

Research Article

Genotypic and Phenotypic Correlation and Path Coefficient Analysis of Rhodes Grass (*Chloris gayana*) Genotypes

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Abstract

Evidence on the collective association of traits is important for effective selection in forage-breeding program. Twenty four genotypes of Rhodes grass and one check were evaluated at Mechara Agricultural Research Center (Onstation) with lattice design in 2023/24 main rainy season to evaluate the Genotypic and phenotypic correlation and determine the direct and indirect effects of yield-related traits on dry matter yield. The mean sum of squares of genotypes showed significant differences ($p < 0.05$) for stand vigor, days to 50% emergence, date to 50% flowering and Plant height and highly significant ($p < 0.001$) for biomass yield, dry matter and number of leaf per plant. Maximum phenotypic variance and genotypic variance value was recorded for days to maturity. The range observed for heritability (H^2_{bs}) was from (0.0%) to (55%). Stand vigor exhibited highest value of genetic advance as percentage of mean followed by number of leaf per plant. Highest genotypic coefficient variation were recorded from days to maturity (89.8%) followed by Plant height (62.3%) and Highest phenotypic coefficient variation were recorded from plot cover (184.9%) followed by days to maturity (225.4%). Phenotypically and Genotypically dry matter yield was highly positive significant associated with of Plot cover (0.546**), stand vigor (0.566**), leaf per plant (0.439**) and showed highly negative significant with days to 50% emergence. The results of phenotypic path coefficient analysis showed that stand vigor (0.378) 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, Heritability, Negative Significant, Phenotypic Correlation, Positive Significant

1. Introduction

Rhodes grass is one of the perennial improved grass which can be grown on-farm and used by small-holder farmers [3]. 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

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1200 mm. Sowing Rhodes grass for more than three years gives rise to development [4]. 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 [8, 6]. Growth performance of Rhodes grass varies with type of cultivar, age of plant and other environmental factors. 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 prerequisite 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.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at Mechara Agricultural Research Center (McARC) experimental field, in West Hararghe zone of Oromia National Region, Eastern Ethiopia during 2023 cropping season under rain fide condition. It is located at about 434 km away from Addis Ababa. McARC site 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 mini-

mum temperature is 31.8oc and 14oc, respectively. The mean annual rainfall is 1100mm. 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.

2.2. Experimental Materials

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

2.3. Experimental Design and Trial Management

The experiment was laid out in 5 × 5 simple lattice design. Seeds of each genotypes were sown in the main field in a plot size of 3m² (2m × 1m) with consisted of four rows. The distance between block, plot and rows was 1m, 1m and 25cm respectively. Sowing was done by drilling the seed in the furrow (line) at depth of 1-2 cm with the seed rate of 12kg/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. 100kg/ha of NPS fertilizer was applied at the time of sowing and 50kg/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.

2.4. Data Collected

Data collected: quantitative characters on recorded on five randomly selected plants from the two middle rows of each plot.

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 (0.25m²) 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 [2].

Biomass yield: The vegetation from each plot will be sampled using a quadrant of 0.25m² (0.5m x 0.5m) 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 [2]. 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 48hrs for further dry matter analysis.

$$DM = \text{Yield (t/ha)} = (10 * TFW * SSDW) / (HA * SSFW)$$

Where:

10 = Constant for conversion of yields in kg/m² to t/ha

TFW = Total fresh weight from harvesting area (kg)

SSDW = Sub-sample dry weight (g)

HA = Harvest area (m²)

SSFW = Sub-sample fresh weight (g)

2.5. Data Analysis

The analysis of variance (ANOVA) was done by using R-software and the least significant difference (LSD) test at 5% level of significance was used for genotypes mean comparisons, whenever genotype differences were significant.

