RESEARCH ARTICLE

Genetic variability and agronomic association on some genotypes of barley (*Hordeum vulgare L*)

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Studying genetic variability in crops is important for improving the crops and enhancing the production. Genetic variability is the occurrence of differences among varieties due to differences in their genetic composition and/or the environment in which they are raised. Fifteen barley (*Hordeum vulgare L.*) genotypes were evaluated for 13 traits in RCBD with three replications at two locations, Legambo and Mekdela. Days to heading showed the highest heritability at both locations, that is, (86.70%) at Legambo and (80.00%) at Mekdela. Moderate to high heritability was observed for plant height (66.90%), spike length (56.90%), number of kernel/spike (53.20%), and days to maturity (51.20%), number of spikelet (48.50%) and thousand kernel weight (24.30%) at Legambo, and spikelet/spike (45.30%), days to maturity (43.90%) and hectoliter weight (41.80%) at Mekdela. Estimated genetic advance as percent of the mean was generally low for the 13 characters. Among the characters, number of kernel/spike had higher genetic advance as percent of the mean value at both locations and followed by thousand kernel weight. Grain yield showed positive and significant phenotypic correlation with biological yield, harvest index and hectoliter weight at both locations. While biological yield and grain yield can be considered for selection, widening the genetic base of the barley germ-plasm in Ethiopia is a pre-requisite for a successful breeding program.

Key Words: *Genotype; GCV; Heritability; Path-coefficient analysis*

INTRODUCTION

Barley (*Hordeum vulgare L.*) is one of the maximum crucial staple food plants within the highlands of Ethiopia [1]. Its grain bills for over 60% of the food of the human beings inside the high lands of Ethiopia, for whom barley is one of the foremost sources of energy. It is a fab season crop, the maximum dependable, early maturing cereal grain with noticeably high-yield capability which include in marginal regions where other cereal plants aren't adapted [2,3]. Slightly is the sector's fourth important cereal crop after wheat, maize, and rice in production [4].

Barley may be cultivated at altitudes among 1500 and 3500 masl but, is predominantly grown among altitudes of 2000 to 3000 masl [5]. Barley cultivation and use in Ethiopia is precise in that during no different USA the crop is grown in environments so numerous in phrases of altitude, rainfall, soil and farming structures. About more than eighty five% of the total production [6] comes from the fundamental barley growing areas, which encompass Wello, Shewa, Arsi, Gojam, Bale, Gondar and Tigray. This indicates wide ecological and physiological plasticity during the country [7]. It's far produced two times annually, i.e. throughout the primary season (meher) and the quick rainy season (belg) [6]. The crop is also produced under residual moisture pressure in some regions of Gondar, Wellega and Gojam from September to January [8].

The important use of barley includes human consumption, in malting strategies and rated [3]. In Ethiopia, it is prepared in special types of indigenous food and homemade liquids [9]. Barley grain specially consists of carbohydrates, proteins, and lipids [10]. Barley is the fifth maximum essential cereal crop in Ethiopia after maize, tef, sorghum and wheat masking approximately 1.1 million hectares of land with average annual production of over 1.three million lots [1].

Barley landraces are suggested to have better model and useful developments like energetic seedling established order, high tillering ability, and quick grain filling period, high seed weight and resistance to shoot fly, aphids and frost [5,11]. Beside this, the unique function of Ethiopian barleys have been found out considering the fact that a long term and has played a prominent role in breeding programs worldwide as supply of genes for resistance towards illnesses and viruses [3,12]. In barley production, most of the Ethiopian farmers are counting on local cultivars [11] however its productiveness is low in comparison to some primary barley generating international locations [5]. It is confined by means of negative yield-capability of varieties, diseases, bugs, poor soil-fertility, water logging, drought, soil acidity and weeds [5,13].

Consequently, one of the ways to enhancing barley yield may be indirect selection for morpho-agronomic characters together with a few different genetic variant the various breeding strains. For any deliberate breeding packages as a way to enhance grain yield potentials of plants, it's miles vital to achieve good enough records on the significance and type of genetic variability [14]. Correlation studies also help especially to understand or understand approximately the suitability of diverse characters for indirect choice in view that choice for one or greater characters bring about correlated reaction for several other developments [15].

