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Genetic Variablity of Korerima [Aframomum corrorima (Braun) P. C. M. Jansen] Genotypes for Morphologial Traits in Tepi, Ethiopia

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Abstract
Genetic variability study generates relevant information on the possibility of genetic improvement of crop for yield and quality attributes. This study was conducted to assess the genetic variations among genotypes. Twenty five korerima genotypes were evaluated for17 agro morphology characters in a simple lattice designs in Tepi National Spices Research Centre in 2016. Analysis of variance results revealed the presence of significant differences among genotypes for all characters. Moreover, the genotypes had dry capsule and pure seed yields ranged from 203.6 to 921.83 and 36.33 to 170.5 kg ha-^{1}, respectively. Most of the characters had low Phenotypic (PCV) and genotypic (GCV) coefficient of variations, heritability (H^2) and genetic advance (GAM) except number of capsule bearing sucker per plant, fresh capsule length, dry capsule diameter, dry capsule length, dry capsule yield in kg ha^{-1} pure seed yield, and number of seed per capsule had high values. Therefore, selection of genotypes for the mentioned characters could be used as simultaneous selection of genotypes for seed and dry capsule yield..
Keywords: *Aframomum corrorima*, Korerima, Variability, Heritability, Genetic Advance, Dry capsule yield,

INTRODUCTION

Korarima [*Aframomum corrorima* (Braun) P.C.M. Jansen] is herbaceous, perennial and aromatic species classified in the monocotyledonous family Zingiberaceae and belongs to the genus Aframomum. The chromosomes of korarima were observed to be small in size and their diploid number was found to be 2n= 2x=48 (Surawit and Wondyifraw, 2013). The plant consists of an underground rhizome, a pseudo stem, and several broad leaves and morphologically it resembles Elettaria species. Mature korarima plant can reach a height of 1-2 m. It sets seed after 3-5 years of planting depending on the planting materials used and it continue to bear seeds for a number of decades (Eyob, 2009).

Seeds of korerima are mainly used as a spice and condiment in different traditional Ethiopian dishes and they serve as a source of income to the growers as they fetch high prices both at local and export markets. In addition, pods, leaves, rhizomes and/or flowers of korerima are commonly used in traditional medicine and as a spice and condiment in different parts of the country, including Southern Ethiopia (Eyob *et al.*, 2008).

Korerima is propagated both by seeds and rhizome parts (Ravindran *et al.*, 2002; Girma *et al.,* 2008). It grows in lower strata of natural forests and it needs 55 to 63% shade level for its proper development. It grows in areas located in altitudes ranging from 1000 to 2300 m.a.s.l. and received 1500 mm and more of rainfall per year. Other report indicates that the korerima plant grows naturally at 1700-2000 m.a.s.l. (Ravindran *et al.*, 2002).

Assessment of genetic variability in crops has a strong impact on plant breeding and conservation of genetic resources. It is particularly useful in crops not well studied. The knowledge of the crop nature, extent and distribution of genetic variation is crucial for successful selection of individual genotypes to be used as parents in hybridization program or to develop as variety. The number of populations necessary to conserve genetic diversity within a species depends on the measure of diversity and its pattern of partition within and among populations (Kassahun, 2006). Very recently, by Tepi National Spices Research Centre large numbers of korerima genotypes were collected from major growing regions of Ethiopia to assess the genetic variations among genotypes and thereby to develop to varieties. However, characterization and genetic variability study has not been started in these collections of korerima. Therefore, this research was initiated with the following objective.

- To assess the genetic variability in korerima genotypes for seed yield and related characters

MATERIALS AND METHODS

Description of the Study Area

The experiment was conducted at Tepi National Spices Research Center (TNSRC). Tepi National Spices Research Center is located in South Nation and Nationalities People (SNNP) Regional State at an elevation of 1200 meter above sea level. The research center is situated at Latitude of 70 10’ 54.5’’ N and with a Longitude

of 350 25' 04.3-28.2' E in the warm humid low land area of south western Ethiopia. The mean annual rain fall recorded at the station is 1559 mm and the average annual minimum and maximum temperatures were 15.5° C and 29.7°C, respectively (TNSRC, 2015).

