https://doi.org/ 10.33472/AFJBS.6.5.2024. 6944-6957

African Journal of Biological Sciences

Study the genetic performers of genotypes cabbage under mosul condition.

Esaa Abd-alhuseein Jasim* **Kamal Benyamin Esho****

Dept. of Horticulture and landscape design, college of agriculture and forestry, Mosul Univ.

*** Esraa.AJ@uomosul.edu.iq**
****kamalesho@rocketmail.com , or kamalesho@uomosul.edu.iq**

Article History
Volume 6, Issue 5, 2024
Received: 15 May 2024
Accepted: 22 May 2024
doi: *10.33472/AFJBS.6.5.2024. 6944-6957*

Abstract

In order to investigate the genetic parameters for the elephant (11) of cabbage genotypes, various combinations of genotypes have been examined in the vegetable research field, which is connected to Dept. of Horticulture and Landscape Design, College of Agriculture and Forestry, Univ. of Mosul, throughout the fall growing season 2021/2022. Using an analysis of variance table, results have shown that, at the 5% probability level, the genotypes had considerably differed among themselves in the majority of attributes that were evaluated. In addition, Broutis genotype did better than the other genotypes with regard to head weight and length as well as abscess leaf diameter, whereas the Ruby ball genotype performed better than the other genotypes with regard to abscess leaf diameter and head weight and length. Features of the overall yield per unit area compared to the remaining genotypes. With the exception of the trait of percentage of total dissolved solids, which has been very low, the traits of diameter, length, and yield per ton per unit area had high phenotypic variance (δ^2p) and genetic variance (δ^2g), has been high for most of the traits studied and the rate of heritability in the broadest sense($H^2_{b.s.}$) more than 80%. The total yield has been associated with r=0.496, r=0.387, and r=0.369, respectively, the area unit exhibits a strong positive genetic and phenotypic connection with internal stem length, TSS, and internal stem length.

Introduction

The plant is of the cruciferous family Brassicaceae (Cruciferae) or the Mustard family, and it is a large family that includes about 300 genera and about 3000 species. It is also found growing wild in the coasts of the United Kingdom, Denmark, northern France and Greece (Al-Hassan, 2002). Plant has been cultivated for more than 4500 years, and it was known to ancient Egyptians, Greeks and Romans, it is said that it is in Roman cemeteries (Surour *et al*., 1936). The leaves of the plant are used in filling and pickling, and also eaten cooked or boiled. The plant contains nutritional components including water, proteins, fats, carbohydrates, fibers and nutritional elements, which include calcium, phosphorous, iron, sodium, thiamine, vitamin A, niacin, riboflavin, and ascorbic acid (Watt and Merrill, 1963). Varieties vary among themselves in many phonotypical characteristics, including the size of the head, color and texture of the leaves, weight of the head, and the date of maturity, in addition to the fresh use. In addition to variations between the varieties in the extent of their readiness for early flowers for the purpose of obtaining seeds. Because the yield and its constituent characteristics are polygenic, environmental factors have an impact on them. To introduce genetic improvement in cabbage, it is crucial to understand the interrelationships between the different components and how they affect yield both directly and indirectly. Plant breeders can choose the best selection criteria for increased yield with the use of the path coefficient. Path analysis makes it easier to divide correlation coefficients between indirect and direct effects of different characteristics on gross weight. This information could be helpful in enhancing yield or other associated characters. There is insufficient information available about the correlation and path coefficient analysis of cabbage.