Estimation of genetic progress from a breeding software and periodic assessment of development within the genetic gain of a crop is required to recognize modifications produced with the aid of breeding activities, to assess the performance of past development works in genetic yield capacity and suggest on future selection course to facilitate similarly development. even though enormous resources were allocated to barley variety development, there had been no research performed to determine the progress in genetic advantage in grain yield capability and related agronomic trends, in addition to high-quality attributes inside the observe regions. The general objective is to observe turned into to know the genetic variability and affiliation among agronomic characters in some genotypes of barley grown in Legambo and Mekdela. The general objective of the study was to know the genetic variability and association among agronomic characters in some genotypes of barley grown in Legambo and Mekdela.

MATERIALS AND METHODS

Description of the study areas

The study was conducted during the 2019 main cropping season at two locations, namely Legambo and Mekdela. Legambo Woreda is one of the 24 Woredas in South Wollo Zone, Amhara Region. It is located at an altitudinal range of 3250 masl and is found at a distance of 481 km Northeast of Addis

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Ababa. Its soil types are primarily clay or clay loams which have evolved from volcanic rocks (basalt) and the dominant soil color is reddish brown to dark brown. The rainfall regime in Legambo is bimodal, that is the first round season occurs between March to April and the second round takes place from June to August. The mean minimum and maximum annual rainfall are 900 mm and 2000 mm, respectively, while its minimum temperature varies between 11-13°C and the maximum temperature is in the ranges between 18-23°C.

Mekdela Woreda is one of the 24 woredas in South Wollo Zone, Amhara Region. It has an altitudinal range from 2953 masl and is located at a distance of about 550 km Northeast of Addis Ababa. The major soil types of the area include black basaltic (Vertisols) and red basaltic (Nitosols), in addition to this; alluvial and sand soils are also common. The rainfall of the area is characterized by erratic and uneven distribution throughout the year. The highest rainfall occurs from the end of spring season to the beginning of autumn season (May to September) and reaches its peaks in the month of August. The average annual rainfall ranges from 1000-1400 mm, while the annual temperature of the area ranges from 12 to 16°C.The area is located at 11 29' 59.99"N latitude and 3 44 59.99" longitudes and an altitude of 2953 masl.

Experimental materials

In this study, 15 barley varieties in Table 1 were taken from different sets of barley variety trials conducted by barley breeding section of Holetta Agricultural Research Center, using the purposive sampling procedure.

TABLE 1
Description of barley varieties

No	Variety	Name Source	Year of Release	Row Number
1	HB-1307	HARC	2006	Six row
2	Cross 41/98	HARC	2012	Six row
3	EH-1493	HARC	2012	Six row
4	Misrach	HARC	1998	Six row
5	Shege	HARC	1996	Six row
6	Ardu-12-60	HARC	1986	Six row
7	HB-42	HARC	1985	Six row
8	Ahor 880/61	HARC	1980	Six row
9	Balami	HARC	Local	Irregular
10	Bekoji-I	HARC	2010	Two rows
11	Holker	HARC	1979	Two row
12	IBON 174/03	HARC	2012	Two row
13	EH-1847	HARC	2011	Two row
14	HB-1533	HARC	2004	Two row
15	Miscal-21	HARC	2006	Two row

Note: HARC: Holetta Agricultural Research Center.

Experimental design and treatments

The experiment was conducted in a randomized complete block design with three replications. Each treatment was planted on a plot size of 1.2 m × 2.5 m, consisting of six rows of 2.5 m length with 0.2 m spacing between rows, 0.4 m between plots and 1.5 m between blocks. Seed rate was 100 kg/ha in both sites. Fertilizer was applied during planting in the form of Di-Ammonium Phosphate (DAP) only and urea was applied after 40 days from sowing at a rate of 62/69 N/P_2O_5. Seeds were planted by hand drilling on July 22, 2019 at Mekdela and July 29, 2019 at Legambo. For data collection, the middle four rows were used (2 m^2 area).All experimental factors were applied uniformly to the entire plot.