Experimental materials and design

The genetic variability study was conducted using 25 Korerima genotypes that were collected from Kaffa, Bench-Maji, Gamo Gofa, Sheka, Sidamo, Wollega, Illubabor, Bale, Jimma, South Omo and north western of Ethiopia growing regions for variety development and the collections were maintained at Tepi National Spices Research Center. The descriptions of the genotypes were presented in (Table 1).

The experiment was superimposed on those which were planted in a simple lattice design with two replications and five genotypes per incomplete block. Twenty plants per plot were planted with a spacing of 2 m both between rows and plants. The genotypes were grown under natural forest shade trees. Each genotype was assigned in one plot in each replication where each plot was with width and length of 8 x 10 m. Plants grown at two rows left the two plants grown at most end of each row were considered for data collection. The data collected from the field were analyzed as per simple lattice design..

Experimental procedure and data collection

Data from the experimental field was collected on sample plants and net plot basis. For this purpose, ten red ripe capsules were collected from ten randomly taken plants from net plot for each genotype and replication. Fresh and dried capsules characters were measured and the mean value was registered for analysis. The seeds were extracted after drying of the sample capsules and seeds physical quality parameters was measured. All the data collected for capsules, seed physical quality and capsule yield (kg ha^{-1}) from the experimental field was analyzed using the simple lattice design where the genotypes were maintained.

Data Collection

The following data were collected from the experiment both per plot and per plant basis:

Plant height (cm): Plant height was measured from ten randomly taken plants in centimeters from ground level to the plant tip and the average measurement was taken.

Number of sucker per plant: Number of sucker produced from ten randomly taken plants in each net plot was counted and the average measurement was taken.

Number of capsules bearing sucker per plant: Number of capsule bearing suckers produced from ten randomly taken plants in each net plot was counted and the average measurement was taken.

Internodes length (cm): It was measured in centimeters the length that was found between two consecutive nodes at physiological maturity using ten randomly taken plants.

Number of leaves per stem: Number of leaves produced from ten randomly taken plants in each net plot was counted and the average measurement was taken.

Leaf area (cm^2): Leaf area was taken using (cm) from ten randomly taken plants in each net plot and the average measurement was taken.

Number of capsules per plant: Number of capsules produced from ten randomly taken plants in each net plot was counted and the average measurement was taken.

Fresh capsules diameter (cm): Ten capsules was randomly taken from capsules collected from ten plants and each capsule girth was measured to the widest portion using caliper and the average of the ten capsules measurement was taken.

Fresh capsules length (cm): It was measured from ten capsules that girth was measured. Each capsule length was measured from the top to the lower end of capsule and the average of 10 capsules was calculated to register fresh capsules length in (cm).

Dry capsules diameter (cm): Ten capsules was randomly taken from capsules collected from five plants and dried, each dried capsule girth was measured to the widest portion using caliper and the average of the ten capsules measurement was taken.

Dry capsules length (cm): It was measured from 10 dried capsules that girth was measured. Each dried capsule length was measured from the top to the lower end of capsule and the average of 10 capsules was calculated to register dried capsules length in (cm).

Fresh capsules weight (g): It was calculated from capsules collected from ten randomly taken plants in each net plot by weighed the total capsules collected and divided by the number of capsules.

Dry capsules weight of (g): It was calculated from capsules collected from ten randomly taken plants after drying, weighed and divided by the total number of capsules.

Dried capsules yield (kg per plot): All red ripe capsules produced by the plants in net plot were harvested, dried under open sun, weighed and calculated the dried capsule yield (kg per plot basis).

Dried capsules yield (kg ha^{-1}): All red ripe capsules produced by the plants in net plot was harvested, dried under open sun, weighed and calculated the dried capsule yield (kg ha-1 basis).

Number of seeds per capsule: Number of seed(s) per capsule was recorded by taking the mean number of seeds obtained from ten sampled capsules

1000 seeds weight (g): It was taken by weighing 1000 seeds drawn randomly from the yield obtained from each experimental plot.

Total seeds weight per capsule (g): It was registered the pure seed obtained from ten capsules weight in gram and taking the mean value.

Pure seed yield (kg per plot): It was calculated from pure seeds weight per capsule considering the plant population per plot and number of capsules collected per plant.