A study that has been carried out by Abdel-Qader and Al-Saeedy (2000) revealed that the plant weight and head weight of various cabbage varieties differ significantly, with K.K. cross and Tropicana cultivars exhibiting highest significant increases. This suggests that the K.K. cross as well as Tropicana cultivars outperform other cultivars in terms of marketing yield, as they yielded 12.69tons/don and 10.28tons/don, respectively, compared to 5.7.27 tons/don in the Copenhagen market cultivar on average throughout both growing seasons. The total yield has been 16.06tons/don and 13tons/don, compared to 8.40 tons/don, on average, during the two growing seasons. According to Esho's (2005) research in Mosul, the Broutis genotype significantly outperformed other kinds in terms of overall yield, head diameter, head weight, and head height. Numerous researchers have already used correlation and path analysis to study the links between yield and different yield components as well as the impacts of yield components on yield in cabbage (Ji *etal*. 2005, Yadav *et al*. 2003; Meena *et al*. 2009, 2010; Singh *et al*. 2010 and Sharma 2010).

Ali et al. (2012) report that earliness and yield showed genetic variations for the studied traits. The accessions "El-Fayum" and "El-Minofia" had earliest 50% head formation along with need of fewest days for the purpose of reaching maturity as well as terminating lifecycle. But, "El-Sharkia" was the variety which reached 50% head formation last and also had the longest time for maturity and life cycle end. The accessions "El-Giza" and "El-Sharkia" yielded the highest marketable gross yield and weight of the head. The accession of "El-Dakhalia" produced lowest Gross Yield. Conversely, the "El-Fayyum" accession yielded the least amount of the marketable head weight. The findings of this research may be helpful in developing cabbage breeding efforts. Kibar *et al*.'s (2014) research, eleven economic characteristics, including plant diameter, outer leaf length, plant height, outer leaf width, head weight, core length, diameter of the head, head length, inner stem diameter, days to maturity, and yield, have been analyzed using correlation and path coefficients. For every trait, a significant variance was found between the genotypes of cabbage. With the exception of days to maturity and length of the core, all of the yield components were shown to have highly significant and positive associations with yield. The relationship between yield and head weight had the strongest significant positive association (r = 0.927**). Head weight (0.7139, 56.81%), length of the head (0.2265, 23.820%), and diameter of the plant (0.1907, 16.59%) showed the largest positive direct effects on yield, according to path coefficient analysis. Due to the fact that such characteristics were the most significant yield components influencing cabbage yield, head length, head weight, plant height, plant diameter, length , width of outer leaf, diameter of the head, and diameter of interior stem can be utilized as criteria of selection in breeding program of the varieties of cabbage with high yielding.

Gross head weight, plant spread, polar diameter, net head weight, marketable heads for each one of the plots, equatorial diameter, ascorbic acid content, and TSS had shown a positive significant correlation with the marketable head yield for each plot at phenotypic as well as genotypic levels, according to Kaur *et al.*'s (2018) estimates of the correlation coefficient. This suggests that selection depending on such characters, either combined or alone, will find genotypes with high yield potential. According to the estimations of direct impacts at genotypic level, the number of non-wrapper leaves, ascorbic acid content and compactness of head, and polar diameter were top five factors having positive direct influence on marketable head yield per plot. So, in cabbage breeding if we want to get more yield then selection factors such as net weight of head should be considered along with compactness or density (m/v) and polar diameter. As per the results of Shrestha (2019), Wonder Ball had better performance compared to Green Coronet in terms of days to harvest, yield, average head weight, freshness and market liking. It has been found that the Wonder Ball has high vigour and uniformity with significantly superior qualities like freshness, yield, average head weight and preference in market compared to cultivar Green Coronet. The next one which got second position is Green Challenger that had possessed yield along with fresh quality also an early harvestable date besides being liked by markets too. So, we have made a choice to list Wonder Ball and Green Challenger as varietals and move forward with growing them for business.