Data collection

Data on agro- morphological traits for barley varieties were collected according to Anderson et al. [16] and descriptors for barley [17]. The plant basis was on ten randomly selected plants from the central four rows in each plot and the average values were recorded.

The following 13 traits were used to characterize the variability in the barley genotypes. Days to Heading (DH): it was recorded as the number of days from sowing to the date on which 75% of the plants in four central rows of a plot have produced heads. Days to Maturity (DM): it was recorded as the number of days from sowing to the stage when 75% of plants in four central rows of a plot have reached maturity. Grain Filling Period (GFP): number of days from heading to physiological maturity. Biological Yield (BY): it was determined by weighing the total air dried above ground biomass from the four central rows of each plot and expressed in kilogram per plot. Grain Yield (GY): grain yield in kilogram of the four central rows adjusted to 12% moisture content and expressed in kilogram per hectare. Harvest Index (HI): It was calculated as the ratio of dry weight of the grain to dry weight of the above ground biomass and expressed as a percentage. Thousand Kernel Weight (TKW): weight in gram of random sample of thousand seeds per plot. Hectoliter Weight (HW): Flour density produced in a hectoliter of the seed and determined using moisture and hectoliter analyzer. Tiller number per plant (TI): Number of tillers per plant excluding the main plant recorded at maturity and expressed as an average of randomly selected ten plants per plot. Plant Height (PH): It was measured as the height in centimeter from the soil surface to the tip of the spike excluding the awns at maturity and expressed as an average of randomly selected ten plants per plot. Spike Length (SL): Spike length of the main plant measured in centimeter from base to tip excluding the awns and expressed as the average of randomly selected ten plants in a plot. Spikelet number per spike (SPL): It was recorded by counting the number of spikelet on each spike on the main tiller of and expressed as the average of randomly selected ten plants in each plot. Kernel number per spike (KN): It was determined by counting the number of kernels produced on the main tiller of each plant and expressed as an average of randomly selected ten plants in each plot.

Statistical analysis

All measured agro-morphological traits and quality parameters were subjected to analysis of variance using SAS software version 9.00 (Anonymous, 2002). Bartlett's test for homogeneity of variance was carried out to determine the validity of the experiment.

The data were also subjected to analysis of variance in Table 2, phenotypic and genotypic correlation as well as path coefficient analysis using SAS software version 9.00 (Anonymous, 2002).

TABLE 2
RCBD model for individual locations

Source of variation	Degree of freedom	Mean square	Expected mean
Replication	r-l	Msr	$\sigma^2e+g\sigma^2r$
Genotype	g-1	Msg	$\sigma^2e+rg\sigma^2$
Genotype	g-1	Msg	$\sigma^2e+r\ \sigma^2gl+rl\sigma^2g$
Error	(r-l) (g-1)	Mse	σ^2e
Total	gr-le		

Note: σ^2g=genotypic variance, σ^2e=error variance, Msr=Mean square of replication, Mse=Mean square of error, Msg= Mean square of genotypes.

RESULTS AND DISCUSSION

Heritability and genetic enhance

Heritability estimate for character beneath examine at Legambo, some characters had high heritability values. Cases in point are days to heading (86.70%), harvest index (72.90%) and plant peak (66.90%). Different characters which include days to maturity (51.20%), spike period (56.90%) and wide variety of spikelet/spike (48.50%) had moderately excessive heritability. At Mekdela, days to heading had been the only character with

high heritability cost (80.00%). other characters together with spikelet/spike (45.30%), days to adulthood (forty 3.9%), hectoliter weight (41.80%), harvest index (37.60%), plant height (34.90), quantity of kernels/spike (33.00%) and harvest index (37.60%) exhibited reasonably high heritability values. Mittal and Sethi [18] said high heritability for grain yield in step with plant in barley.