Analysis of variance and treatments mean comparison:

Data collected were subjected to analysis of variance for the design and treatment arrangement as the procedure indicated by Gomez and Gomez (1984) using Statistical Analysis System (SAS, 2001) computer software. Where significant differences were detected, the means separation was carried out using the least significant differences (LSD) at 0.05 level of probability.

Here are the formulas used for this investigation and results are published by Karim *et al*. (2007):

Phenotypic and genotypic variations

The variability of genotypes was estimated by simple measures, namely range, mean, standard error, phenotypic and genotypic variance and coefficient of variations. The phenotypic and genotypic variance was estimated according to the methods suggested by Burton and De Vane (1953).

$^2p = {}^2g + {}^2e$, $^2g = \frac{Mg-Me}{r}$: Where, p = phenotypic variance, ^{2} g = Genotypic variance, ^{2} e = Environmental (error) variance, (Error mean square), *Mg*= mean sum square of genotypes, *Me*= mean sum square of error, *r*=Number of replications

Genotypic and phenotypic coefficient of variations

The phenotypic and genotypic coefficients of variations were estimated according to the methods suggested by Burton and De Vane (1953).

Phenotypic coefficient of variation, PCV =

Genotypic coefficient of variation, GCV = $\frac{\sqrt{\sigma^2 g}}{\bar{x}}*100$, $\frac{\sqrt{\sigma^2 p}}{\bar{x}} * 100$ Where $\bar{x}$ = population mean

Heritability and genetic advance

Broad sense heritability was computed for each pod and seed quality parameter based on the formula developed by Allard(1960) as: $H^2 = \frac{\sigma 2g}{\delta 2p}*100$, Where, ^2p = phenotypic variance, ^2g= Genotypic variance, $^2p = {}^2g + {}^2e$, ^2e = Environmental (error) variance

Heritability will be classified as suggested by Robinson*et al.* (1949) into low (0-30%), moderate (30.1-60%) and high (>60%). The genetic advance (GA) for selection intensity (K) at 5% was calculated by the formula suggested by Allard (1960) as: GA= (K) (δP) (h^2)

Where, GA= Expected genetic advance, δP = the phenotypic standard deviation, h2 = the heritability, K= Selection differential (K=2.06 at 5% selection intensity). GA (as % of the mean) = $\frac{GA}{\bar{X}}*100$, Where, $\bar{x}$= population mean. The GA as percent of mean was categorized as low, moderate and high as suggested by Johnson *et al.*(1955) as follows: 0 - 10% = Low, 10 – 20 = Moderate and > 20 = High

RESULTS AND DISCUSSION

Genetic Variability in Korerima Genotypes:

Mean squares of 17 characters from analysis of variance (ANOVA) presented in Table 2. The ANOVA result revealed that the presence of significant differences among genotypes (P<0.05) for all characters of korerima genotypes. This significance differences among genotypes indicated the presence of variability among the genotypes for all characters. The presence of variability among genotypes was a good opportunity for breeders to improve characters of interest through selection. The current finding is in agreement with the finding of Hikmat *et al.* (2012) reported significant difference among 20 turmeric genotypes for number of tiller, number of leaves and plant height. Islam et al. (2008) reported significant differences among 19 ginger genotypes for plant height, tiller per plant, leaf area and number of leaves per plant.

Range and mean values

Mean value of genotypes for growth characters

Range and mean values of the 17 characters are presented in Table 3. Plant height of 25 korerima genotypes ranged from 92 to 136 (cm) with overall mean of 118.5 (cm), while internodes length (cm) varied from 5.38 to 10.85 with mean values of 8.25 (cm). Similarly capsule bearing suckers per plants varied from 2.54 to 3.33 with a mean value of 3.01. Leaf area ranged from 110.45 to 179.3 (cm^2) with a mean valued of 152.11 (cm^2), while numbers of leaves per plants ranged from 12.84 to 13.81 with mean values of 13.37 (Table 3).

The genotypes BM34/03 and BM31/03 collected from SNNPR showed the highest mean value for plant

height but the genotype 015/03 collected from Oromia showed lowest mean value for plant height, internodes length, number of leaves per suckers and leaf area. Genotypes 001/10 collected from SNNPR showed lowest number of suckers per plants. The highest and lowest mean value of capsule bearing suckers per plants was observed for genotypes105/03 and 009/00.