2.6. Estimation of Variance Components

Different genetic parameters including genotypic variance (σ^2_g), phenotypic variance (σ^2_p), phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were estimated by using the formula, adopted from [5, 10].

$$V_g = \frac{MS_g - MSe}{r}, V_p = V_g + V_e$$

Where,

V_g = genotypic variance, MS_g = mean square due to genotypes, MSe = environmental variance (error mean square), r = number of replication, V_e = environmental variance

$$\text{Genotypic coefficient of variation: } GCV = \frac{\sqrt{V_g}}{\bar{x}} \times 100$$

$$\text{Phenotypic coefficient of variation: } PCV = \frac{\sqrt{V_p}}{\bar{x}} \times 100$$

$$\text{Environmental coefficient of variation: } ECV = \frac{\sqrt{V_e}}{\bar{x}} \times 100$$

Where,

\bar{x} = Population mean of the character being evaluated. GCV and PCV values were categorized as low (0-10%), moderate (10-20%) and high (20% and above) values as in-

dicated by [5, 13].

2.7. Estimation of Genetic Advance and Broad Sense Heritability

Genetic Advance under Selection (GA) is expected genetic advance for different characters under Selection was estimated using the formula suggested by [1].

$$GA = \frac{V_G}{\sqrt{V_P}} \times K$$

Where, V_p = Phenotypic standard deviation, GA = Expected genetic advance and k = the standardized selection differential at 5% selection intensity ($K=2.063$). Genetic advance as percent mean was categorized as low (0-10%), moderate (10-20%) and ($\geq 20\%$) as given by [10] and [7].

Broad sense heritability (H^2_{bs}): Heritability in broad sense (H^2_b) was estimated according to the formula suggested by [10, 9].

$$H^2 = \frac{V_g}{V_p} \times 100$$

Where, H^2 = Heritability in broad sense, V_g = Genotypic variance, V_p = Phenotypic variance. The heritability was categorized as low (0-30%), moderate (30-60%) and high (60% and above) as given by [12].

3. Results and Discussions

3.1. Analysis of Variances

The mean sum of squares of genotypes showed significant differences ($p < 0.05$) for stand vigor, 50% emergence date, 50% Flowering date and Plant height and highly significant ($p < 0.001$) for biomass yield, dry matter and number of tiller per plant (Table 1). Indicates that there was ample scope for selection of promising genotypes for yield improvement. Highest values were estimated for plot cover followed by Plant height, days to 50% flowering, fresh biomass yield, days to 50% emergence and Dry matter yield. The wide range of variation observed in 81% of the characters offers scope of selection for different quantitative traits of Rhodes grass. The significant genetic variation among genotypes might be because genotypes were genetically diverse and it could be a good opportunity for breeder to select genotypes for trait of interest for different Forage improvement program. While Seed yield, maturity date and leaf to stem ratio showed non-significant difference among the tested genotypes.

Table 1. The ANOV and range for 11 Traits of 24 genotypes and one Check.

Traits	Max	Min	Mean	Mean square of		CV	LSD at 5%
				Genotypes	Error		
PC	99	30	76.7	356.8*	318.9	22.3	36.3
SV	5	1	2.84	2.2*	0.9	34	2
BY	56.4	13.8	33.5	40.1**	44.7	19.9	13.8
DM	17	3.2	8.1	6.5**	4	24.6	4.1
LSR	66	15	37.2	130.1	132.3	30.9	23.7
ED	26	13	17.5	17.5*	5.5	13.3	5
FD	90	59	81	95.8*	30.6	6.7	11.8
PH	161	110	140.8	169.5*	99.3	6.9	21.2
NLPP	11.8	5.4	9.1	3.1**	0.89	10.6	1.9
MD	130	106	119.2	588.6	322.9	14.8	38.3
SY	19.2	4.07	8.8	8.4	10.9	43.4	7

Note: PC= Plot Cover, SV= Sand vigor, BY=Biomass Yield, DM= Dry Matter, LSR= Leaf to stem Ratio, ED= Emergency Date, FD=50% Flowering Date, PH= Plant Height, NLPP= Number of Leaf per Plant, MD= Maturity Date, SY= Seed Yield, CV=coefficient of variation, LSD=Least significance difference