At Legambo, genetic increase as a percent mean ranged from <1% for hectoliter weight to 16.65% for variety of kernels/spike. inside this range, a fairly excessive genetic boost changed into determined for kernel wide variety per spike (16.65%), harvest index (13.09%), spike period (12.47%) and days to heading (11.03%). the bottom estimate become determined for grain filling period (<1%), biological yield (1.21%), days to maturity (three.39%) and grain yield (4.37%). At Legambo, biological yield had fantastic and full-size phenotypic correlation coefficient (r=0.650) with grain yield and it had the best direct effect (0.602). The value of the direct effect turned into equal to that of the phenotypic correlation coefficient. At Mekdela, like that of Legambo, biological yield had the very best tremendous phenotypic direct impact (0.689) and it had high-quality and significant phenotypic correlation with grain yield (0.770).

Oettler et al., [19] also reported high heritability in barley for grain yield in keeping with plot, thousand kernel weight, and plant top and dry is counted. Mogghadahm et al. [20] in barley acquired excessive heritability for thousand kernel weight, tillers/plant, quantity of kernels/spike and harvest index. Grain yield changed into discovered to have low heritability at each of the two locations. This suggests the environmental impact constitutes a chief portion of the full phenotypic version Mogghadahm et al. [20].

At Mekdela, the range of genetic advance as percent of imply changed into from 1.03% for grain filling duration to eleven 56% for harvest index. At this place, quantity of kernel/spike showed 11.52%, thousand kernel weight 10.12% and wide variety of spikelet/spike 10.01% genetic increase as percent of mean. the bottom genetic strengthen as percentage of suggest observed for days to adulthood (3.01%), grain filling length (1.03%), organic yield (4.79%), grain yield (4.92%) and hectoliter weight (3.18%). This low estimate of genetic strengthens as a percentage of mean arises from low estimate of phenotypic variance and heritability.

Choice based on the ones traits with an exceptionally excessive genetic improve as a percent of mean can bring about the improvement of the performance of the genotypes for the tendencies. A working example is quantity of kernel/spike. This trait had also reasonably excessive heritability price. Usually, there was no as such appreciable distinction among the two locations as a long way as heritability and genetic enhance (as percent of suggest) were involved. Those tendencies with high heritability and genetic enhance at Legambo exhibited high heritability and genetic improve at Mekdela. The ones having medium to low heritability and genetic boost at Legambo additionally confirmed medium to low heritability and genetic boost at Mekdela.

The phenotypic correlation it had with grain yield become poor and substantial. The oblique consequences thru other developments have been negligible. Consequently, the phenotypic correlation days to heading had with grain yield become largely because of its direct effect. Quantity of tillers had negative phenotypic correlation coefficient with grain yield. The oblique outcomes thru other developments have been negligible. Therefore, phenotypic correlation it had with grain yield changed into because of its indirect effect. Wide variety of kernel and thousand kernel weight had high-quality direct impact. The phenotypic correlations that they had with the grain yield have been fantastic. Their oblique impact *via* other characters changed into mostly positive and negligible; consequently, their effective correlation coefficient with grain yield was especially due to direct effect. The phenotypic residual value (0.2311) at Legambo shows that the characters within the course coefficient analysis accounted for 76.89% of the variant in grain yield.

Path coefficient analysis

As correlation does no longer permit the partitioning of each genotypic and phenotypic correlation coefficient into direct and indirect impact, they may be in addition analyzed through direction coefficient analysis. in accordance with the paintings of Dewy and Lu [21], inside the present have a look at, only six out of the thirteen characters which can be believed to have direct dating with grain yield have been included in path analysis and each genotypic and phenotypic correlations have been partitioned into direct and oblique effects using grain yield as a dependant variable. The phenotypic and genotypic direct and indirect impact of different characters on grain yield for Legambo, Mekdela and mixed over the two locations are presented in Tables 3-8.