Mean value of genotypes for capsule yield and yield components

Number of capsules per plant showed variation from 2.32 to 2.77 with the mean value of 2.55, while fresh capsule diameter (cm) ranged from 2.4 to 4.28, with a mean value of 2.74. The overall fresh capsule weight varied from 15.55 to 22.22 (g) with mean value of 18.21 (g). Fresh capsule length varied from 3.83 to 4.84 (cm) with mean value of 4.37 (cm). Dry capsule weight varied from 1.71 to 4.86 (g) with mean value of 3.35 (g). Dry capsule diameter ranged from 1.40 to 2.12 (cm) with the mean value of 1.71 (cm), while dry capsule length ranged from 1.23 to 4.09 (cm) with the mean value of 3.41 (cm). Total weight of dry capsule yield kg ha^{-1} ranged from 203.6 to 921.83 (kg) with mean valued of 516.1 (kg) (Table 3).

The genotypes 059/03 which was collected from Oromia had revealed highest mean value for fresh capsule length, dry capsule weight, dry capsules yield in kg per plot and dry capsules yield in kg ha^{-1} but genotype 025/03 obtained the same region had showed lowest mean value for number of capsules per plant, dry capsule length, dry capsules diameter, dry capsules yield in kg per plot and dry capsules yield in kg ha^{-1}. Generally, genotypes 059/03 and 025/03 showed a wide range of variability which gives a good information for future breeding.

Mean value of genotypes for seed characters and seed yield

Number of seed per capsule ranged from 96 to 176.81 with the mean value of 153.4, while total seeds weight per capsule varied from 0.91 to 3.26 (g) with mean value of 2.07 (g). Similarly pure seed yield kg per plot ranged from 0.30 to 1.34 (kg) with mean value of 0.56 (kg). (Table 3). The genotype 059/03 which was collected from Oromia revealed highest mean value for total seed weight per capsule, pure seed yield per plot and number of seed per capsule but the lowest mean value for total seed weight per capsule and pure seed yield per plot were recorded by BM31/03. Korerima genotypes revealed relatively narrow range of variation for number of seed per capsule.

Genotypic and phenotypic coefficients variations

Variance components and coefficients of variation estimate of characters are presented in Table 3. The genotypic coefficient of variation (GCV) ranged from 0.49 for dry capsule yield kg ha^{-1} to 35.57% for dry capsule diameter, while phenotypic coefficient of variation (PCV) ranged from 0.93 for dry capsule yield kg ha^{-1} to 64.38% for pure seed yield kg per plot (Table 3). Phenotypic coefficient of variation values were generally higher than their corresponding GCV values for all characters indicating the higher influence of environment on the expression of these characters in genotypes. According to Deshmukh *et al.* (1986) PCV and GCV can be categorized as low (<10%), moderate (10-20%) and high (>20%). Accordingly, both PCV and GCV values were high for number of capsule bearing suckers per plant, dry capsule diameter, and pure seed yield in (kg) per plot, while, internodes length (cm), dry capsule length (cm) and dry capsule weight (g) had high PCV values but GCV were moderate for these characters. The result suggested that selection based on phenotypic expression of genotypes is effective in improving these characters.

Both PCV and GCV values had moderate value for number of capsule per plant. whereas, plant height (cm), number of leave per plant, fresh capsule diameter (cm), dry capsule yield kg per plot and total seed weight per capsule had moderate PCV value , and also dry capsule length (cm) and dry capsule weight (g) had moderate GCV value (Table 3). This indicated the considerable influence of the environment on the expression of these characters and suggested the possibility of improvement of these characters through repeated selection based on the phenotype of genotypes. Hikmat *et al*. (2012) reported moderate phenotypic coefficients of variation for plant height and leaf area in turmeric which is support the current finding.

Both GCV and PCV values were low for leaf area (cm^2), fresh capsule length (cm), fresh capsule weight (g), dry capsule yield kg ha^{-1} and number of seed per capsule, and also, plant height (cm), internodes length (cm), number of leave per plant, leaf area (cm^2), fresh capsule length (cm), fresh capsule length, fresh capsule weight (g), dry capsule yield kg per plot, dry capsule yield kg ha^{-1}, number of seed per capsule and total seed weight per capsule had low GCV value. This indicates the presence of high influence of environmental factors on these characters and selection based on phenotypic performance of genotypes for these characters would be ineffective to bring about considerable improvement . Islam *et al*. (2008) reported leaf area, capsule length and fresh capsule weight were showed low GCV and PCV value which support the current finding. Selection is not appropriate breeding method to improve these characters because of the high masking of environmental factors on the expression of characters).

