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RESEARCH ARTICLE

Selection of Some Cowpea (*Vigna unguiculata* L.) Genotypes for High Forage Yield in Egypt.

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ABSTRACT

The present investigation was carried out at the experimental farm of Sakha Agricultural Research Station, Kafrelsheikh Governorate, Agriculture Research Center, Egypt, during 2021, 2022, 2023, and 2024 growing summer seasons. This study was conducted to evaluate 24 cowpea genotypes were selected from base balady population based on morphological traits, in the second season, 24 selected genotypes with commercial variety Giza18 were sown in a randomized complete block design with three replicates, and select the best twelve genotypes saved to next generation ,in the third season 2023,the best twelve lines with the commercial variety Giza18 were sown, the same design and select the best six genotypes and saved to next generation, in the fourth season 2024,six superior genotypes with the commercial variety Giza18 were sown the same design. The obtained results could be summarized as follows: At the second season, the mean squares of the 24 selected genotypes based on the higher values of fresh and dry forage yield, as well as some morphological, technological, and chemical traits, were found to be significant for all the studied traits.

In the third season , the highest significant values for all the studied traits were twelve lines; number 2, 4 , 5, 9 , 10, 11 ,12, 16, 17, 20,21 , and 22 compared to the commercial variety Giza18 , meaning that selection for these traits was effective in improving the studied traits in these materials. In contrast, high genotypic variability and genotypic variability were detected for total dry yield, stem diameter, and leaf stem ratio %, while moderate (pcv) and (gcv) were detected for plant height, germination %, Seedling length, and Seedling fresh weight (g). On the other hand, low values of (pcv) and (gcv) were obtained for total fresh yield, no. of branches /plant, crude protein, crude fiber, and Seedling dry weight (g). Moderate to high heritability estimates were noted for the studied traits, ranging from 58.45 for seedling fresh weight (g) to 94.10 for total fresh forage yield (kg). / Plot. In the fourth season, the highest significance for all the studied traits was lines; number 4, 9, 10, 16, 20, and 22 compared to the commercial variety Giza18. This study highlights the importance of selecting fresh and dry forage yield and yield components traits, germination and seedling length for fresh and dry forage yield and yield components traits, as well as germination and seedling length, in breeding programs to develop high-yielding cowpea varieties.

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INTRODUCTION

Forage Production in Egypt is insufficient in quantity and quality, especially in the summer season; this is considered to be one of the main problems in feeding animals in Egypt. So, many studies have been conducted to increase forage quantity and quality production. Cowpea [*Vigna unguiculata* (L.)] Walp.] Is one of the most important legume crops (Bennett-Lartey and Ofori, 1999). Which has the ability to do well even in the drought, high temperature and other abiotic stress conditions. Cowpea grain contains about 25% protein and 64% carbohydrate (Ajeigbe *et al.,* 2008). It can fix about 240 kg/ ha of atmospheric nitrogen and make available about 60 - 70 kg/ha of nitrogen for succeeding crops grown in rotation with it (Rao and Shahid, 2011). Cowpea is the only fodder crop that contains high protein content and is rich in lysine and tryptophan amino acids as compared to other fodder crops (Ngompe-Deffo *et al.,* 2017). So it plays very important role in feeding animals during summer for its high quality, quantity, and nutritive value.

(Tarawali *et al.,* 1997) found that cowpea haulm is used to feed the livestock, which later provides manure for soil. So, it was necessary to set a plan to improve forage yield and quality characteristics of cowpea which now is considered an important summer forage crop. Genetic diversity plays an important role in the success of any breeding program (Ali *et al.,* 2008). Generally, genetic diversity is estimated by measuring variation in phenotypic or quantitative and qualitative traits; however, sometimes it is limited to the characterization of quantitative traits influenced by environmental conditions (Fernandes *et al.,* 2012). The phenotype is the first and easiest approach for the appraisal of genetic diversity in plant genetic resources, and is useful as a guide to follow-up characterization and evaluation studies (Bozokalfa *et al*., 2011). The assessment of genetic diversity and relationships among cowpea genotypes is of great importance for the determination of agro- morphological properties of gene pool and development of conservation strategies and identification of plant genetic resources (Martinezgomez et al., 2003; EL hamzaoui *et al.,* 2014; Rajab *et al.,* 2021) evaluated seventeen cowpea genotypes to detect the magnitude of variability degree of association between the different traits based on the performance of yield and its yield components and seed storage protein. (El-Nahrawy, 2018) evaluated 24- cowpea genotypes and found significant for all studied traits in two years Knowledge of genetic diversity in available germplasm and genotypes is very useful for plant improvement all over the world, promoting the efficient use of genetic variations in breeding programs through supporting the proper selection of cross combination among large sets of parental genotypes (Elteib and Gasim, 2020).