TABLE 3

Estimates of direct (bold diagonal) and indirect effect (off diagonal) at phenotypic level of six traits on grain yield of 15 barley genotypes tested at Legambo (2019)

Traits	DH	PH	KN	TI	BY	TKW	rp
DH	-0.269	-0.001	0.0011	-0.003	-0.034	-0.081	-0.377*
PH	-0.0012	-0.011	-0.005	0.014	0.218	0.028	0.232
KN	-0.045	0.001	0.065	0.016	0.055	-0.069	0.023
TI	-0.014	0.002	-0.016	-0.065	-0.022	-0.001	0.115
BY	0.015	-0.004	0.006	0.002	0.602	0.029	0.650**
TKW	0.115	-0.002	-0.024	0	0.092	0.189	0.371*

Note: Residual=0.231, DH:Days to Heading, PH: Plant Height, KN: Kernel Number per spike, TI: Tiller number per plant, BY: Biological Yield, TKW: Thousand Kernel Weight, *- Significant difference between treatments, **- Highly-significant difference between treatments.

Table 4

Estimates of direct (bold diagonal) and indirect effect (off diagonal) at phenotypic level of six traits on grain yield of 15 barley genotypes tested at Mekdela (2019)

Traits	DH	PH	KN	TI	BY	TKW	rp
DH	-0.201	0.081	0.094	0.001	0.282	-0.115	0.142
PH	-0.106	0.153	0.129	0	0.434	-0.069	0.542**
KN	-0.086	0.09	0.218	-0.001	0.329	-0.048	0.502**
TI	-0.008	0.004	-0.014	0.0017	0.058	-0.042	0.015
BY	0.082	0.096	0.104	0.001	0.689	-0.039	0.770**
TKW	0.101	-0.046	-0.046	-0.003	-0.117	0.229	0.117*

Note: Residual=0.2787, DH=Days to Heading, PH= Plant height, KN=Kernel Number per spike, TI=Tiller number per plant, BY=Biological Yield, TKW=Thousand Kernel Weight, *- Significant difference between treatments, **- Highly-significant difference between treatments.

Table 5

Estimates of direct (bold diagonal) and indirect effect (off diagonal) at phenotypic level of six traits on grain yield of 15 barley genotypes tested at combined over two locations Legambo and Mekdela (2019)

Traits	DH	PH	KN	TI	BY	TKW	rp
DH	-0.328	0.02	0.009	0	0.161	-0.26	-0.397**
PH	-0.046	0.144	0.097	-0.002	0.29	0.004	0.487**
KN	-0.014	0.066	0.212	-0.003	0.178	0.008	0.466**
TI	-0.001	-0.009	-0.0212	0.027	-0.004	-0.012	-0.0025
BY	0.098	0.077	0.07	0	0.539	-0.068	0.520**
TKW	0.237	0.002	0.005	-0.001	-0.102	0.359	0.499**

Note: Residual=0.2464, DH=Days to heading, PH=Plant Height, KN=Kernel Number per spike, TI=Tiller number per plant, BY=Biological Yield, TKW=Thousand Kernel Weight, **- Highly-significant difference between treatments.

Table 6

Estimates of direct (bold diagonal) and indirect effect (off diagonal) at genotypic level of six traits on grain yield of 15 barley genotypes tested at Legambo (2019)

Traits	DH	PH	KN	TI	BY	TKW	rp
DH	-0.617	0.041	-0.292	-0.048	-0.118	0.028	-1.006**
PH	0.016	-1.58	0.401	0.812	0.537	-0.012	0.175

KN	-0.212	0.746	-0.85	0.263	-1.291	-0.012	-1.290**
TI	-0.015	0.66	0.115	-1.944	0.186	0.054	-1.006**
BY	0.219	-2.57	3.321	-1.097	0.33	-0.02	0.184
TKW	0.315	-0.346	0.834	-0.292	0.122	-0.555	0.577

Note: Residual=0.2570, DH: Days to Heading, PH: Plant Height, KN: Kernel Number per spike, TI: Tiller number per plant, BY: Biological Yield, TKW: Thousand Kernel Weight, **- Highly-significant difference between treatments.