The largest plant height (30.51cm) has been reported from V3 (Ruby King), while highest seedling height (13.15cm) was discovered from V2 (Summer warrior). Maximum leaves/seedlings (4.8), leaf diameter (19.67 cm), leaves/plant (15.97), average head weight (1.14 kg), early head formation (46.10 days), yield/ha (54.63 ton), and yield/plot (28.97 kg) were all recorded by summer warrior (V2). Eva *et al*. (2020) discovered that, except for leaf length, seedling height and leaf diameter, there were big differences in the maximum characteristics of cultivars from their research in Bangladesh. The biggest plant height (30.51cm) was reported by V3 (Ruby King), and the highest seedling height (13.15cm) was found in V2 (Summer warrior). Maximum leaves/seedlings (4.8), leaf diameter (19.67 cm), leaves/plant (15.97), average head weight (1.14 kg), early head formation (46.10 days), yield/ha (54.63 ton), and yield/plot (28.97 kg) were all recorded by summer warrior (V2).

Conversely, V3 (Ruby King) had the longest leaf length (21.41 cm), and Atlas-70 (V1) had the shortest head harvesting days and duration. V3 (Ruby king) had the lowest height of seedlings (10.98 cm), the highest number of loose leaves/plant (13.74), the lowest plant height (24.57 cm), the highest yield/plot (15.93kg) and yield/ha (30.67ton), the average head weight (0.64 kg), and the longest time taken for head formation (56.78 days) and harvesting (141.38 days). In light of the findings, it could be said that the summer Warrior cabbage variety outperformed the other types statistically in terms of characteristics that contribute to yield and maximum growth.

The aim of this research was to study the genetic performers of genotypes cabbage under mosul condition.

Materials and Method

Different combinations of Cabbage genotypes were studied in vegetable research field, affiliated with the Dept. of Horticulture and Landscape design, Agriculture and Forestry College, Univ. of Mosul throughout fall growing season2021/2022 to study the genetic parameters of the cabbage genotypes as shown in Table 1.

Table1: the sources of cabbage genotypes that have been studied.

No.	Name variety	Color	Original	Source
1	Cavalo cappuccino rose	Red	Italy	Local market, nenevah, Iraq
2	Syrian	green	Syria	my garden production,every green , Syria
3	Copenhagen market	Green	Turkish	Local market, Duhok, Kurdistan region, Iraq
4	Mohrenkopf	Red	Turkish	Local market, Duhok, Kurdistan region, Iraq
5	Yalova sarmalik	Green	Turkish	selcuklu / konya, Turkia
6	Kirmizi –tohurau	Red	Turkish	Local market, Erbil, Kurdistan region, Iraq
7	Broutis	Green		State company for agric. suppl., Iraq
8	Brunswick	Green	U.S.A	U.S.A subsi of atlantic rich field Asgrow seed company
9	Red head	Red		Local market, Duhok, Kurdistan region, Iraq
10	Ruby ball	Red		Local market,Nenevah, Mosul, Iraq
11	Tropicana	Green	U.S.A.	Peto seed company

As its seeds were sown in the wooden canopy on 9/1/2021, and when the seedlings reached a height of approximately 15 cm in the third or fourth true leafy stage, seedlings have been transferred to land that has been designated for them, as they were planted on terraces with 1.5 m width and a length of 50 m per terrace, as experimental unit has been formed. One of two lines for each terrace with a 4m length and a 40cm distance between one seedling and another. The number of plants per experimental unit was 16 seedlings. Seedlings or treatments were distributed based on randomized complete block design with 3 replications for every one of the genotypes (treatments). Under drip irrigation system, all of the agricultural service operations were carried out as is the practice in productive fields of the cabbage plant (Matloob *et al*. 1989). All of the treatments were fertilized with compound chemical fertilizer NPK (15:15:15) at a 360 kg / ha rate and added in two batches, the first after three weeks From seedlings and the second batch when the head are formed and with the feeding system below the plants, at a distance of 10cm and an 8cm depth. The data were taken on six plants from every one of the experimental units. Data included: head length and diameter (cm), head weight (kg), diameter and length of inner stem (cm), outer leaf length and width (cm), total soluble solids (TSS), and total yield (ton/ha). The results have been statistically analyzed by using the SAS (2001) program. Averages have been compared based on Duncan's multinomial test at a probability level of 1 and 5% (Steel and Torrie, 1980).). Genetic parameters were also studied according to the genotypic and phenotypic variations and coefficient variation of genotypic and phenotypic according to (Walter,1975), the broad-sense heritability rate was also calculated (H^2b.s.) Which means that if $H^2{}_{b.s}$. is less than 40% it's low, $H^2{}_{b.s}$. among 40-60% it's medium and $H^2{}_{b.s}$. more 60 are high according to (Cruz, 2013), and estimated genetic advance (GA) and expected GA percentage from mean (GAM) according to (Ali,1999), the estimated GA ratio had been reported by (Johnson, et al., 1955).) as: less than 10 % it mean low, among 10% to 30 % is medium and more than 30 % is high. $GA = K \times Ơ^2p \times H^2{}_{b.s}$,, the genetic advance as mean percentage:

GA mean =(GA / Ŷ) x 100, Where K =is selection intensity at 5% had been 2.06, $H^2{}_{b.s}$ = heritability as a general sense, Ŷ= general average and $Ơ^2$p= phenotypic variation for the trait. The correlation between the traits was done according to (Walter ,1957)

Result and discussions

Analysis of ANOVA table :

Table 2 shows summation of mean squares for studied traits for the genotypes of the cabbage plant. Through statistical analysis of the data, the genotypes differed significantly between the genotypes for most traits, except for the trait of percentage of total solids, as they did not differ significantly for Duncan's multinomial test at a 5% probability level. Those results have been in agreement with findings by (Pathak *et al.* 2007; Singh *et al.* 2009;. Adeniji *et al*, 2010 and Kibar, *et al.*, 2015)

It is clear from Table 3 that genotypes significantly differed amongst themselves in studied traits. With regard to the trait of head length, the Broutis genotype was significantly superior to all genotypes, which produced the highest length of 27.167 cm - while the two genotypes Ruby ball and Cavalo cappuccino rose achieved the lowest. Its length reached 14,800 and 15,033 cm, respectively. The Tropicana genotype also had the highest significant value for head diameter, which reached 20.367 cm, and the lowest resulting diameter for the Syrian variety, which reached 9.7 cm. As for the head weight trait of the cabbage plant, the Broutis genotype was superior to most of the studied genotypes, which had resulted in the production of the highest weight in this trait, which had amounted to 2.933 kg, and lowest weight resulting from the Cavalo cappuccino rose genotype, which amounted to 0.993 kg. The Broutis genotype also outperformed the remaining genotypes in terms of inner stem diameter, which reached 5.287 cm, while the Yalova sarmalik genotype produced the lowest diameter, which amounted to 2,940 cm. The genotype from cabbage achieved highest significant length of the inner stem of the plant, which reached a total of 21,367cm, and it differed considerably with the remaining genotypes. Genotypes: Syrian, Mohrenkopf, and Tropicana genotypes achieved the lowest length, reaching 12.9, 13.3, and 13.33 cm, respectively.The Copenhagen market genotype also achieved highest outer leaf length of 22.5cm and has been considerably superior to genotypes under study. The Ruby ball and Cavalo cappuccino rose genotypes achieved the lowest significant length of 13.467 and 13.933 cm, respectively. The genotypes Copenhagen market, Mohrenkopf, Yalova sarmalik, Krimizi tohurau and Broutis also achieved the highest outer leaf diameter and have been significantly superior to the rest of the genotypes for this trait. There have also been no significant differences in percentage of total solids between the genotypes under study.

