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Correlation and path coefficient analyses of Rhodes grass (*Chloris gayana*) genotypes at Mechara Agricultural Research Center on Station

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ABSTRACT

Sympathetic the nature and degree of association between dry matter yield and dry matter yield related traits is the essential to study for any underutilized forage improvements of sustainable genetic enhancement. Though, there is a lack of sufficient evidence on dry matter yield and related trait correlation and path coefficient analysis of Rhodes grass in Ethiopia generally and in west Hararghe particularly. To fill the existing knowledge gap, the present study was conducted to determine the nature and degree of phenotypic and genotypic correlation and path coefficient analysis among 10 quantitative traits. A total of 25 Rhodes grass genotypes were tested in 5 × 5 simple lattice design at Mechara Agricultural Research Center during 2023/2024 rainy season. Phenotypic coefficients of variation were higher than their corresponding genotypic coefficient of variation, indicating that the little influence of environment on the expression of these characters. The highest phenotypic and genotypic variance value was recorded for days to maturity. Stand vigor exhibited highest value of genetic advance as percentage of mean followed by number of leaf per plant. The chief genotypic coefficient variation, were recorded from days to maturity flowed by plant height and highest phenotypic coefficient variation were recorded from plot cover followed by days to maturity. Phenotypically and genotypic ally dry matter yield was highly positive significant associated with of plot cover, stand vigor, leaf per plant and showed highly negative significant with days to 50% emergence. The results of phenotypic path coefficient analysis showed that stand vigor and leaf per plant had exerted moderate positive direct effect on dry matter. stand vigor followed by plant height, plot cover and leaf per plant had exerted high and positive direct effect on dry matter yield and genotypic path analysis showed stand vigor followed by plant height, plot cover and leaf per plant had exerted high and positive direct effect on dry matter yield.

This indicates that selection based on these traits could be more effective to maximize dry yield.

Keywords: Genotypic correlation; Genotypic coefficient variation; Phenotypic correlation; Phenotypic coefficient variation; Dry matter

INTRODUCTION

Rhodes grass is one of the perennial improved grass which can be grown on-farm and used by small-holder farmers [1]. It is high-yielder, fast growing, palatable and deep rooted grass which grows under a wide range of environmental conditions and is useful in cut-and-carry system and for open grazing and is very popular for hay making. It does well in low rainfall areas and is drought tolerant; stands heavy grazing and cutting; very palatable. Rhodes grass is very palatable and has good nutritive value and has high protein content (9-12%) with an average water intake of about 600 mm to 1200 mm. Sowing Rhodes grass for more than three years gives rise to development [2].

Due to its deep roots, it can withstand long dry periods (over 6 months) and up to 15 days of flooding. It grows well on a drained moderate to high fertility soils and survives on infertile soils although it is unproductive and may eventually die out particularly if grazed regularly. Rhodes grass is a full sunlight species, which does not grow well under shady environments [3,4]. Growth performance of Rhodes grass varies with type of cultivar, age of plant and other environmental factors (FAO, 2009). Rhodes grass productivity generally ranges from 7-25 tons of DM ha^{-1} per year, depending on variety, soil fertility, environmental conditions and cutting frequency. However; there is only one variety of Rhodes grass in Ethiopia which was released by Holota Agricultural Research Center in 1984 and accepted by huge farmer and private farms.

The productivity of the forage is low due to many limiting factors such as shortage of adapted high yielding varieties, using unknown seed sources and poor-quality seeds, lack of genotypes. Diversity studies are an essential step and pre-requisite in forage breeding and could produce valuable knowledge for forage improvement programmers. The presence of genetic variability in forage is essential for its further improvement by providing options for the breeders to develop new varieties and hybrids. Hence, generating information on the degree and pattern of genetic diversity of the Rhodes grass genotypes were less/no evaluated scientifically using either molecular or morphological studies in Ethiopia. Genotypic and phenotypic correlations are of value to indicate the degree of which various morpho-physiological characters are associated with economic productivity. A correlation coefficient is useful in quantifying the magnitude and direction of components influence in the determination of main characters. Analysis of genetic diversity using quantitative or predictive methods has been used in the analysis of composition of populations. However, the magnitude of this diversity has not yet evaluated. Therefore, the objectives of this study were, to estimate phenotypic and genotypic variations, Genetic variability, heritability, expected genetic advance, correlation coefficient of yield, yield related traits in the Rhodes grass make the necessary information available for future breeding and forage improvement programs in genotype.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Mechara Agricultural Research Center (McARC) experimental field during 2023/2024 cropping season under rain fide condition. It is located at about 434 km away from Addis Ababa. McARC is located between 80.34’ N latitude and 40.20’ E longitude m.a.s.l. The altitude of the area is about 1760 m.a.s.l. It has a warm climate with annual mean maximum and minimum temperature is 31.8℃ and 14℃, respectively. The mean annual rainfall is 1100 mm. Daro labu district is characterized mostly by flat and undulating land features and the rainfall is erratic; onset is unpredictable, its distribution and amount are also quite irregular. The soil of the experimental site is well-drained slightly acidic Nit sol.