Table 7

Estimates of direct (bold diagonal) and indirect effect (off diagonal) at genotypic level of six traits on grain yield of 15 barley genotypes tested at Mekdela (2019)

Traits	DH	PH	KN	TI	BY	TKW	rp
DH	-1.118	0.449	0.593	-0.008	0.223	-0.134	-0.064
PH	-0.704	0.758	0.376	-0.07	0.281	-0.045	0.597
KN	-0.639	0.258	1.103	-0.025	0.169	-0.01	0.858
TI	-0.04	0.215	0.111	-0.246	0.473	0.067	0.581
BY	-0.7	0.564	0.493	-0.307	0.378	-0.101	0.327
TKW	0.947	-0.202	-0.063	-0.098	-0.2228	0.168	0.524

Note: Residual=0.2445, DH: Days to Heading, PH: Plant Height, KN: Kernel Number per spike, TI: Tiller number per plant, BY: Biological Yield, TKW: Thousand Kernel Weight.

Table 8

Estimates of direct (bold diagonal) and indirect effect (off diagonal) at genotypic level of six traits on grain yield of 15 barley genotypes tested at combined over two locations Legambo and Mekdela (2019)

Traits	DH	PH	KN	TI	BY	TKW	rp
DH	5.489	0.406	0.568	0.055	1.202	-8.719	-0.998*
PH	-0.702	-3.176	-0.194	1.901	0.644	1.949	0.423
KN	-3.373	-0.666	0.925	1.53	-1.937	6.063	0.693
TI	0.446	-8.99	-8.1	0.672	5.613	5.081	0.715
BY	3.15	-0.977	0.855	1.799	2.095	-7.661	-0.739
TKW	-5.333	-0.69	-0.625	0.38	-1.789	8.973	0.917*

Note: Residual=0.3001, DH: Days to Heading, PH: Plant Height, KN: Kernel number per spike, TI: Tiller number per plant, BY: Biological yield, TKW: Thousand Kernel Weight, *- Significant difference between treatments.

Phenotypic-route coefficient

The existence of low and superb indirect impact of organic yield with maximum of the opposite characters ascertains that the correlation of this trait with grain yield changed into located to be specifically because of the direct impact. Days to heading showed terrible direct impact and the correlation coefficient it had with grain yield changed into advantageous and the indirect effect through different characters had been generally tremendous. Therefore, the correlation of days to heading with grain yield changed into because of oblique effect. Thousand kernel weights had tremendous direct impact. The phenotypic correlation of thousand kernel weight with grain yield became additionally nice. The oblique effects were in the main terrible and negligible. Therefore, the correlation they'd with grain yield turned into in large part due to the direct effect. The phenotypic residual value (0.2787) in this phenotypic route coefficient evaluation for grain yield shows that the characters under have a look at accounted for 72.13% of the variability in grain yield. By using comparing the two places residual price (0.2311) for Legambo and (0.2787) for Mekdela, grain yield changed into better expressed at Legambo than Mekdela *via* the characters within the direction analysis. typically, characters that confirmed effective direct impact as well as high-quality and tremendous correlation coefficient with grain yield were known to have an effect on grain yield to the favourable path and needs tons attention for the duration of the technique of selection instances in point are organic yield and thousand kernel weight.

Combined over the two locations, biological yield had superb and large correlation coefficient and it showed the very best superb direct effect (0.539). The correlation coefficient of this character with grain yield was (zero.520) that's equivalent to its direct effect. This suggests the correlation explains the actual dating and the direct choice thru this trait can be effective. Plant height, range of kernel and thousand kernel weight had advantageous and sizeable correlation with grain yield and that they confirmed high-quality direct impact. The respective oblique effects of these characters had been either negligible or terrible. For this reason, the correlation coefficient that they had grain yield became in large part due to their direct impact. Their indirect consequences *via* other trends were typically effective and negligible. For this reason, the correlation they had with grain yield became largely due to direct impact. The correlation coefficient of days to heading with grain yield became terrible and huge. Its indirect results *via* other traits had been mainly nice and negligible. Subsequently, the correlation of days to heading with grain yield turned into in large part because of direct impact. The phenotypic residual rate (0.2464) in this phenotypic direction coefficient analysis for grain yield in blended over the 2 places suggests that the characters underneath observe accounted for seventy 5.36% of the variety in grain yield.

