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The Study of Heritability in Bread Wheat (*Triticumaestivum*L.) Genotypes for Yield and Yield related traits

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Abstract: *Genetic variability and heritability as well as correlation among agronomical useful traits is necessary to design an advantageous plant breeding method. The present research was conducted at Holeta Agricultural Research center, Ethiopia during the 2021-2022 main crop growing season. The experimental material consisted of 100 wheat genotypes tested in alpha lattice design with two replications in two checks. Main agronomic traits were included in the investigation. Highly significant differences were revealed among wheat genotypes for all traits studied, suggesting the possibility of improving wheat for these traits. Grain yield per hector, harvest index, kernel per spike and thousand kernel weight, showed the highest phenotypic and genotypic coefficients of variations and genetic advance, whereas, plant height and fertile tiller per plant had moderate values. Days to maturity exhibited highest heritability value of 97% while tiller per plant showed moderate value of 69.6%. so, these traits should be considered as useful selection criteria for the development of high yielding wheat varieties.*

Keywords: *Productivity, Genetic advance, Heritability, Coefficient of variation*

1. Introduction

Bread wheat (*Triticumaestivum*) is an important food crop for more than one third of the population. The demand of this crop increasing from time to time due to high population.Its tons and its mean productivity is about 3 ton per hectare (CSA, 2021), this is relatively lower than the attainable yield of the crop, it is reaching up to 5 tha^{-1} (Zegeye*et al.*,2020).

The productivity of wheat in Ethiopia has increased in the last few years, but its average yield (2.28 t ha^{-1}) remains extremely low compared to other wheat-producing countries. On the other hand, about 85 improved varieties were released in Ethiopia which can provide up to 5.5 and 6.5 t ha^{-1} on farmers' and research fields, respectively (MoANR, 2018). Thus demonstrated that wheat productivity can be improved through the use of improved varieties and production packages.

The low productivity of wheat in Ethiopia is because of several stresses, including biotic (diseases, insect pests, and weeds), abiotic (water logging, drought, poor soil fertility, and soil acidity) (Zegeye*et al*., 2001). Besides the aforementioned environmental factors, inadequate accessibility of quality seeds of improved varieties to wheat growers causing farmers to use their wheat grain as seed is also a bottleneck of increasing grain yield of wheat in Ethiopia. Wheat diseases are rust diseases, which can reduce yield significantly, for instance up up to 60% by leaf and stripe (yellow) rusts and 100% by stem rusts are recorded (Park *et al*., 2007).

Wheat production needs to be increased in Ethiopia to remain stable and secure economically in terms of food security. This can be achieved through the use of well-adapted, disease resistant and high-yielding varieties and effective agronomic practices. Plant breeding is an ongoing process of developing better adapted and high yielding varieties than the ones already in the production. The presence of variability, heritability, and genetic advance in various yield-related traits in bread wheat has been reported by Desalegn and Chauhan (2016), Kifle*et al*. (2016), and Rahman*et al*. (2016). However, no variability study has been done on the genotypes used in this study.Then, the genetic stocks harboring the desired genes must be identified in light of various yield contributing characters. This can be achieved by studying the genetic variability and association of different traits in a breeding population. Therefore, this study was carried out to Study of Genetic Variability and Heritability in Bread Wheat.

2. Materials and Methods

The experimental material for the present investigation comprised 100 accessions of the drawn from wheat gene pool maintained at Holeta agricultural research mentioned in Table 1. The accessions were raised and followed recommended packages and practices during Main season, 2021-2022. The experiment was laid out in alpha lattice Design with two replication and two checks. Each experimental plot was 2.5m long and 1.2 m wide, with six rows 20 cm apart, giving a gross plot area of 3 m^2. The seed rate was 150kg/ha-1. All other agronomic practices were done as recommended for wheat production in the area.
The characters studied and techniques adopted to record the observations were given below:

- Grain yield per hector(g)
- Harvest index (%)
- Kernel per spike
- Thousand kernel weight(g)
- Plant height(cm)
- Fertile tiller per plant
- Days to maturity

Variability for different characters was estimated as suggested by Burton and de Vane (1953).Heritability**(H_b^2)**:in a broadsense of allcharacterswascomputedusingtheformulagivenby Falconer(1989). Genetic advance as per cent of mean for each character was worked out as suggested by Johnson *et al.*, (1955).
$PCV=\sqrt{\sigma 2p}/\bar{x}\times 100$ $GCV=\sqrt{\sigma 2g}/\bar{x}\times 100$
Where, $\sqrt{\sigma 2p}$ = Phenotypic standard deviation
$\sqrt{\sigma 2g}$ = Genotypic standard deviation
$\bar{x}$ = Grand mean for the characteristic x;
PCV, GCV Phenotypic and Genotypic coefficient of variation, respectively.
Heritabilityin broad sense**(H_b^2)** = $(\sigma^2_{g/}\ \sigma^2_{p)}$ x100
GA= K * $\sqrt{\sigma^2 p}$ * H
Where, GA = expected genetic advance, δ_p = phenotypic standard deviation on mean basis, H= Heritability in broad sense, K =selection differential (where k = 2.06 at 5% selection intensity**).**