Improvement in forage crop has to be considered in terms of quality of forage, forage yield, palatability and animal performance which are to be taken into consideration simultaneously. Therefore, it is essential to know the association of various quantitative as well as qualitative characters in order to initiate an effective selection programmer aiming at the improvement of yield and quality of the forage. (Akhshi *et al.,* 2014; Alidu *et al.,* 2020). Wide differences in forage yield were observed among genotypes of fodder cowpea (Owusu *et al.* 2018). High genetic variability was observed developing a breeding population aimed at developing high yielding cowpea varieties may result in significant genetic gains as mentioned by (Chipeta *et al.,* 2024). Despite its numerous benefits, breeding of the cowpea poses a lot of challenges, hence its production is not adequate to satisfy domestic demand for the commodity. Although cowpea is a single crop species, the varietal requirements in terms of plant type, seed color or type, maturity, and use pattern are extremely diverse from region to region, making breeding programs for the crop more complex than for other crops (Singh *et al.,* 1997). This study was conducted to evaluate 24 cowpea genotypes for fresh and dry forage yield and yield components, as well as some morphological, technological, and chemical traits, and select the best lines with desirable traits for improving the forage yield in Egypt.

MATERIALS AND METHODS

The present investigation was carried out at the experimental farm of Sakha Agricultural Research Station, Kafrelsheikh Governorate, Agriculture Research Center, Egypt, during 2021, 2022, 2023 and 2024 growing summer seasons.

In the first growing season 15 May 2021, 200 seeds of the base balady population and commercial variety Giza 18 were sown in non-replicated rows. Each row 3 m long and spaces between rows were 0.7 m with 30cm between plants. Seeds were sown by hands (3 seeds / hill), plant / hill was maintained. All agriculture practices were carried out as usual for ordinary Cowpea field in the area, at the proper time. At flowering time and harvest, the best 24 plants (genotype) were selected based on the higher values of morphological traits (plant height, stem diameter, and number of branches) and saved to the next generation.

In the second season 2022, 24 selected lines with the commercial variety Giza18 were sown in a randomized complete block design with three replicates, Plot size was 6.3m^2 (3rows, .07m wide and 3m long) and 20cm between hills. After two weeks, the hills were thinned to one plant per hill. Recommended agricultural practices were applied.

The treatments were fertilized with 30 kg P_2o_5 /fad which wereadded during land preparation and 33 kg N/fad which were divided into two equal parts, part added before the first irrigation and the other after the first cut. Three cuts were taken after 50, 90, and 120 days from sowing, respectively.

Studied traits:

1- Morphological traits; (i) Total fresh yield (Kg \ plot) , (ii) Total dry forage yield (Kg\plot), (iii) Mean plant height (cm)m,(vi) Stem diameter (cm), (v) Number of branches per plant, and (IV) Percent fresh leave \stem weight. Data was determined at each cutting, and averages of the overall cuts were taken

2-Technological traits were made in the seed technology Lab. (i) Germination (%) according to ISTA (1999). (ii) Seedling length (cm). And (iii) Seedling fresh and dry weight (g).

3- Chemical traits; (i) crude protein and (ii) Crude fiber according to AOAC (2000).

3.4. Statistical and genetic analyses:

The variance components from the regular analysis of a randomized complete block design as outlined by Steel and Torrie (1980) were used to estimate the phenotypic and genotypic variances as outlined in Table 1.

The phenotypic and genotypic coefficient of variability:

The phenotypic (PCV) and genotypic (GCV) coefficient of variability were calculated as (σ p / ×⁻) 100 and (σ g / ×⁻) 100 , respectively .