3.2. Range and Mean Values

The mean Biomass yield per hectare ranged from 56.4 to 13.8 tons per hectare. The range observed for Dry matter yield per hectare was 17 to 3.2 with overall mean of 8.1 ton per hectare. The range observed for Plot cover was 99 to 30 with overall mean of 76.7%. Number of tiller per plant ranged from 11.8 to 5.4 with a mean value of 9.1 numbers. The range observed for seed yield per hectare was 19.2 to 4.07 with overall mean of 8.8 quintals per hectare. The maximum and minimum values of plant height were 161cm and 110cm respectively, with a mean value of 140.8cm. The range observed for 50% emergence date was 26 to 13 with overall mean of 17.5 days. The range observed 50% flowering date was 90 to 59 with overall mean of 81. The range observed for maturity harvest was 130 to 106 with overall mean of 119 days. This high range and mean value for each trait of interest suggests that great opportunity to improve the various desirable traits through selection as short-term strategy. Hence, there is an opportunity to find genotypes having disease resistance and good nutritional value among the tested entries that perform better than that existing varieties to utilize for the future Rhodes grass improvement breeding program.

3.3. Estimation of Variance Components

The estimates of variance, coefficient of variation, herita-

bility and genetic advance for all the eleven characters studied are presented in (Table 2). Maximum (VP) value was recorded for days to maturity, plot cover, plant height and leaf to stem ratio, 508, 341.7, 130.7 and 128.5 respectively. Similarly, the (Vg) value for these characters were also high indicating for days to mature, days to 50% flowering and plot cover, 80.7, 38.8, 28.5 and 15.1 respectively. Also Maximum (Ve) value was recorded for days to maturity, plot cover, leaf to stem ratio and plant height 427.3, 326.7, 127 and 91.9 respectively. Less difference in the estimates of genotypic and phenotypic variance and higher genotypic values compared to environmental variance for all the characters suggested that the variability present among the genotypes were mainly due to genetic reason with minimum influence of environment and hence heritable (1).

The estimates of heritability are more advantageous when expressed in terms of genetic advance (10). The range observed for heritability (H^2bs) was from (0.0%) to (55%). The moderate heritability were recorded for number of leaf per plant (55%), days to 50 % flowering (42.3%), days to 50% emergence (30.8%), stand vigor (31.3%). The rest of the traits were grouped in low values of heritability.

Genetic advance as percentage of mean ranged from 0% to 30.2% stand vigor and seed yield respectively (Table 2). Stand vigor exhibited highest value of genetic advance as percentage of mean (30.2%) while number of leaf per plant (18.4%) and days to 50% emergence (13.2%) where exhibited moderate value of genetic advance as percentage of mean. The all the rest traits recorded lowest values during observation.

In the present study (Table 2) showed that estimates of phenotypic coefficient of variation were higher than their corresponding genotypic coefficient of variation, indicating that the little influence of environment on the expression of these characters. According to [5] categorization, all traits showed high phenotypic coefficients of variation except

stand vigor (12.6%) and leaf per plant (14.1%) showed moderate. Highest genotypic coefficient variation were recorded from days to maturity (89.8%), Plant height (62.3%), Days to 50% flowering (53.4), Plot cover (38.9), days to 50% emergence (20.2%). All the rest of traits showed moderate to low values for genotypic.

Table 2. Estimation of genetic parameters for 10 Traits in 24 Rhodes genotypes and one check varieties.

