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Research Article

Estimation of genetic variability and correlation among different ryegrass genotypes for fodder yield and quality related traits

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ABSTRACT

Ryegrass (Lolium perenne) is the most important fodder crop grown worldwide. The present research work was carried out at the research area of MNS university of Agriculture, Multan. Twenty ryegrass accessions were sown in three replications following a randomized complete block design. Analysis of variance showed that genotypes significant for all traits instead of fresh fodder yield and dry fodder yield. The genotypes 193145 and 196538 showed best results for most of the traits studied. The phenotypic and genotypic positive and significant association of plant height, leaf area and dry weight with fresh fodder yield was observed. Dry fodder yield had a positive and significant association with plant height and leaf area, fresh weight, crude protein and ash contents at genotypic level. So, the dry weight had highest positive direct effect on fresh fodder yield followed by number of tillers. Leaf area and crude protein was negative direct effect on fresh fodder yield. The highest positive indirect effect by crude protein via dry fodder yield followed by number of tillers and leaf area. It was concluded that plant height, number of tilers, plant height, leaf area and dry weight will be used as selection criteria for improving the fodder yield.

Keywords: *Analysis of variance, Path analysis,* Lolium perenne*, Biomass weight, Yield*

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1. INTRODUCTION

Perennial ryegrass (*Lolium perenne* L.) is one of the most widely sown forage grass species in the world used as a source of energy and protein for livestock. Livestock contributes to 11.1% in GDP of Pakistan and its share in agriculture is 58.92%. (Pakistan Economic Survey. 2020-21). The production of fodder crops in Pakistan is used to meet the 30% of the total requirement for livestock (Habib *et al*. 2016). So, there is a need to enhance the total fodder production area in a country. Fodder related problems can be alleviated by improving the breeding strategies and introducing new fodder varieties. Among the all fodder crops, Ryegrass has a maximum potential to fulfill the gap between the demand and production of fodder in the developing countries like Pakistan. Perennial ryegrass is a temperate grass species of paramount importance both to cattle feed production and amenity services due to its outstanding forage quality, grazing tolerance, and turf quality (Wilkins, 1991). Therefore, it is necessary to introduce ryegrass fodder crop in country. Correlation analysis for fodder yield provide opportunity for selection and leads to a directional model based on yield and its component in field experiment. The phenotypic and genotypic correlation coefficients are used to measure the strength and nature of relationship among characters. Path coefficient analysis is a technique of statistical analysis specially designed to quantify the interrelationship of different components and their direct and indirect effect on fodder yield. Path analysis is used to find the direct and indirect result on different yield related parameters. So, there is a need to develop genotypes of ryegrass of high yielding and adapted to local environment. Keeping in mind these evidences the present study was carried out to select and develop the genotypes of ryegrass with high fodder yield.

2. MATERIAL AND METHODS

The present study was performed at MNS-university of Agriculture, Multan in winter. Twenty ryegrass genotypes were sown in a randomized complete block design with three replications. Each genotype consisted of 1 row of 2-meter length and distance between rows was maintained at 30 cm while plant to plant distance was kept 15 cm. For this purpose, 1.5x 272ft^2(408.376 square feet) land was well prepared and required fertilizer dosage (5kg DAP and 20kg Urea) was applied at the time of land preparation. The sowing was done by dibbling method. Weedicides and insecticides were not applied in ryegrass field. After initiation of flower, five random plants of each trial were taken from each replication and data were recorded of plant height, leaf area, and numbers of tillers, fresh biomass yield and dry biomass yield. The fodder quality parameters like protein, fiber and ash contents (%) were estimated by using the methods described by AOAC (1990). The data for all traits was subjected to analysis of variance using formula of Steel *et al*. (1997). Genotypic and Phenotypic correlation coefficients were estimated according to kwon and Torrie (1964). Path coefficients were determined following Dewey and Lu (1957) to study direct and indirect effects of different morphological traits under study on the fresh fodder yield.

3. RESULTS

All the genotypes differed significantly for recorded parameters except fresh fodder yield and dry fodder yield (Table 1). Mean performance of genotypes for studied is presented (Table 2). The ranged of plant height, leaf area, number of tillers, fresh fodder yield, dry fodder yield crude protein, crude fiber and ash content had 6.78 to 24.39cm, 77.4 to 93.7 cm^2, 36.9 to 66.0, 76.93 to 203.13 g, 26.37 to 73.33 g, 8.15 to 14.06%, 7.3 to 20.17%, 10 to 17.5% respectively. The genotypes 193145 and 196538 showed best results for most of the traits studied. The genotypes 193145 gave best performance for leaf area, numbers of tillers per plant and crude protein traits. The genotype 196538 gave best performance for fresh fodder yield. Fresh fodder yield had a significant association with plant height, number of tillers per plant, leaf area and dry weight at phenotypic and genotypic level in Table 3. Association of fresh fodder yield was significant and positive with crude protein but phenotypically positive and non-significant. Dry fodder yield had a positive association with plant height and leaf area, fresh weight, crude protein and ash contents at genotypic level. Relationship of number of tillers was positive with plant height and fresh fodder yield at phenotypic as well as at genotypic level while positive with leaf area and dry weight and crude protein at genotypic level. Leaf area was positive association with plant height, dry fodder yield and crude protein at phenotypic level as well as at genotypic level while significant with fresh fodder yield and number of tillers at genotypic level. The highest association was detected with dry weight r_p = (0.69) and dry weight r_g = (0.78). Path analysis coefficient showed that dry weight had highest positive direct effect on fresh fodder yield followed by number of tillers in Table 4. Leaf area and crude protein was negative direct effect on fresh fodder yield. The highest positive indirect effect by crude protein on dry fodder yield followed by number of tillers on dry fodder yield and leaf area through dry weight.