According to Kearsey and Pooni (1996).

Where the genotypic variance σ^2 g = (M2 - M_1)/ r and the phenotypic variance σ^2p = rσ^2 g + σ^2_e/ r

Heritability in the broad sense (h^2_b) was estimated as the percentage of genotypic to phenotypic variance as follows:

$$h_b^2 = \frac{\sigma^2 g}{\sigma^2 p} \times 100$$

The best selected (12) twelve lines saved for the next generation.

In the third season of 2023, the best twelve lines with the commercial variety Giza 18 were sown. The same design, agricultural practices, studied traits, and statistical and genetic analysis were applied as in the 2022 season. The best six lines were selected and saved for the next generation.

In the fourth season 2024, six superior lines with the commercial variety Giza 18 were sown, the same design, agricultural practices, all the studied traits as well as the statistical and genetical analysis were applied as in the 2023 season.

RESULTS AND DISCUSSION

Analysis of variance of 24 genotypes showed highly significant differences for all the studied traits. Indicating the presence of genetic variability among selected lines, it cleared that selection based on the shape and colour of seeds, total fresh yield / plant and total dry yield/plant would be effective. Table (2).

Table 1. The analysis of variance and expected mean squares.

S. O .V.	d.F.	M.S	E.M.S.
Replications	r-1	M3	σ^2_e +g σ^2 r
Genotypes(families)	g-1	M2	σ^2_e + r σ^2 g
Error	(r-1)(g-1)	M1	σ^2_e
Total	(r g - 1)		

Where: r and g ; number of replication and genotypes , respectively .
σ^2_e and σ^2 g = error variance and genetic variance , respectively .

Table 2: **Analysis of variance for all the studied traits of 24 cowpea genotypes and variety Giza18**

S.O.V	d. f	Total fresh yield kg\plot	Total dry yield Kg\plot	Plant height (cm)	Stem diameter (cm)	No. of branches\ plant	Leaf \stem ratio%	Crude protein (%)	Crude fiber (%)	Germ. (%)	S.L (cm)	S.F.W (g)	S.D.W (g)
Rep	2	1.044	0.035	9.470	0.002	0.235	31.309	0.564	3.28	11.19	0.90	0.31	0.01
Gen.	24	120.3**	5.54**	69.69*	0.013**	1.054**	59.83**	1.013**	0.667**	148.541**	8.181**	0.449**	0.147**
Error	48	0.253	0.113	13.212	0.001	0.056	7.037	0.078	0.102	3.790	0.362	0.086	0.008

*, ** significant and highly significant at 0.1 % and 0.05 levels of probability, respectively.

Table 3: Phenotypic coefficients of variability (pcv), genotypic coefficients of variability (gcv), as well as heritability in the broad sense and genetic advances for all the studied traits.

Traits	Total fresh yield kg\plot	Total dry yield Kg\plot	Plant height (cm)	Stem diameter (cm)	No. of branches\ plant	Leaf \ stem ratio%	Crude protein (%)	Crude fiber (%)	Germ. (%)	S.L (cm)	S.F.W (g)	S.D.W (g)
X ⁻	66.43	9.81	61.42	0.67	11.91	65.43	17.46	26.24	90.69	20.53	4.82	26.24
$\sigma 2g$	4.04	1.81	18.83	0.004	0.33	17.59	0.35	0.188	48.25	2.61	0.12	0.188
$\sigma 2$P	4.29	1.93	32.04	0.005	0.39	24.63	0.43	0.290	52.04	2.97	0.21	0.290
G. c. v	3.02	13.71	7.07	9.44	4.82	6.41	3.39	1.65	7.66	7.86	4.45	1.65
p. c .v	3.12	14.16	9.21	10.55	5.24	11.29	3.76	2.05	7.95	8.39	9.44	2.05
H^2%	94.10	93.78	58.77	80.0	84.61	71.14	81.39	64.82	92.71	87.87	58.45	64.82
GA%	4.11	18.59	7.58	11.82	6.21	7.55	4.28	1.86	10.32	10.32	7.72	1.86

Phenotypic, genotypic coefficient of variations, phenotypic coefficients of variability (p c v), and genotypic coefficients of variability (g c v) as well as heritability in broad sense and genetic advances for all the studied traits are presented in table 3.