As for the characteristic of total yield per unit area of genotypes under study, it is clear from Table3 that Ruby ball genotype achieved highest significant total yield of 48.867 tons per hectare, and the lowest total yield of the two genotypes Tropicana and Cavalo cappuccino rose reached 29.820 and 30.133 tons per hectare. respectively. This discrepancy between genotypes may be explained by an impact from genetic factors and genes that are possessed by every one of the genotypes, which greatly affect the characteristics of the head and productivity, besides interaction between genetic and environmental factors, which have a significant impact on the characteristics of the head and yield of the cabbage plant. The results that have been obtained from this study are consistent with results of many Researchers who have obtained through their studies that the varieties and genetic compositions of cabbage differ significantly from each other in the characteristics of growth, head, and productivity per unit area (Watt and Merrill, 1963 ; Al-Saeedy and Abdel-Qader, 2000; Esho, 2005; Singh *et al*. 2010; Obiadalla-Ali *et al*, 2012; Ali *et al.*, 2012; Shrestha,2019 and Eva *et al*, (2020)

Table1: Analysis of variance (ANOVA) for the characteristics in cabbage at growing season autumn 2021*

S.OV.	df	Mean square								
		X1	X2	X3	X 4	X5	X6	X 7	X8	X9
Block	2	3.2754	2.8541	0.0054	0.0183	1.0842	0.1248	1.6048	0.0323	51.0702
Genotypes	10	50.462**	32.4240**	1.0869*	1.4426*	20.3529**	26.6769**	3.0849*	0.0559	117.503**
Errors	20	0.9341	0.4592	0.0696	0.1086	0.5807	0.3645	0.1685	0.0599	6.8146

- 1= Length of the Head (cm), 2=Head diameter(cm), 3=Head weight(kg), 4=diameter of inter stem(cm), 5=length of inter stem, 6= length of inter leaf(cm), 7= diameter of inter leaf, 8= TSS, 9= Total yield (ton ha^{-1})

Table 2: Average value for characteristics for the genotypes cabbage growing season autumn 2021*

Genotypes	Mean value								
	X1	X 2	X3	X 4	X5	X6	X7	X8	X 9
Cavalo cappuccino rose	15.033f	10.400h	0.993d	3.133b-d	15.067de	13.933fg	6.833c	3.700a	30.133e
Syrian	16.867e	9.700h	1.060d	2.867cd	12.900f	14.767ef	7.567bc	4.037a	42.100cd
Copenhagen market	24.233b	12.167g	2.630a	3.627b	16.367cd	22.500a	9.500a	4.153a	44.683a-c
Mohrenkopf	25.167b	12.467g	2.050bc	3.490bc	13.300f	21.033b	9.133a	4.047a	41.533cd
Yalova sarmalik	21.367c	17.800b	1.717c	2.840d	15.433de	20.100b	9.500a	3.833a	42.167cd
Kirmizi –tohurau	19.833cd	14.200f	1.927c	3.367b-d	14.133ef	18.067c	8.933a	4.146a	39.567d
Broutis	27.167a	15.463de	2.933a	5.287a	18.377b	19.033c	8.767a	3.920a	42.847b-d
Brunswick	20.900cd	17.500bc	2.463ab	3.080b-d	21.367a	18.367c	8.033b	4.037a	45.867a-c
Red head	19.200d	16.367cd	1.590c	2.967cd	17.433bc	17.033d	7.067c	3.990a	47.53ab
Ruby ball	14.800f	14.867ef	1.817c	2.903cd	17.600bc	13.467g	6.967c	4.103a	48.867a
Tropicana	17.233e	20.367a	2.070bc	3.310b-d	13.333f	15.333e	7.933b	3.953a	29.820e

- 1= length of the Head (cm), 2=Head diameter(cm), 3=Head weight(kg), 4=diameter of inter stem(cm), 5=length of inter stem, 6= outer leaf length (cm), 7= diameter of outer leaf, 8= TSS, 9= Total yield (ton ha^{-1})

