.0098	0.0100	0.0085	-0.0058	0.4704
Days to 50% silking	0.0078	0.1931	-0.0782	-0.0301	0.0109	0.1009	-0.0201	-0.0001	-0.0146	-0.0095	0.0113	0.00686	-0.0672	-0.0831	-0.5619
Plant Height (cm)	0.0004	-0.3434	0.8482	0.9375	-0.0128	0.0489	-0.2118	-0.1899	-0.0584	0.4036	0.3804	0.1527	0.5755	0.3848	0.4963
Number of leaves per plant	0.0145	0.0956	-0.6786	-0.6139	-0.0245	0.0244	0.1534	0.1275	0.0651	-0.3462	-0.3204	-0.2246	-0.4119	-0.3145	0.5905
Leaf area (cm^2)	0.1448	-0.0147	0.0039	-0.0104	-0.2597	-0.0852	-0.1663	-0.1081	0.0612	0.2174	-0.0426	0.0176	0.1621	0.1040	-0.6263
Internodal length	0.0603	-0.0224	-0.0025	0.0017	-0.0141	-0.0429	-0.0193	-0.0261	-0.0057	0.0042	-0.0287	-0.0426	0.0006	-0.0123	0.3269
Stem girth (cm)	0.0740	0.0066	0.0158	0.0158	-0.0405	-0.0283	-0.0632	-0.0780	-0.0285	0.0137	-0.0155	-0.0087	0.0021	-0.0030	0.1160
Leaf stem ratio	-0.1234	0.0001	0.0748	0.0694	-0.1390	-0.2031	-0.4119	-0.3340	-0.1672	-0.0078	-0.1077	-0.1348	0.0137	-0.0839	0.2270
GFY/Plant/day	-0.0075	0.0171	0.0155	0.0239	0.0531	-0.0301	-0.1075	-0.01128	-0.2253	-0.1093	-0.0969	-0.1455	-0.1151	-0.1094	0.6643
DMY/plant	0.9765	0.0217	-0.2110	-0.2501	0.3711	0.0438	0.0960	-0.0103	-0.2151	-0.4434	-0.1586	-0.2357	-0.4443	-0.3619	0.8016
DMY/plant/day (g)	-0.3599	-0.0325	0.2491	0.2898	0.0912	0.3715	0.1361	0.1790	0.2389	0.1986	0.5553	0.5471	0.2089	0.2572	0.4414
CPY/plant (g)	-0.0051	0.0063	0.0032	0.0065	-0.0012	0.0176	0.0024	0.0072	0.0115	0.0094	0.0175	0.0178	0.0058	0.0071	0.1946
CPY/plant/day (g)	-0.0911	-0.6504	0.2687	0.2547	-0.1671	-0.0269	-0.0610	-0.0769	0.9557	0.8739	0.7033	0.6127	0.8698	0.2500	0.1316
Brix value (%)	-0.0996	0.3165	-0.3338	-0.3769	0.2947	-0.2112	-0.0353	-0.1847	-0.3574	-0.6005	-0.3407	-0.2947	-0.8852	-0.7356	0.2672
GFY/plant (g)	0.3620	-0.0522	-0.0961	-0.1221	0.1249	0.2098	0.1127	0.1444	-0.0111	-0.1673	0.0352	0.0554	-0.1002	-0.0907	-0.3246

Significant at 5% level = * Significant at 1% level = **

Table 4: Phenotypic path coefficients showing direct and indirect effects of different characters on green fodder yield per plant (g) in fodder Maize

Characters	Days to 50% tasseling	Days to 50% silking	Plant Height (cm)	Number of leaves per plant	Leaf area (cm^2)	Internodal length	Stem girth(cm)	Leaf stem ratio	GFY/Plant /day	DMY/plant	DMY/plant /day (g)	CPY/plant (g)	CPY/plant /day (g)	Brix value (%)	GFY/plant (g)
Days to 50% tasseling	0.1103	-0.0071	-0.0267	-0.0186	-0.0193	-0.0310	-0.0231	-0.0201	-0.0408	0.0169	0.0289	0.0246	0.0305	-0.0057	0.2827
Days to 50% silking	0.0005	-0.599	0.0082	0.0071	-0.0105	-0.0013	-00008	0.0040	0.0034	-0.0035	-0.0007	-0.2760	0.0161	0.0112	-0.1261
Plant Height (cm)	0.0616	-0.0321	0.2337	0.2095	0.0218	-0.0174	-0.0501	-0.0334	-0.0002	0.0899	0.0961	0.0445	0.0982	0.1080	0.4432
Number of leaves per plant	0.0146	0.0319	-0.2407	-0.2685	-0.0158	0.0059	0.0479	0.0326	-0.0154	-0.1087	-0.1052	-0.0352	-0.1146	-0.1124	0.3806
Leaf area (cm^2)	0.0397	-0.0015	-0.0008	-0.0005	-0.0083	-0.0011	0.0028	-0.0029	0.0017	0.0039	-0.0012	-0.0006	0.0027	0.0023	-0.1511
Internodal length	0.0787	-0.0055	0.0190	0.0056	-0.0324	-0.2547	-0.0449	-0.0636	-0.0203	-0.0152	-0.1395	-0.0803	-0.0328	-0.0273	0.0808
Stem girth (cm)	0.0155	-0.0012	0.0186	0.0155	-0.0296	-0.0153	-0.0867	-0.0704	-0.0245	0.0120	0.0047	-0.0184	0.0083	-0.0068	0.0283
Leaf stem ratio	-0.0705	0.0150	0.0325	0.0276	-0.0788	-0.0568	-0.1844	-0.2271	-0.0829	-0.0183	-0.0098	-0.0651	-0.0121	-0.0158	0.0865
GFY/Plant/day	-0.0685	0.0157	0.0003	-0.0160	0.0557	-0.0223	-0.0790	-0.1020	-0.2796	0.0946	-0.1080	-0.0773	-0.1253	-0.1283	0.3528
DMY/plant	0.1721	-0.0043	-0.0285	-0.0300	0.0343	-0.0044	0.0103	0.0060	-0.0250	-0.0741	-0.0323	-0.0329	-0.0403	-0.0379	0.5309
DMY/plant/day (g)	0.0054	-0.0047	0.1593	0.1518	0.0546	0.2123	-0.0210	0.0167	0.1496	0.1690	0.3874	-0.1347	0.1190	0.1254	0.3436
CPY/plant (g)	-0.0347	0.0853	0.0353	0.0243	-0.0133	0.0584	0.0392	0.0530	0.0512	0.0820	0.0643	0.1850	0.0339	0.0341	0.2929
CPY/plant/day (g)	-0.0421	-0.3022	0.4727	0.4803	-0.3711	0.1449	-0.1073	0.0600	0.5043	0.6126	0.3456	-0.0201	0.1252	0.9030	0.8651
Brix value (%)	-0.0133	-0.0039	0.0095	0.0086	-0.0057	0.0022	0.0016	0.0014	0.0094	0.0105	0.0067	0.0038	0.0165	0.0206	0.8189
GFY/plant (g)	0.0596	0.0075	-0.0398	-0.0358	0.0668	0.0658	0.0715	0.0729	0.0087	-0.0679	0.0193	0.0072	-0.0827	-0.0566	-0.2025

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