Estimate of heritability (H^2)

Heritability estimate for all the characters were computed in Table 3. The estimate of heritability in the broad sense ranged from 2.67 (cm) for internodes length to 92.31% for number of capsule per plant. According to Verma and Agarwal (1982) heritability of a character is classified as high if it is 50% or more and moderate for the values between 20% and 50% and low for values less than 20%. Accordingly, heritability values were high for number of capsule bearing suckers per plant (89.8%) , number of capsule per plant (92.31%), dry capsule diameter (82.22%) and number of seed per capsule (80%). Selection for such characters could be easy and effective to improve the characters on the phenotypic expression of the genotypes.

Medium heritability estimates were observed for number of leaves per suckers (31.25%), leaf area (31.49), fresh capsule diameter (20%), dry capsule length (22.39%), dry capsule yield kg ha^{-1} (27.89%) and pure seed yield in (kg) per plot (23.08%). This indicates that selection may not be rewarding in one cycle of selection due to considerable masking effect of environmental factors on the expression of these characters in korerima genotypes

The low estimates of heritability (<20%) were observed for plant height, internodes length, fresh capsule length, fresh capsule weight, dry capsule weight, dry capsule yield in (kg) per plot and total seed weight per capsules. This implies that selection may be difficult or virtually impractical due to the masking effect of the environment. This is because the low heritability of characters is due to the higher influence of environment factors than genetic factor which limit the scope of improvement using selection.

Estimation of expected genetic advance

The calculated genetic advance as the percent of the mean (GAM) at 5% selection intensity is presented in Table 3. Estimates of genetic advance ranged from 0.02% for dry capsule yield in kg per plot to 81.4% for dry capsule yield in kg ha^{-1}. The genetic advance as percent of mean was categorized as low (<10%), moderate (10-20) and high (> 20%) as suggested by Johnson *et al.* (1955). Accordingly, high genetic advance as percent of mean were observed for number of capsule bearing suckers per plants (40.02), number capsule per plant (26.89%), dry capsule diameter (66.45%) and pure seed yield in kg per plot (30.61). In addition Genetic advance as percent of mean were showed moderate for dry capsule length (19.17%) and number of seed per capsule (15.33%). It was suggested that the importance of considering both the genetic advance and heritability of character rather than considering separately in determining how much can progress be made through selection (Sharma, 2010).

Higher estimates of heritability coupled with better genetic advance confirms the scope of selection in developing new genotypes with desirable characteristics (Sharma 2010). This indicated that these characters were highly heritable and selection of high performing genotypes is possible to the improvement of the characters. These characters were less influenced by environmental changes. Most of the variations are due to genetic factor and improvement in these characters would be more effective through selection owing to their additive gene action (Sharma, 2010).

Genetic advance as percent of mean was low for plant height, number of leaves per sucker, leaf area, fresh capsule diameter, dry capsule weight, dry capsule yield kg per plot, and total seed weight per capsule. However, genetic advance as percent of mean were very low (<2%) for internodes length, fresh capsule length, fresh capsule weight and dry capsule yield kg ha^{-1}. This implies that the selection of high performing genotypes may not lead to improvement of the characters in the selected generation as compared to the base population due to the higher influence masking of non-genetic factors on the expression of these characters in the population under selection. Genetic advance under selection is a genotypic value, which depends on genetic variability, heritability, masking effect of non-genetic variability and the selection intensity applied (Sharma, 2010) . Therefore, genetic progress would increase with increase in the genetic variance and reduced non-genetic variability.