At Legambo, genotypic course analysis confirmed wonderful direct effect for biological yield and the direct effects of the rest of characters were negative. The correlation coefficients of plant peak, thousand kernel weight and organic yield have been fine but their direct outcomes have been poor. As a result, the correlation that they had with grain yield changed into largely because of the oblique effect. The poor direct effect of plant height at Legambo turned into in harmony with the effects of Pathak [22]. The terrible direct impact of thousand kernel weights at Legambo contradicts with the findings of Mogghhadam et al., [20]. Wide variety of kernel, number of tillers and days to heading had negative direct effect and the genotypic correlation coefficient they'd with grain yield been sizeable and poor. The indirect outcomes they'd with different characters have been basically effective. The terrible direct effect of the variety of tillers in keeping with plant changed into an agreement with the finding of Getachew et al., [23-28] in Ethiopian barley landraces. Plant peak had fantastic genotypic correlation coefficient but it confirmed bad direct effect. The genotypic residual price (0.2570) in Legambo suggests that the characters under look at accounted for 74.30% of the range with grain yield.

At Mekdela, days to heading had terrible direct impact and the genotypic correlation coefficient it had with grain yield been also bad. The direct outcomes through different developments have been particularly effective and for this reason the correlation it had with grain yield was largely because of the direct effect. Plant height had tremendous direct impact and high-quality correlation impact. Its indirect results thru different tendencies have been mostly bad. Consequently, the genotypic correlation coefficient it had with grain yield changed into in particular due to the direct consequences. Quantity of kernel had nice genotypic correlation coefficient and confirmed the very best nice direct impact. The indirect effect through different characters changed into negligible or poor and hence the correlation it had with grain yield became in large part because of the direct impact. Organic yield had a nice direct impact (0.378) which changed into equivalent to the genotypic correlation coefficient (0.327) it had with grain yield. Range of tillers had negative direct impact however the correlation coefficient it had with grain yield become fine and as a result in this case the indirect effects are the cases of the correlation. normally, the route evaluation for grain yield showed the characters protected in the course analysis expressed the variety as suitable at Legambo as at Mekdela for the reason that residual price at Legambo (0.2570) was not that a lot specific as that of Mekdela (0.2445).

Genotypic course coefficient evaluation of mixed over the two locations showed that thousand kernel weights had the very best direct impact (8.973). It had fine and full-size correlation coefficient with grain yield. The indirect results thru other trends were frequently poor. Hence, the genotypic correlation coefficient it had with grain yield changed into largely because of the direct effect. Plant top and quantity of kernel had bad direct effect but they had tremendous correlation coefficient. Consequently, the superb correlation coefficient was largely because of their respective indirect consequences. This implies restricted simultaneous selection needs to be

followed; regulations are to be imposed to nullify the unwanted oblique outcomes on the way to make use of the direct effect of these traits. The direct impact of quantity of tillers changed into high quality. The genotypic correlation coefficient it had with grain yield became also nice. Therefore, the correlation it had with grain yield changed into largely because of the direct effect.

CONCLUSION

Path coefficient analysis based on grain yield as dependent variable shows that biological yield had the highest positive direct effect at phenotypic level at individual locations and even combined over the two locations. The correlation coefficient was also positive and significant at individual locations and when the two are combined. Genotypically, biological yield showed positive direct effect both at Legambo and Mekdela and combined over the two locations. Number of kernel also showed positive direct effect at phenotypic level at Legambo and Mekdela. Since biological yield and number of kernel had positive correlation with grain yield in process of selection much attention should be given to them as these characters are helpful for indirect selection. There were differences in the performance of the genotypes as there were statistically significant differences among genotypes for most of the 13 characters at both locations. Nevertheless, the level of genetic differences for many traits including grain yield may not be sufficient to expect progress in selection. Biological yield showed positive and significant correlation and positive direct effect at individual locations and combined over the two locations, it will be a useful trait for indirect selection to increase grain yield. Number of kernel/spike as it showed a medium to high heritability, relatively better genetic advance as percent of mean and positive correlation coefficient and direct effect on grain yield, this character may be included as a component of indirect selection.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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