Traits	σ^2p	σ^2g	σ^2e	$H^2b\%$	GA	PCV%	GCV%	ECV	GAM%
PC	341.7	15.1	326.7	4.4	1.67	184.9	38.9	23.6	2.2
SV	1.6	0.5	1.1	31.3	0.86	12.6	7.1	36.8	30.2
DM	5.7	0.8	4.9	14.0	0.7	23.9	8.9	27.4	8.6
LSR	128.5	1.6	127	1.2	0.29	113.4	12.6	30.3	0.8
ED	13.3	4.1	9.2	30.8	2.33	36.5	20.2	17.2	13.2
FD	67.3	28.5	38.8	42.3	7.16	82.0	53.4	7.6	8.8
PH	130.7	38.8	91.9	29.7	7	114.3	62.3	6.7	4.9
NLPP	2	1.1	0.9	55.0	1.61	14.1	10.5	10.9	18.4
MD	508	80.7	427.3	15.9	7.37	225.4	89.8	17.1	6.1
SY	8.4	0	8.4	0.0	0	29.0	0.0	38	0

Note: PC= Plot Cover, SV= Sand vigor, HY= Herbage Yield, DM= Dry Matter, LSR= Leaf to stem Ratio, ED= Emergency Date, FD=50% Flowering Date, PH= Plant Height, NLPP= Number of Leaf per Plant, MD= Maturity Date, SY= Seed Yield, LSD=Least significance difference, H^2b = Heritability in broad sense, σ^2p = phenotypic variance, σ^2g =genotypic variance, PCV= phenotypic coefficient of variation, GCV= genotypic coefficient of variation, σ^2e =Environmental variance

3.4. Genotypic and Phenotypic Correlations Coefficient Analysis

Estimates of phenotypic and genotypic correlation coefficients between each pair of traits are presented in (Table 3).

3.4.1. Plant Height (cm)

Plant height is one of the main components in any breed-

ing program as it influences plant vigor and stature by both genetic and environmental factor. Highly visualized positive phenotypic correlation for plant height was recorded with Number of Leaf per Plant (0.404**) mentioned in (Table 4). Genotypically, plant height showed positive significant correlation with stand vigor (0.873**), Leaf to stem ratio (0.421**) and days to 50% flowering (0.674**).

Table 3. Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among 10 traits studied at Mechara Agricultural Research on station.

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**	-335.304**	1.038**
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

Traits	PC	SV	LSR	ED	DF	PH	NLPP	MD	SY	DRY
PH	2.527**	0.307*	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= Stand vigor, DMY= Dry Matter Yield, LSR= Leaf to stem Ratio, DM= Days to 50% Emergence, DF=Days to 50% Flowering Date, PH= Plant Height, NLPP= Number of Leaf per Plant, MD= Maturity Date, SY= Seed Yield

3.4.2. Plot Cover

Plot cover exhibited significant positive phenotypic correlated with stand vigor (0.873**), Leaf to stem ratio (0.421**), Plant height (2.527**), Number of Leaf per Plant (0.441**), Days to 50% flowering (-0.499*) 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 (1.4661**), Leaf to stem ratio (6.656**), Plant height (2.527**), Number tiller per plant (1.561**), Dry Matter yield (1.621**), while the genotypic correlation was negative with days to 50% emergence (-1.229**) and seed yield (-6.374**).

3.4.3. Days to Maturity

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 (0.886**), stand vigor (0.488*), Leaf to stem ratio (1.301**), Plant height (0.674**). However, Seed yield and Dry matter yield exhibited negative non-significant phenotypic association.

3.4.4. Number Leaf per Plant

Number of Tiller 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 (1.561**), stand vigor (0.659**), Leaf to stem ratio (3.82**), Plant height (0.785**), Days to 50 % flowering (0.719**) however, it was highly significant negative correlated with longer days to 50% emergence (-0.439**). Phenotypically tillers plant showed highly significant positive correlations with dry matter yield (0.439**).

3.4.5. Days to 50% Flowering

Genotypic correlation of Days to 50 % flowering showed highly prominent positive association with Plot cover

(0.808**), stand vigor (0.445*) Leaf to stem ratio (3.824**), whereas, Days to 50 % flowering (-0.623**) showed highly negative correlation with days to 50% emergence. Genotypically days to 50 % flowering was highly and significantly positive correlated with plant height (0.369**) and Number tiller per plant (0.445**).