3. Results and Discussion

Analysis of variance revealed highly significant differences for all characters under study among the 100 genotypes at 5% level of significance, indicating the presence of sufficient variability among genotypes.
Genetic Variability
Genotypic coefficient of variation (GCV) ranged from 5.019 to 35.951. Higher magnitude of GCV was recorded for grain yield per hector(35.951%), followed by harvest index (24.117%), thousand kernel weight(20.851%), Fertile tiller per plant (11.698%), kernel per spike(6.95%),plant height (5.019%), showed lowest GCV values.
A wide range of phenotypic coefficient of variation (PCV) was observed and ranged from 5.097 to 35.978. High magnitude of phenotypic coefficient of variation (PCV) was recorded for grain yield per hector(35.978%), followed by harvest index (26.68%), thousand kernel weight(20.981%), Fertile tiller per plant (14.025%), kernel per spike(7.517%),plant height (5.097%), showed lowest GCV values.
Estimates of genotypic variance, phenotypic variance, genotypic coefficient of variation (GCV), phenotypic of variation (PCV), heritability in broad sense (h2), genetic advance (GA) and genetic advance as percent of mean (GAM) are summarized in Table 1.)
Heritability
The GCV estimates indicated the total amount of genetic variation present in materials. But, the proportion that is transferred from parents to their offspring is reflected in heritability. In 2007, Gangaprasad and Pramoda noted that heritability estimates ranged from 40% to 80%.
Traits such as grain yield (99.8%)thousand kernel weight(98.8%), plant height(97%), harvest index(81.69%) were very high heritable traits while fertile tiller per plant(69.6%) was moderately high heritable trait. Similarly DeshevaandCholakov,(2014)reported thatplantheight,spike length,and

the number ofgrainsperspike were highly heritable and concluded that the selection process might be effective in early generations for these traits.The high number of genetic variations and the low environmental impact were the main factors that affected the character traits.

Table.1 Extent of genetic parameters for yield and its attributing characters in wheat genotypes.

Traits	Mean	Range	PV	GV	PCV(%)	GCV(%)	H^{2}(%)	GA	GAM (%)
Days to maturity	143.19	129.00-151.00	22.782	22.088	3.333	3.28	97	9.533	6.658
Grain yield	3192.96	1027.20-5620.76	1199789.15	1197838.65	35.978	35.951	99.8	225290.82	70.527
Thousand kernel weight	31.38	8.52-46.64	43.354	42.816	20.981	20.851	98.8	13.395	42.686
Harvest index	0.27	0.06-0.4	0.00519	0.00424	26.68	24.117	81.69	0.873	3.23
Fertile tiller per plant	6.753	4.40-10.80	0.897	0.624	14.025	11.698	69.6	1.358	20.108
Kernel per spike	48.318	13.60-79.00	103.343	102.658	18.687	18.242	99.3	20.803	43.054
Plant height	92.29	83.00-106.40	22.130	21.458	5.097	5.019	97	9.396	10.181

Genetic advance as percent of mean

Heritability alone did not provide any indication of how much genetic change would come from choosing individual genotypes. Hence it was most important to learn about genetic development coupled with heritability. AccordingtoJohnson*etal.*(1955),geneticadvanceaspercentof the mean(GAM) wascategorizedashigh(>20%),moderate(10-20%)andlow(0-10). Maximum genetic improvement was reported for grain yield (70.527%), kernels per spike (43.054%), thousand kernel weight (42.686%) and fertile tillers per plant (20.108%) (Table1). Mohammed*etal.*(2011)andNavin*etal.*(2014)alsoreportedhighgeneticadvanceas a percentageof the meanforgrainyieldandyield- relatedtraitslikethousandkernelweight and harvest index whichare similar to the present findings.This study in line with Anshuman*etal*., (2013),Desheva and Cholakov,(2014reported high heritabilityaccompaniedbyhighexpectedgeneticprogressinthecaseofgrain yield perhector, thousand kernel weight, fertile tiller per plant, kernel per plant which indicated that heritability was due toadditivegen eeffects andselectionmaybeeffectiveinearlygenerationsforthese traits. It also in line with Shukla*etat.*(2000),Firouzian*etal.*(2003)andSalim*etal.*(2003)reportedhigh heritability with high genetic advance for thousand kernel weight.Because of this additive variability, selection for these characters would be highly sensitive, and a superior genotype could be produced as the environment had the least impact on the speech of these characters.

4. CONCLUSION

The genetic variability among the tested genotypes from different traits helpful for direct and indirect selection. Attention should be given for which had moderate to high variability and heritability in order to bring an effective response of grain yield improvement. The variability among genotypes and heritability in the tested traits of the genotypes confirmed possibility to increase wheat productivity in target area. Hence selection and hybridization on those genotypes based on the trait with high GCV, heritability on grain yield can be recommended for further yield improvement of bread wheat at particular location.

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