Phenotypic and genotypic coefficients of variability varied from one trait to the other. High G C V value of traits suggested the possibility of improving these traits through selection. Data showed that, high phenotypic coefficients of variability (p c v) and genotypic coefficients of variability (g c v) were detected for total dry yield kg. /plot (14.16 and 13.71), stem diameter (10.55 and 9.44) and leaf stem ratio % (11.92 and 6.41) respectively, while moderate phenotypic coefficients of variability (p c v) and genotypic coefficients of variability (g c v) were detected for plant height (9.21 and 7.07), germination % (7.95 and 7.66), seedling length (8.39 and 7.86) and S.F.W. (g) (9.44 and 4.45), respectively. On the other hand, low values of (p c v) and (g c v) were obtained for total fresh yield (3.12 and 3.02), no. of branches / plant (5.24 and 4.82), crude protein (3.76 and 3.39), crude fiber (2.05 and 1.65) and S.D.W. (g) (2.05 and 1.65), respectively.These results agree with (Mamta *et al.,* 2014; El-Nahrawy, 2018; Rajab *et al.*, 2021; Nkhoma *et al.,* 2020)

Heritability estimate is considered one of the most critical parameters to selection response in early generation, indicating the importance of the genetic effects in the inheritance of all the studied traits. Heritability values were estimated from the analysis of variance of lines and commercial variety Giza18 are presented in Table 3. Moderate to high heritability estimates were noted for the studied traits and ranged from (58.45) for S.F.W. (g) to (94.10) for total fresh yield kg. / Plot. The traits: plant height, crude fiber, F. W. (g) and S.D.W. (g) showed moderate heritability estimates (58.77, 64.82, 58.45, and 64.82, respectively), while the other traits showed high heritability estimates, as mentioned with (El-Nahrawy, 2018; Rjab *et al.,* 2021; Chipeta *et al.*, 2024; Jonah *et al.*, 2024).

With respect to genetic advance (G A %), high values were detected for the traits ; total dry forage yield , stem diameter , germination and seedling length . (Saha *et al.,* 2024) reported that, the traits which exhibited high heritability and substantial genetic advance, suggesting that direct selection for these traits would be effective

Mean performances of 24 lines and the commercial variety Giza18 for all the studied traits are presented in Table (4)

For total fresh yield kg/ plot, the lines number2, 4, 5, 9, 10, 11, 12, 16, 17, 20, 21, and 22 showed significant or highly significant for total fresh yield kg/ plot than the commercial variety Giza18.

The lines number 4, 9, 10, 16, 20, 21 and 22 exhibited significant higher of total dry yield kg / plot than the commercial variety Giza18. While, the other families showed lower for this trait.

Regarding plant height (cm), the lines number 9, 10, 16, and 19 significantly surpassed the commercial variety Giza18 for this trait, while the other lines showed shortest plant height relative to commercial variety. With respect to stem diameter (cm), the lines number 5, 9, 10, 11, 15, 16, 20 and 22 had significantly higher stem diameter relative to commercial variety .

For number of branches / plant the lines 4, 5, 8, 9, 10, 11, 12, 13, 16, 20, 21, and 22 expressed significant higher number of branches / plant relative to commercial variety Giza18.

With respect to leaves / stem ratio % the lines number 7, 8, 9, 10, 1 6, 20 and 21 were highly significant compared to commercial variety for this trait.

For crude protein %, lines 4, 9, 10, 11, 12, 16, 17, 20, 21, and 22 surpassed the commercial variety Giza18.

Regarding crude fiber %, the lines number 4, 6, 7, 12, and 14 showed significant or highly significant for crude protein % relative to the commercial variety Giza18. Meanwhile, the other lines exhibited less crude fiber %, relative to the commercial variety Giza18.

Germination %, ranged from 74.00 % for line no.6 to 98.67 % for line no.10, also, the results showed that the lines number 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 14, 16, 17, 18, 20, 21 and 22 were highly significant compared to the commercial variety Giza18 for crude protein %.