3.4.6. Dry Matter Yield (tha-1)

Phenotypically dry matter yield was highly positive significant associated with numbers of Plot cover (0.546**), stand vigor (0.566**), Number tiller per plant (0.439**) whereas Days to 50% emergence showed highly negative significant. Genotypically it was significantly positively correlated with, plot cover (1.621**), stand vigor (0.858**), Leaf to stem ratio (0.858**), Number tiller per plant (0.886**), though it was significantly negative correlated with Days to 50% emergence (-0.694**) and Seed yield (-101.54**).

3.4.7. Seed Yield (Qtha-1)

Genotypically Seed yield was highly significant positive correlated with of stand vigor (13.394**), Days to 50% emergence (44.014**), Days to 50 % flowering (2.128**) and Days to maturity (65.348**) however, negatively highly significant associated with Plot cover (-6.374**), Plant height (-6.264**), Number tiller per plant (-29.459**), Leaf to stem ratio (-335.304**). Phenotypically it was non-significantly positively correlated with, plot cover (0.099) stand vigor (0.1297), Leaf to stem ratio (0.219), and Days to 50% emergence (0.212).

3.4.8. Stand Vigor

Stand Vigor shown highly positive phenotypic correlation with dry matter yield (0.566**), leaf to stem ratio (0.449**), Tiller number (0.412**) and Plot cover (1.4661**) but positively non-significant correlation with days 50% flowering, days to maturity and seed yield. Genotypically stand vigor showed high significant positive linkage with leaf to stem ratio (6.656**), days to 50% flowering (0.808**), Plant height (2.527), number of tiller (1.561**), days to maturity (0.886**) and Dry matter yield (1.621**), whereas, significant negative linkage was exhibited with

days to 50% emergence (-1.229**) and seed yield (-6.374**).

4. 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 4). According to [11] 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. 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 negligible 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.

Table 4. 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	-2.460	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= Stand vigor, BY= Biomass Yield, DM= Dry Matter, LSR= Leaf to stem Ratio, ED= Emergence Date, FD=50% Flowering Date, PH= Plant Height, NLPP= Number of Leaf per Plant, MD= Maturity Date

5. 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 5). Stand

vigor (0.378) and leaf per plant had exerted moderate positive direct effect on dry matter. Also plot cover (0.13) and seed yield (0.06) had exerted low and negligible positive direct effect on dry matter respectively. However, leaf to stem ratio (-0.127), days to 50% emergence (-0.107), days to 50% flowering (-0.067), plant height (-0.047) and days to maturity (-0.169) had negative direct effect on dry matter yield.

Table 5. Phenotypic path coefficient analysis for direct (bold diagonal) and indirect effect (off diagonal) 10 traits studied at Mechara Agricultural Research Center on station.

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

Traits	PC	SV	LSR	ED	FD	PH	NLPP	MD	SY
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 stem Ratio, ED= Emergency Date, FD=50% Flowering Date, PH= Plant Height, NLPP= Number of Leaf per Plant, MD= Maturity Date

6. 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. The mean sum of squares of genotypes showed significant differences for most traits. Maximum phenotypic variance and genotypic variance value was recorded for days to maturity. The range observed for heritability (H^2_{bs}) was from (0.0%) to (55%). Stand vigor exhibited highest value of genetic advance as percentage of mean followed by number of leaf per plant. Highest genotypic coefficient variation were recorded from days to maturity followed by Plant height and Highest phenotypic coefficient variation were recorded from plot cover followed by days to maturity. Phenotypically and Genotypically 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.

Author Contributions

Lensa Urgesa: Conceptualization, Data curation, Formal Analysis, Investigation, Supervision, Validation, Writing – original draft, Writing – review & editing

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Conflicts of Interest

The authors declare no conflicts of interest.

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