Experimental materials

Twenty-four genotypes along with one-released variety as check (Masaba) were used in this study. The genotypes brought form International Livestock Research Institute, Addis Ababa, Ethiopia.

Experimental design and trial management

The experiment was laid out in 5×5 simple lattice design. Seeds of each genotype were sown in the main field in a plot size of 3 m^2 (2 m×1 m) with consisted of four rows. The distance between block, plot and rows was 1 m, 1 m and 25 cm respectively. Sowing was done by drilling the seed in the furrow (line) at depth of 1-2 cm with the seed rate of 12 kg/ha. It was sown on well prepared seed bed and sowing similar to that of teff. Then the seed was covered with thin soil by over passing light sticks and fingers over the furrows. 100 kg/ha of NPS fertilizer was applied at the time of sowing and 50 kg/ha urea after establishment. Before sowing, appropriate experimental site was be selected, ploughed and leveled for ease of layout and managements. All managements were applied uniformly for all genotypes at necessary time.

Data collected

Growth: The developmental process such as days to emergence, days to 50% flowering and maturity stage will be recorded.

Plant height (cm): The average plant height will be measured from ground to the tip of the main stem. The measurement will be done by taking ten random plants at 50% flowering stage from the two middle rows of each plot.

Number: Counts of plant number, number of leaves per plant and number of tillers per plant will be recorded at 50% flowering stage. Ten plants from each plot in a quadrant (0.25 m^2) will be taken to measure number of tillers per plant, number of leaves per plant and number of leaves per tiller. Average results from each measurement will be recorded to evaluate the performance [5].

Biomass yield: The vegetation from each plot will be sampled using a quadrant of 0.25 m^2 (0.5 m x 0.5 m) sizes during a predetermined sampling period (50% flowering stage). The quadrant will be randomly thrown on a plot and the average weight from the quadrant will be used to determine the biomass yield. The average weight of the fresh fodder will be used and extrapolated into dry matter yield per hectare (t/ha). Three adjacent rows from the center of each plot will be taken at 50% flowering stage for fodder yield evaluation [5]. The fresh harvested biomass will be chopped into small pieces using sickle and a sub-sample of 250 g was taken and partially dried in an oven at 60˚C for 48 hrs for further dry matter analysis.

DM=Yield (t/ha)=(10*TFW*SSDW)/(HA*SSFW) Where:

10=Constant for conversion of yields in kg/m^2 to t/ha

TFW=Total Fresh Weight from harvesting area (kg)

SSDW=Sub-Sample Dry Weight (g)

HA=Harvest area (m^2)

SSFW=Sub-Sample Fresh Weight (g)

Data analysis

The data were subjected to analysis of variance by using R-software to check the presence of variation among the genotypes for the tested traits and then based on the ANOVA result; all highly significant traits were promoted for correlation and path coefficient analyses. Phenotypic and genotypic correlations between dry matter and dry matter yield related traits were estimated using the method described by Miller et al.

The phenotypic correlation coefficient= $(rp_{xy}) = \frac{}{\sqrt{(\quad px)(\sigma \; py)}}$

The genotypic correlation coefficient = $(rg_{xy}) = \frac{}{\sqrt{(\quad gx)(\sigma \; pg)}}$

Where, rp_{xy} is phenotypic correlation coefficient and Genotypic correlation coefficient (rg_{xy}) between character x and y; Cov_{pxy} and Cov_{gxy} are phenotypic covariance and genotypic covariance between character x and y; pg are genotypic variances traits x and y; $\sigma^2 px$ and $\sigma^2 py$ are phenotypic variances of traits x and y, respectively. The coefficient of correlation was tested using tabulated value at n−2 degree of freedom, at 5% probability level, the number of treatments (genotypes) as described by Robertson A [6].

RESULTS AND DISCUSSION

Genotypic and phenotypic correlations coefficient analysis

Estimates of phenotypic and genotypic correlation coefficients between each pair of traits are presented in Table 1. Plant height is one of the main components in any breeding program as it influences plant vigour and stature by both genetic and environmental factor. Highly visualized positive phenotypic correlation for plant height was recorded with number of leaf per plant. Genotypic ally, plant height showed positive significant correlation with stand vigor, leaf to stem ratio and days to 50% flowering.

Table 1. Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among 10 traits.