Regarding seedling length (cm), lines 1, 2, 4, 9, 10, 11, 16, 17, 20, 21, and 22 significantly surpassed the commercial variety Giza18 for this trait, while the other lines showed the shortest seedling length (cm) relative to commercial variety Giza18.

Table 4: Mean performance of all the studied traits of 24 lines and commercial variety Giza18 cowpea.

Genotypes	Total Fresh yield Kg\plot	Total Dry yield kg\plot	Plant height (cm)	Stem diameter (cm)	No. of branches \plant	Leaf \ stem ratio%	Crude protein (%)	Crude fiber (%)	Germ. (%)	S.L (cm)	S.F.W (g)	S.D.W (g)
1	65.73	9.42	52.89	0.65	11.63	55.99	16.56	26.57	94.90	21.00	4.70	1.50
2	66.65	10.06	57.89	0.67	13.92	75.72	18.10	25.87	95.00	21.57	5.93	1.90
3	65.50	9.17	60.00	0.67	11.28	57.89	16.40	26.77	90.00	18.50	4.40	1.52
4	70.23	10.84	57.55	0.73	13.20	76.11	17.90	25.67	96.40	21.47	5.68	2.10
5	67.10	10.15	61.44	0.68	13.11	69.55	17.47	25.63	95.67	20.53	5.52	1.90
6	57.07	8.37	59.33	0.63	11.13	62.81	17.00	26.67	74.00	19.63	4.13	1.53
7	61.37	9.00	60.78	0.67	11.34	68.96	17.17	26.76	86.67	19.57	4.30	1.70
8	66.23	9.72	62.44	0.58	12.06	69.11	17.40	27.27	90.00	20.57	4.70	1.70
9	72.00	11.18	68.11	0.71	13.87	69.57	18.00	25.60	97.00	22.57	5.65	2.10
10	86.07	13.68	70.11	0.82	13.14	74.47	18.80	25.47	98.67	23.77	5.50	2.23
11	68.63	10.41	60.55	0.73	12.06	66.42	18.13	26.00	96.33	22.67	5.55	2.03
12	66.70	10.47	62.89	0.69	13.34	64.67	17.87	26.27	95.00	21.57	5.57	1.77
13	64.93	9.52	63.89	0.61	12.27	67.22	16.93	26.67	80.33	18.00	4.67	1.47
14	64.00	8.75	61.00	0.56	11.82	60.44	17.33	26.73	89.67	18.80	4.20	1.80
15	65.80	8.11	62.56	0.72	11.27	61.00	17.07	26.43	77.00	19.43	4.03	1.67
16	72.43	11.49	70.17	0.73	12.52	70.79	18.33	25.93	97.00	22.23	6.65	2.10
17	66.76	10.18	59.67	0.68	13.39	69.13	17.83	26.37	94.00	21.27	4.96	1.93
18	63.50	8.47	64.33	0.69	11.13	66.22	17.03	26.27	90.33	20.00	4.86	1.63
19	60.83	8.31	68.89	0.63	11.06	60.00	16.80	26.50	85.33	18.57	4.67	1.70
20	73.73	11.58	64.34	0.76	13.31	71.95	18.17	25.57	98.00	22.13	5.68	2.13
21	67.82	10.58	61.22	0.69	13.40	69.67	18.00	25.87	95.67	21.77	5.48	1.90
22	68.57	10.65	62.78	0.73	13.47	66.12	18.07	25.97	97.00	22.10	5.68	1.80
23	64.27	8.78	54.67	0.66	11.84	64.89	16.73	26.57	87.33	19.67	4.86	1.60
24	50.23	7.37	51.67	0.52	10.94	61.00	17.00	26.57	79.67	17.00	4.70	1.60
Giza18	65.70	9.85	59.37	0.67	12.13	64.11	17.30	26.13	86.33	20.00	5.00	1.77
F .test	**	**	**	**	**	**	**	**	**	**	**	**
Lsd0.01	1.10	0.73	7.95	0.07	1.55	5.80	0.61	0.69	4.26	1.31	0.64	0.12
Lsd0.05	0.83	0.55	5.96	0.03	1.16	4.35	0.46	0.52	3.19	0.99	0.48	0.09

Seedling fresh weight (g): lines 4, 5, 9, 10, 11, 16, 19, 20, and 22 exhibited significantly higher seedling fresh weight (g) than the commercial variety Giza 18. The other families showed lower scores for this trait.