CONCLUSION

Based on the present investigation the following conclusion could be made; the genotypic coefficient of variation (GCV) ranged from 0.49% to 35.57% while phenotypic coefficient of variation (PCV) ranged from0.93% to 64.38%. Phenotypic coefficient of variation values were generally higher than their corresponding GCV values for all characters indicating the higher influence of environment on the expression of these characters in genotypes. The estimate of heritability in the broad sense was ranged from 2.67% (cm) for internodes length to 92.31% for number of capsule per plant. Estimates of genetic advance ranged from 0.54% for dry capsule yield kg ha^{-1} to 66.45% for dry capsule diameter. Both PCV and GCV values were high for number of capsule bearing suckers per plant, dry capsule diameter, and pure seed yield in (kg) per plot, while, internodes length (cm), dry capsule length (cm) and dry capsule weight (g) had high PCV values but GCV were moderate for these characters. Heritability values were high for number of capsule bearing suckers per plant (89.8%) , number of capsule per plant (92.31%), dry capsule diameter (82.22%) and number of seed per capsule (80%), while genetic advance as percent of mean were also high for leaf area (46.6%), number capsule per plant (23.65%), dry capsule diameter (33.77%), dry capsule yield kg ha^{-1} (81.4) and pure seed yield in kg per plot. The estimates of genetic variability components suggested selection will be fairly easy and efficient to this character.

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Table 1. List of the 25 korerima genotypes.

No.	Genotypes code	Region	Zone	Wereda	Altitude
1	053/03	SNNPR	South omo	Kemba	1850
2	046/03	Oromiya	Illubabor	Algea	1500
3	114/03	Oromia	Illubabor	Sombo	2229
4	029/84	Oromia	Wollega	Gimbi	1930
5	038/01	SNNPR	Sidamo	Arero	2829
6	045/03	SNNPR	Gamogofa	Damot	2121
7	021/00	SNNPR	Benchi maji	Bebeka	1285
8	015/03	Oromiya	Illubabor	Smbo	2229
9	Jimma local	Oromia	Jimma	Jimma	1580
10	686/87	Amhara	Gojam	Metekel	1525
11	001/00	Oromia	Bale	Genale	1000
12	093/00	Amhara	Gojam	Debre markos	2446
13	BM31/03	SNNPR	Kafa	Chena	1500
14	028/84	Oromia	Wollega	Arjo	1800
15	701/87	SNNPR	Kafa	Decha	2500
16	68/87	Amhara	Gojam	Agew midir	1500
17	25/03	Oromia	Illubabor	Metu	1605
18	BM34/03	SNNPR	Kafa	Chena	1972
19	059/03	Oromia	Wollega	Nekemte	2088
20	018/00	SNNPR	Kafa	Yeki	1097
21	016/84	Oromia	Illubabor	Sombo	2229
22	009/00	Amhara	Gojam	Metekel	1525
23	105/03	Oromia	Illubabor	Yayu	1387
24	010/00	SNNPR	Kafa	Chena	1972
25	011/00	SNNPR	Sidamo	Sidama	2759

Source: Tepi National Spice Research Centre

Table 2. Mean squares from analysis of variance for 17 characters of 25 korerima genotypes at Tepi during 2016

Characters	Repl.	Blocks within rep.(Adj)	Treatment		Error			Efficiency relative to RCBD	CV (%)
			(unadj.)	(adj.)	Intra	RCBD	Total		
	(1)	(8)	(24)	(24)	(16)	(24)	(49)		
Plant Height (cm)	120.4	248.24	284.2	284.24**	233.9	238.7	258.9	100.11	4.47
Number of capsule bearing sucker per plant	0.098	0.024	0.929	0.929**	0.05	0.043	0.068	81.67	19.9
Internodes length	3.95	0.93	3.84	3.81**	3	3.65	3.26	100.08	7.08
Number of leaves per plant	0.34	0.11	0.2	0.2*	0.12	0.11	0.11	98.48	9.58
Leaf area (cm^2)	768	182.43	441.3	441.35**	253.8	230	344.5	90.62	6.24
Number of capsule per plant	0.32	0.02	0.25	0.25*	0.15	0.019	0.02	101.41	8.2
Fresh capsule diameter (cm)	1.15	0.18	0.24	0.23**	0.15	0.16	0.22	101.04	14.2
Fresh capsule length (cm)	0.29	0.066	0.12	0.12**	0.1	0.091	0.11	85.3	14.4
Dry capsule length (cm)	0.043	0.37	0.9	0.9**	0.77	0.63	9.8	98.98	5.83
Dry capsule diameter (cm)	0.78	0.085	0.82	0.82**	0.067	0.073	0.77	101.6	15.1
Fresh capsule weight (g)	43.09	11.41	12.55	12.55**	11.77	11.65	0.75	82.59	5.86
Dry capsule weight (g)	1.31	0.49	1.02	1.02**	0.86	0.74	0.89	85.69	6.36
Dry capsule yield (kg per plot)	0.056	0.25	0.255	0.255**	0.17	0.203	0.014	86.02	16.5
Dry capsule yield (kg ha^{-1})	10.79	15.74	29.7	29.7**	17.26	16.75	0.61	72.45	16.6
Number of seed per capsule	514.5	216.82	623.5	623.51**	0.1	0.08	359.8	87.02	5.82
Total seed weight per capsule (g)	0.11	0.083	0.1	0.1**	0.07	0.08	0.22	98.1	7.63
Seed yield (kg per plot)	0.19	0.105	0.16	0.16**	0.088	0.094	22.97	97.06	17.8