Table. 1 Mean Square (M.S.) of fodder yield related attributes

SOV	D.F	Plant Height	Leaf Area	Numbers of tillers	Fresh Biomass Weight	Dry Biomass weight	Protein Content	Fiber Content	Ash Content
Genotypes	19	80.05**	62.04**	185.9**	2989.90	32.91	13**	55.34**	14.1**
Replication	2	7.12	32.91	74.95	2427.54	80.04	0.2771	3.4	6.1
Error	38	2.47	12.9	25.06	2428.33	230.19	0.3123	3.04	3.9

*= Significance at 5% probability level ($p < 0.05$)

SOV= Source of variation, DF=Degree of freedom

Table.2 Mean performance of twenty ryegrass genotypes for various traits.

Accessions numbers	Plant height(cm)	Leaf Area(cm^2)	Numbers of tillers	Fresh fodder yield(g)	Dry fodder yield(g)	Crude protein (%)	Crude fiber (%)	Ash content (%)
225726	24.39 **a**	77.4 **h**	63.13 **ab**	152 **abcd**	41.4 **bcde**	9.36 **fg**	12.5**cd**	13.0 **cdefgh**
223568	23.92 **a**	90.1 **abc**	66.0 **a**	100.27 **bcd**	36.1 **cde**	14.06 **a**	18.7 **a**	15.5 **abc**
189390	2382 **a**	84.02 **defg**	55.1 **bcde**	168 **abc**	53.1 **abcd**	11.97 **bc**	7.3 **efg**	14.33 **bcd**
202509	23.01 **ab**	90.2 **abc**	45.7f**g**	141.9 **abcd**	61.0 **abc**	9.91 **cd**	18.5 **a**	11.5 **defgh**
201980	22.38 **abc**	85.8 **bcdef**	60 **abcd**	120.3 **bcd**	41.2 **bcde**	8.98 **ghi**	14.3 **bc**	14.83 **abc**
235038	22.26 **abcd**	83.7 **defg**	47.8 **efg**	134.3 **abcd**	45.06 **bcde**	12.80 **b**	9.8 **efg**	13.67 **bcdef**
196538	21.07 **abcd**	90.8 **ab**	57.5 **bcd**	203.13 **a**	63.19 **ab**	14.07 **a**	8.3 **efg**	13.5 **bcdefg**
199251	20.92 **abcd**	84.6 **cdefg**	60.4 **abc**	146.8 **abcd**	49.3 **abcde**	8.4 **hi**	12.5 **cd**	11 **bcdefg**
200344	20.38 **bcde**	91.2 **ab**	55.0 **bcde**	181.4 **ab**	38.5 **bcde**	9.1 **fgh**	12.0 **cd**	10.83 **fgh**
189389	20.22 **bcde**	89.2 **abcd**	47.9 **efg**	110.2 **bcd**	34.04 **de**	8.15 **i**	7.8 **efg**	13.5 **bcdefg**
193145	19.97 **cde**	93.7 **a**	66.6 **a**	153.3 **abcd**	48.5 **abcde**	14.87 **a**	19.0 **a**	14.1 **bcde**
235157	14.76 **cde**	81.3 **efgh**	48.4 **efg**	108.8 **bcd**	37.51 **cde**	11.48 **c**	8.6 **defg**	15.83 **abc**
211828	19.45 **de**	86.02 **bcbe**	51.8 **def**	161.8 **abc**	52.62 **abcd**	12.64 **b**	12.3 **cd**	10.67 **fgh**
204878	14.76 **e**	87.3 **bcd**	56.4 **bcd**	138.2 **abcd**	46.9 **bcde**	9.91 **ef**	7.0 **g**	11.17 e**fgh**