Seedling dry weight (g), the lines 4, 5, 9, 10, 11, 16, 17, 20 and 21 exhibited significant higher of Seedling dry weight (g) than the commercial variety Giza18. While, the other families showed lower for this trait.

Generally, the results showed that, the twelve selected lines 2, 4 , 5, 9 , 10, 11 ,12, 16, 17, 20,21 , and 22 significantly out yielded or surpassed the commercial variety Giza18 for

Table 5. Analysis of variance for all the studied traits of 12 lines and cowpea genotypes and commercial variety Giza18

S.O.V	d. f	Total fresh yield kg\plot	Total dry yield Kg\plot	Plant height (cm)	Stem diameter (cm)	No. of branches\ plant	Leaf \ stem ratio%	Crude protein (%)	Crude fiber (%)	Germ. (%)	S.L (cm)	S.F.W (g)	S. D.W (g)
Rep	2	0.054	0.086	2.679	3.466	1.669	0.543	24.92	0.325	0.001	3.060	0.07	0.745
Geno	12	0.098**	0.230**	4.561**	99.360**	0.321**	0.974	46.9**	1.47**	0.008**	141.31**	4.876**	82.76**
Error	24	0.004	0.014	0.092	1.033	0.121	0.025	11.143	0.054	0.001	38.37	0.05	0.393

Table 6: Phenotypic, genotypic coefficient of variations, phenotypic coefficients of variability (p c v), genotypic coefficients of variability (g c v) as well as heritability in broad sense and genetic advances of the best twelve selected lines for all the studied traits.

Traits	Total fresh yield kg\plot	Total dry yield Kg\plot	Plant height (cm)	Stem diameter (cm)	No. of branches\ plant	Leaf \ stem ratio%	Crude protein (%)	Crude fi ber (%)	Germ. (%)	S.L (cm)	S.F.W (g)	S.D.W (g)
$\bar{X}$	2.02	5.09	22.10	94.88	26.269	18.00	68.98	12.828	0.747	67.477	11.66	71.48
$\sigma2g$	0.031	0.07	1.32	32.77	0.213	0.31	11.93	0.475	0.002	34.315	1.606	27.32
$\sigma2P$	0.035	0.08	1.41	33.80	0.332	0.34	23.07	0.529	0.003	72.683	1.664	27.72
G. c. v	8.72	5.27	5.19	6.03	1.75	3.09	5.00	5.37	5.98	8.68	10.86	7.31
p. c .v	9.26	5.76	5.37	6.13	2.19	3.23	6.96	5.66	7.33	12.60	11.06	7.36
H^2%	88.57	81.39	93.61	96.9	64.15	91.17	51.71	89.79	77.7	47.21	96.51	98.56
GA%	11.48	6.56	7.04	8.31	1.96	4.13	5.04	7.12	5.95	8.35	14.94	10.16

Table 7: Mean performances of all the studied traits of 12 lines and commercial variety Giza18 cowpea.