Traits	PC	SV	LSR	ED	DF	PH	NLPP	MD	SY	DRY
PC		1.466**	6.656**	-1.229**	0.808**	2.527**	1.561**	0.886**	-6.374**	1.621**
SV	0.873**		3.059**	-0.972**	0.445*	0.486*	0.659**	0.488*	13.394**	0.858**
LSR	0.421**	0.449**		-4.741**	3.824**	5.397**	3.299**	1.301**	-335.30**	1.0381**
ED	-0.499*	-0.515**	-0.193ns		-0.623**	-0.521**	-0.439*	0.04ns	44.014**	-0.694**
DF	0.185ns	0.169ns	-0.018ns	-0.386**		0.674**	0.719**	0.169ns	2.128**	0.278ns
PH	2.527**	0.3073*	0.137ns	-0.203ns	0.369**		0.785**	0.674**	-6.264**	0.247ns
NLPP	0.441**	0.412**	0.193ns	-0.346*	0.445**	0.404**		0.052ns	-29.459**	0.886**
DM	0.098ns	0.117ns	0.01ns	-0.099ns	0.041ns	0.125ns	0.041ns		65.348**	0.244ns
SY	0.099ns	0.129ns	0.219ns	0.212ns	-0.09ns	-0.122ns	-0.130ns	-0.033ns		-101.54**
DMY	0.546**	0.566**	0.177ns	-0.37**	0.158ns	0.168ns	0.439**	-0.10ns	0.053ns	

Note: PC: Plot Cover; SV: Sand Vigor; DMY: Dry Matter Yield; LSR: Leaf to Steam RATIO; DM: Days to 50% Emergency; DF: Days to 50% Flowering Date; PH: Plant Height; NLPP: Number of Leaf per Plant; MD: Maturity Date; SY: Seed Yield

Plot cover exhibited significant positive phenotypic correlated with stand vigor, leaf to stem ratio, plant height, number of leaf per plant, days to 50% flowering were showed negatively significant while seed yield (0.098NS) showed positive non-significant, however, non-significant positive relationship was observed with days to maturity. Genotypic relationship of plot cover was highly significant with stand vigor, leaf to stem ratio, plant height, number tiller per plant, dry matter yield, while the genotypic correlation was negative with days to 50% emergence and seed yield.

Least days to maturity in forage harvest is the best indication for a desirable variety, because it contracts forage duration. Genotypic correlation for days to reach physiological maturity was highly significant positive correlated with plot cover, stand vigor, leaf to stem ratio, plant height. However, seed yield and dry matter yield exhibited negative non-significant phenotypic association. Number of leaf influencing biomass yield and especially biological yield in terms of dry matter production. Genotypic association for tillers plant-was highly significant and positive correlated with Plot cover, stand vigor. Leaf to stem ratio, plant height, days to 50% flowering. However, it was highly significant negative correlated with longer days to 50% emergence. Phenotypically tillers plant showed highly significant positive correlations with dry matter yield.

Genotypic correlation of days to 50 % flowering showed highly prominent positive association with plot cover, stand vigor, leaf to stem ratio, whereas, days to 50 % flowering showed highly negative correlation with days to 50% emergence. A genotypic ally day to 50 % flowering was highly and significantly positive correlated with plant height and number tiller per plant.

Phenotypically dry matter yield was highly positive significant associated with numbers of plot cover, stand vigor, number tiller per plant, even though days to 50% emergence showed highly negative significant. Genotypic ally it was significantly positively correlated with, plot cover, stand vigor, leaf to stem ratio, number leaf per plant, though it was significantly negative correlated with days to 50% emergence and seed yield.

Genotypically seed yield was highly significant positive correlated with of stand vigor, days to 50% emergence, days to 50 % flowering and days to maturity. However, negatively highly significant associated with plot cover, plant height, number tiller per plant, leaf to stem ratio. Phenotypically it was non-significantly positively correlated with, plot cover stand vigor, leaf to stem ratio, and days to 50% emergence. Stand vigor shown highly positive phenotypic co-relationship with dry matter yield, leaf to stem ratio, leaf number and plot cover, but positively non-significant correlation with days 50% flowering, days to maturity and seed yield. Genotypic ally stand vigor showed high significant positive linkage with leaf to stem ratio, days to 50% flowering, Plant height, number of tiller, days to maturity and dry matter yield, whereas, significant negative linkage was exhibited with days to 50% emergence and seed yield.

Genotypic path coefficient analysis of dry matter yield with other traits

The results of genotypic path coefficient analysis of dry matter yield with other 9 traits are presented in Table 2. According to Muchero et al., who classified path coefficients (0.00-0.09) negligible, (0.10-0.19) low (0.20-0.29) moderate, and (0.30-0.99) high and more than 1.00 is very high [7]. In the present investigation, stand vigor followed by plant height, plot cover and leaf per plant had exerted high and positive direct effect on dry matter yield, also leaf per plant and seed yield had exerted moderate and neglible positive direct effect on dry matter yield. However, leaf to stem ratio, days to 50% emergence, days to 50% flowering, days to maturity had exerted negative direct effect on dry matter yield [8-10].