189152	14.71 **f**	87.8 **bcd**	52.2 **cdef**	145.1 **abcd**	73.33 **a**	9.9 **bc**	7.0 **g**	10 **h**
238886	14.16 **f**	79.9 **efgh**	54.9 **bcde**	105.2 **bcd**	35.6 **de**	12.6 **b**	8.3 **def**	10.5 **gh**
197975	11.06 **f**	90.1 **abcd**	59.8 **abcd**	141.7 **abcd**	47.64 **bcde**	14.35 **a**	11.0 **de**	17.5 **a**
238937	11.05 **f**	84.6 **cdefg**	41.4 **gh**	91 **cd**	30.11 **de**	12.27 **bc**	17.5 **ab**	16.3 **ab**
238885	9.93 **g**	80.4 **efgh**	58.5 **abcd**	157.7 **abcd**	51.48 **abcd**	10.49 **be**	10. **defg**	14.50 **abcd**
238939	6.78 **g**	78.8 **gh**	36.9 **h**	76.93 **d**	26.37 **e**	9.17 **fgh**	20.17 **a**	14 **bcde**

Table. 3. Phenotypic and Genotypic correlation coefficients among various plant traits in ryegrass

		LA	**NOT**	**FFY**	**DFY**	**CP**	**CF**	**AC**
PH	**Phenotypic**	0.31*	0.38*	0.27*	0.17	0.04	-0.15	-0.11
	Genotypic	0.38*	0.51*	0.98*	0.35*	0.01	-0.17	-0.19
LA	**Phenotypic**		0.15	0.24	0.31*	0.31*	0.07	0.04
	Genotypic		0.39*	0.84*	0.46*	0.41*	0.20	-0.07
NOT	**Phenotypic**			0.26*	0.18	0.19	-0.09	-0.01
	Genotypic			0.90*	0.36*	0.27*	-0.08	0.04
FFY	**Phenotypic**				0.69*	0.10	-0.24*	-0.21
	Genotypic				0.78*	0.33*	-0.89*	-0.73*
DFY	**Phenotypic**					0.20	-0.20	-0.29*
	Genotypic					0.42*	-0.40*	0.55*
CP	**Phenotypic**						0.096	0.24*
	Genotypic						0.12	0.35*
CF	**Phenotypic**							0.16
	Genotypic							0.24*

*= Significance at 5% probability level ($p < 0.05$), PH= Plant height, LA= Leaf area, NOT= Numbers of tiller, FFY= Fresh fodder yield; DFY= Dry fodder yield weight (g) CP= Crude Protein (%), CF= Crude fiber (%), AC= Ash content.

Table. 4 Direct (bold font) and indirect (normal font) effect of various attributes on fodder yield in ryegrass.

	PH	**LA**	**NOT**	**DFY**	**CP**	**CF**	**AC**
PH	**-0.78**	-0.47	1.29	1.28	-0.27	-0.19	-0.25
LA	-0.30	**-1.24**	0.98	0.70	-0.98	0.22	-0.93
NOT	-0.40	-0.49	**2.50**	1.33	-0.64	-0.09	0.06
DFY	-0.27	-0.58	0.91	**3.67**	-1.00	-0.43	-1.00
CP	-0.008	-0.51	0.68	1.55	**-2.37**	0.13	0.44
CF	-0.14	-0.25	-0.22	-1.48	-0.30	**1.07**	0.31
AC	0.15	0.91	0.12	-2.02	-0.84	0.27	**1.26**

PH= Plant height, LA= Leaf area, NOT= Numbers of tiller, DFY= Dry fodder yield(g) CP= Crude Protein (%), CF= Crude fiber (%), AC= Ash content

4. DISCUSSION

Significant difference among genotypes suggested that variability is present in breeding so selection may be effective to improve studied traits. The genotypes 193145 and 196538 showed best results for most of the traits studied (Ahmad *et al.* 2001; Palladiono *et al*., 2009; Sartie *et al.,* 2008) also reported significant result for these traits. Association of fresh fodder yield was positive and significant with various studied attributes were positive and significant. These results show that fresh fodder yield can depend upon the number of tillers, plant height, leaf area and dry weight (Ozokse and Tamock, 2014 and Rios *et al*., 2019) had reported significant correlation of fresh biomass with plant height, number of tillers, leaf area and dry weight. (Ullmann *et al.* 2017; Akdeniz *et al*. 2019) also found significant correlation between significant and positive association with fresh fodder yield. Abel *et al*., (2017) detected a direct and positive effect of numbers of tillers on fresh fodder yield. Dry weight had highest positive direct effect on fresh fodder yield followed by number of tillers. Leaf area and crude protein was direct and negative effect on fresh fodder yield. The indirect positive effect of crude protein on dry fodder yield followed by number of tillers on dry fodder yield and leaf area on dry weight. These results suggested that greater number of tillers and dry weight; that ultimately results of higher yield of fresh fodder. Significant and positive correlation of various attributes under observation with each other and with fresh fodder yield and their indirect and direct of on fresh fodder yield revealed that fresh fodder yield of ryegrass can be enhanced by the improved plant features viz, plant height, leaf area, number of tillers. In addition, these attributes can be used for the improvement of ryegrass high yielding genotypes.

5. Conclusion

It is revealed that Fodder yield frequently depends on plant height, dry weight leaf area and number of tillers. This emphasizes that these traits will be useful for the identification of genotypes which can efficiently utilize for the selection of high yielding variety.

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