Lines	Total Fresh yield Kg\plot	Total Dry yield kg\plot	Plant height (cm)	Stem diameter (cm)	No. of branches\ plant	Leaf \ stem ratio%	Crude protein (%)	Crude fiber (%)	Germ. (%)	S.L (cm)	F.W (g)	D. W (g)
2	69.56	11.20	65.14	0.72	12.50	67.87	17.30	26.17	94.00	22.60	5.00	1.77
4	72.62	12.12	66.50	0.74	12.77	68.40	18.67	25.97	96.57	22.90	5.33	2.10
5	69.87	11.24	64.73	0.69	12.37	67.70	17.67	25.73	97.33	20.50	5.07	2.00
9	73.33	12.49	73.10	0.77	13.23	71.30	18.20	25.90	97.67	23.33	5.30	2.20
10	86.53	15.02	81.97	0.87	14.23	76.00	19.00	25.80	99.00	24.00	5.63	2.27
11	69.13	11.10	64.67	0.76	12.43	67.00	18.17	26.27	98.57	23.00	4.83	2.03
12	68.67	11.3	65.70	0.72	13.60	67.95	18.35	26.85	97.3	22.77	5.6	2.04
16	73.52	12.18	79.37	0.78	13.37	72.02	18.47	26.53	97.67	22.73	5.16	2.13
17	68.40	10.87	66.40	0.73	12.63	66.85	17.97	26.93	95.00	21.70	4.70	1.90
20	74.77	12.51	69.93	0.81	13.57	73.33	18.40	26.03	98.33	22.37	5.30	2.27
21	68.50	11.00	65.00	0.76	12.93	72.17	18.07	26.17	95.33	21.67	5.07	2.00
22	70.33	11.44	65.70	0.75	13.07	69.00	18.27	26.66	98.00	22.27	5.20	2.03
Giza18	67.07	10.46	62.00	0.70	12.27	63.50	17.20	26.80	87.33	20.50	4.93	1.90
F .test	**	**	**	**	**	**	**	**	**	**	**	**
Lsd0.01	1.43	0.55	15.44	0.58	0.58	7.54	0.35	0.85	2.32	0.69	0.27	0.43
Lsd0.05	1.06	0.41	10.94	0.05	0.41	5.57	0.26	0.61	1.7	0.51	0.19	0.32

Table 8: Analysis of variance for all the studied traits of six line cowpea and commercial variety Giza18.

S.O.V	d.f	Total Dry yield kg\plot	Plant height (cm)	Stem diameter (cm)	No. of branches\ plant	Leaf \stem ratio%	Crude protein (%)	Crude fiber (%)	Germ. (%)	S.L (cm)	F.W (g)	D. W (g)
Rep	2	0.023	1.714	0.001	0.961	2.218	0.301	0.192	4.33	0.803	0.065	0.025
Genotypes	6	4.537**	284.60**	0.020**	2.687**	81.769**	1.083**	0.534*	110.762**	5.504**	0.226**	0.143**
Error	12	0.019	8.77	0.001	0.038	0.127	0.019	0.152	1.33	0.175	0.013	0.003

most the studied traits, meaning that selection was effective in improving the studied traits in these materials.

Analysis of variance of the best twelve selected lines and commercial variety Giza18 in the third season (2023) Table 5 showed highly significant for all the studied traits. Indicating the presence of genetic variability among these lines, meaning that selection based on these traits was effective in improving the studied traits in these materials. As *well* as mentioned by (El-Nahrawy, 2018; Rajab *et al.,* 2021; Saha *et al.,* 2024).

Phenotypic, genotypic coefficient of variations, phenotypic coefficients of variability (p c v), and genotypic coefficients of variability (g c v) as well as heritability in broad sense and genetic advances of the best twelve selected lines for all the studied traits are presented in table 6.

Phenotypic and genotypic coefficients of variability varied from one trait to the other. High G C V value of traits suggested the possibility of improving these traits through selection. Data showed that, high phenotypic coefficients of variability (p c v) and genotypic coefficients of variability (g c v) were detected for total fresh yield kg. /plot (9.26 and 8.72), seedling length (12.6 and 8.68) and seedling fresh weight (11.06 and10.86) respectively, while moderate phenotypic coefficients of variability (p c v) and genotypic coefficients of variability (g c v) were detected for stem diameter , crude protein , germination and seedling dry weight .On the other hand, the other traits showed low phenotypic coefficients of variability (p c v) and genotypic coefficients of variability (g c v).

Heritability estimate consider one of the most important parameters to selection response in early generation, indicating the importance of the genetic effects in the inheritance of all the studied traits. Heritability values were estimated from the analysis of variance of lines and commercial variety Giza18 are presented in Table (6). Moderate to high heritability estimates was noted for the studied traits and ranged from (51.71) for crude protein to (98.56) for seedling dry weight.

Generally, the results showed that, the twelve selected lines 2, 4 ,5, 9, 10, 11 ,12, 16, 17, 20, 21, and 22 significantly out yielded or surpassed the commercial variety Giza18 for most the studied traits, meaning that selection was effective in improving the studied traits in these materials Table7.