Table 2. Genotypic path coefficient analysis for direct (bold diagonal) and indirect effect (off diagonal) 9 traits studied on Rhodes grass dry matter yield.

Trait	PC	SV	LSR	ED	FD	PH	NLPP	MD	SY
PC	0.338	1.455	-0.43	0.019	-0.519	2.154	0.331	-1.637	-0.089
SV	0.495	0.992	-0.197	0.015	-0.286	0.414	0.139	-0.902	0.187
LSR	2.249	3.036	-0.065	0.072	-2.46	4.601	0.7	-2.403	-4.693
ED	-0.415	-0.964	0.306	-0.015	0.401	-0.444	-0.093	-0.084	0.616
FD	0.273	0.441	-0.247	0.009	-0.643	0.575	0.153	-0.312	0.029
PH	0.854	0.482	-0.349	0.008	-0.434	0.852	0.166	-1.245	-0.087
NLPP	0.528	0.654	-0.213	0.007	-0.463	0.669	0.212	-0.095	-0.412
MD	0.299	0.485	-0.084	-0.001	-0.109	0.575	0.01	-1.847	0.914
SY	-2.16	13.355	21.76	-0.679	-1.375	-5.364	-6.277	-121.27	0.014
Residual	1.309								

Note: PC: Plot Cover; SV: Sand Vigor; BY: Biomass Yield; DM: Dry Matter; LSR: Leaf to Steam Ratio; ED: Emergency Date; FD: 50% Flowering Date; PH: Plant Height; NLPP: Number of Leaf per Plant; MD: Maturity Date

Phenotypic path coefficient analysis of dry matter with other traits

The results of phenotypic path coefficient analysis of seed yield with other 9 traits are presented in Table 3. Stand vigor and leaf per plant had exerted moderate positive direct effect on dry matter [11,12]. Also plot cover, and seed yield had exerted low and negligible positive direct effect on dry matter respectively. However, leaf to stem ratio, days to 50% emergence, days to 50% flowering, plant height and days to maturity had negative direct effect on dry matter yield.

Table 3. Phenotypic path coefficient analysis for direct (bold diagonal) and indirect effect (off diagonal) 9 traits studied on Rhodes grass dry matter yield.

Traits	PC	SV	LSR	ED	FD	PH	NLPP	MD	SY
PC	0.13	0.33	-0.053	0.052	-0.013	-0.013	0.123	-0.017	0.006
SV	0.113	0.378	-0.057	0.054	-0.011	-0.015	0.114	-0.019	0.008
LSR	0.054	0.169	-0.127	0.02	0.001	-0.007	0.053	-0.002	0.013
ED	-0.064	-0.195	0.025	-0.107	0.026	0.009	-0.096	0.017	0.013
FD	0.024	0.064	0.002	0.041	-0.067	-0.017	0.124	-0.007	-0.005
PH	0.036	0.116	-0.017	0.021	-0.025	-0.047	0.112	-0.021	-0.007
NLPP	0.057	0.156	-0.025	0.037	-0.03	-0.019	0.278	-0.007	-0.009
MD	0.012	0.045	-0.001	0.011	-0.003	-0.006	0.011	-0.169	-0.002
SY	0.013	0.049	-0.028	-0.022	0.006	0.006	-0.036	0.006	0.06
Residual	0.575								

Note: PC: Plot Cover; SV: Sand Vigor; BY: Biomass Yield; DM: Dry Matter; LSR: Leaf to Steam Ratio; ED: Emergency Date; FD: 50% Flowering Date; PH: Plant Height; NLPP: Number of Leaf per Plant; MD: Maturity Date

CONCLUSION

Scientific information about the relationship of dry matter and dry matter-related traits are very important for successful forage breeding strategies. Phenotypic correlation coefficients were found to be higher in magnitude than that of genotypic correlation coefficients in most of the traits under study, which clearly indicates the presence of inherent association among various traits. Highest genotypic coefficient variation were recorded from days to maturity flowed by plant height and highest phenotypic coefficient variation were recorded from plot cover followed by days to maturity. Phenotypically and genotypic ally dry matter yield was highly positive significant associated with of plot cover, stand vigor, leaf per plant and showed highly negative significant with days to emergence. Phenotypic path coefficient analysis showed that stand vigor and leaf per plant had exerted moderate positive direct effect on dry matter. Stand vigor followed by plant height, plot cover and leaf per plant had exerted high and positive direct effect on dry matter yield and genotypic path analysis showed stand vigor followed by plant height, plot cover. Therefore, selection based on high biological biomass yield and leaf per tiller together with the above indicated traits is recommended for further dry matter yield improvement of Rhodes grass if selection will be done for individual different location.

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