* and **, significant at $P<0.05$ and $P<0.01$, respectively, numbers in parenthesis represented degree of freedom, blocks within rep.(Adj.)= adjusted blocks mean squares within replication, Treatments (Unadj.)= unadjusted treatment mean squares, Treatments (adj.)= adjusted treatment mean square, CV (%) = coefficient of variation in percent, RCBD= randomized complete block design.

Table 3. Estimates of variability components for different characters of various korrema genotypes at Tepi

Character	Range	Mean	SE	σ^2ph	σ^2g	PCV (%)	GCV (%)	H^2 (%)	GA	GAM (5%)
Plant Height (cm)	92-136	118.8	2.27	261.47	22.77	13.61	4.02	8.71	2.90	2.44
Number of capsule bearing sucker per plant	2.54-3.33	3.01	0.037	0.49	0.44	23.26	22.04	89.80	1.29	43.02
Internodes length	5.38-10.85	8.25	0.256	3.75	0.10	23.47	3.83	2.67	0.11	1.29
Number of leaves per plant	12.84-15.81	13.37	0.047	0.16	0.05	11.87	6.64	31.25	0.26	7.64
Leaf area (cm^2)	110.45-179.3	152.1	2.625	33.57	10.57	3.81	2.14	31.49	3.76	2.47
Number of capsule per plant	2.32-2.77	2.55	0.024	0.13	0.12	14.14	13.58	92.31	0.69	26.89
Fresh capsule diameter (cm)	2.4-4.28	2.74	0.066	0.20	0.04	16.32	7.30	20.00	0.18	6.72
Fresh capsule length (cm)	3.83-4.84	4.37	0.047	0.11	0.01	7.59	2.29	9.09	0.06	1.42
Dry capsule length (cm)	15.55-22.22	18.21	0.44	0.77	0.14	4.82	2.05	18.18	0.33	1.80
Dry capsule diameter (cm)	1.40-2.12	1.71	0.039	0.45	0.37	39.23	35.57	82.22	1.14	66.45
Fresh capsule weight (g)	1.23-4.09	3.41	0.12	2.01	0.45	41.58	19.67	22.39	0.65	19.17
Dry capsule weight (g)	1.71-4.86	3.35	0.13	0.88	0.14	28.00	11.17	15.91	0.31	9.18
Dry capsule yield (kg per plot)	1.63-7.37	4.13	0.067	0.23	0.03	11.61	4.19	13.04	0.13	3.12
Dry capsule yield (kg ha^{-1})	203.6-921.83	516.1	0.67	23.23	6.48	0.93	0.49	27.89	2.77	0.54
Number of seed per capsule	96-176.8	153.4	0.017	0.1	0.08	9.30	8.32	80.00	0.52	15.33
Total seed weight per capsule (g)	0.91-3.26	2.07	0.043	0.09	0.01	14.49	4.83	11.11	0.07	3.32
Seed yield (kg per plot)	0.30-1.34	0.56	0.05	0.13	0.03	64.38	30.93	23.08	0.17	30.61

σ^2g=Genotypic variance, σ^2ph= Phenotypic variance, GCV= Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, H^2 = Broad sense heritability, GA = genetic advance, GAM (%)=Genetic advance as percent of mean.