Analysis of variance of the best six line cowpea and commercial variety Giza18 in the fourth season (2024) showed highly significant for all the studied traits. Indicating the presence of genetic variability among these lines, meaning that selection based on these traits was effective in improving the studied traits in these materials (El-Nahrawy, 2018; Rajab *et al.,* 2021; Saha *et al.,* 2024; Dairo, 2024).

Table 9: Phenotypic, genotypic coefficient of variations, phenotypic coefficients of variability (p c v), genotypic coefficients of variability (g c v) as well as heritability in broad sense and genetic advances for all the studied traits.

Traits	Total Fresh yield Kg\plot	Total Dry yield kg\plot	Plant height (cm)	Stem diameter (cm)	No. of branches \plant	Leaf \ stem ratio%	Crude protein (%)	Crude fiber (%)	Germ. (%)	S.L (cm)	S.F.W (g)	S.D. W (g)
X ̄	74.75	12.63	75.28	0.79	13.35	71.23	18.31	26.88	95.19	22.52	5.24	2.12
$\sigma 2$g	49.18	1.51	91.94	0.006	0.88	27.21	0.35	0.55	36.47	1.77	0.071	0.046
$\sigma 2$P	49.43	1.53	100.71	0.007	0.92	27.34	0.37	0.64	37.80	1.95	0.084	0.049
G. c. v	9.38	9.61	12.71	9.69	7.03	7.32	3.23	2.75	6.34	5.90	5.08	10.12
p. c .v	9.40	9.77	13.33	10.47	7.18	7.34	3.32	2.97	6.46	6.20	5.53	10.44
(H^2)%	99.40	98.75	91.29	85.71	95.87	99.53	94.59	85.93	96.48	90.76	84.52	93.87
GA%	13.08	13.51	17.03	12.56	9.64	10.22	4.39	3.58	8.72	7.87	6.54	13.72

Table 10: mean performance of all the studied traits of six lines and commercial variety Giza18 cowpea.

Lines	Total Fresh yield Kg\plot	Total Dry yield kg\plot	Plant height (cm)	Stem diameter (cm)	No. of branches \plant	Leaf \ stem ratio%	Crude protein (%)	Crude fiber (%)	Germ. (%)	S.L (cm)	S.F.W (g)	S. D. W (g)
9	73.57	12.50	75.67	0.78	13.40	72.83	18.30	26.30	98.33	23.57	5.40	2.27
10	87.40	15.06	84.67	0.87	14.37	76.93	19.06	26.63	99.00	24.20	5.70	2.33
16	74.83	12.47	77.67	0.81	13.03	73.43	18.63	26.23	98.00	23.03	5.18	2.23
20	75.77	12.80	77.33	0.85	13.33	75.53	18.53	26.27	98.67	22.86	5.30	2.27
21	69.82	11.78	68.92	0.78	13.27	72.4	18.43	27.00	96.30	22.45	5.17	2.02
22	70.80	11.68	75.67	0.77	13.37	70.83	18.50	27.26	98.00	22.57	5.20	2.10
Giza18	67.37	11.09	69.33	0.75	12.47	64.90	18.00	27.50	91.67	20.90	5.03	1.93
F .test	**	**	**	**	**	**	**	**	**	**	**	**
Lsd0.01	1.25	0.33	7.38	0.07	0.48	0.88	0.34	0.74	2.88	1.04	0.27	0.14
Lsd0.05	0.88	0.23	5.23	0.05	0.15	0.63	0.24	0.53	2.03	0.74	0.19	0.09

Phenotypic (PCV) and genotypic (GCV) coefficients of variability as well as heritability in broad sense were estimated from the analysis of variance of six line and commercial variety G18 are showed in Table 9.

The previous results showed that the differences between PCV and GCV were small, which indicated the importance of genetic variance in the inheritance of all the studied traits, and suggested that the environment had little effect on the expression of these traits.

Generally, the results showed that, the six selected lines;4, 9 , 10, 16, 20 and 22 significantly out yielded or surpassed the commercial variety Giza18 for most the studied traits table 10, indicating wide differences among the genotypes selected and these selected genotypes may be promising at the breeding program to produce superior yielding new varieties (El-Nahrawy, 2018; Rajab *et al.,* 2021; Jonah *et al.,* 2024; Saha *et al.,* 2024).

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