Genetic parameters

Table 4 shows genetic parameters of genotypes in cabbage. The genetic variance, δ^2G, and phenotypic variance, δ^2P, were high for characteristics of length, diameter, and total ton per unit area, reaching 16.5093, 10.655, and 35.896 for the genetic variance, and 17.443, 11.414, and 43.710 for the phenotypic variance, and it was low for the head weight traits. 0.339 and 0.4086 for genetic and phenotypic variance, respectively, and for internal stem diameter and internal stem length, 0.445 and 6.771 for genetic variance, and 0.5536 and 7.1717 for phenotypic variance. The values of the outer leaf diameter and total soluble solids (TSS) percentage were also low. It also appears from the same table that heritability percentage in broad sense has been high for most of the traits studied, as it exceeded 80%, except for the trait of total dissolved solids percentage, which was very low, and that the expected genetic enhancement has been high for the traits of head length and diameter, and for the traits of inner stem length and outer leaf length. For traits of total yield per unit area, it has been low for the traits of head weight, inner stem diameter, outer leaf diameter, and TSS. As for the general average of expected genetic enhancement, it has been a high value for all traits that have been studied: head length and diameter, length of inner stem diameter, and the total yield per unit area was more than 49, and it was average for the weight traits. The head and outer leaf diameter were low for the TSS trait.. This could be explained by the fact that those characteristics have been quantitative ones, which are influenced considerably by environmental conditions in the area of study, which is why, the selection has been considered effective on bases of external phenotypic traits values (Almukhtar 1988). Heritability percentage in its general sense of studied vegetative growth characteristics could be an indication of additional effect significance. And additional genes that control those traits' inheritance (Jinks & Mather, 1982)) and that the high heritability rate had indicated that the person has great correlation with genetic makeup, which indicates as well that there is a possibility to introduce direct enhancement to those characteristics in the seasons that follow based on the programs of breeding. To be placed thus, it can be utilized as well in the use of suitable program for the breeding and improvement. The results of this study that have been obtained by us were in agreement with (Alard, 1960) that the high heritability rate in general sense, which has been consistent with high genetic improvement values for those traits, had provided evidence for a prediction that can be obtained from method Selection: In light of this, it can be inferred that the total selection method achieves the desired goal of improving potatoes (Welsh, 1981). These results are explained by the fact that the majority of those traits are quantitative characteristics that have been characterized by their impact upon environmental as well as climatic conditions that prevail in the area where this work has been carried out, where environmental and genetic factors that surround a plant interact with their impact on Those traits make the programs of selection effective based upon trait values as well as plant's outer appearance (Almukhtar, 1988). Those results could be explaining high heritability rate (Welsh, 1981). This results from significance of influence of additional and non-additional genes that have the ability to control these traits. High heritability (Mather and Jinks, 1982). This increase in the heritability rate indicates that the external appearance of a plant (the individual) has high correlation with its genetic makeup. This gives the plant breeder an indication of possibility of the introduction of direct morphological and genetic enhancements to those characteristics in subsequent years or seasons. It can also be used in choosing a method. Or an appropriate breeding program

Genetic correlation between pairs of traits

It appears from Table 5, head length was genetically and significantly positively correlated with each of the characteristics of head weight, r = 0.694, inner stem diameter r = 0.646, outer leaf length r = 0.851, and outer leaf diameter r = 0.727. There appeared to be significant positive genetic correlations for the trait of head diameter with both head weight, r=0.372, and with inner leg length, r=0.314. There have also been significant positive genetic correlations for weight of the head with inner stem diameter trait, r=0.594, with the inner stem diameter, r=0.437, with the outer leaf length, r=0.568, and with the outer leaf diameter, r=0.517. When it appears from the same table that there is There was a positive, significant genetic correlation between the inner stem diameter and the outer leaf length, r=0.364. There has been a high, significant genetic correlation between the inner stem length trait and total yield per unit area, amounting to r=0.496. The outer leaf length trait was associated with a positive genetic correlation with the leaf diameter trait. The external factor reached r = 0.793, and from the same table it appears that the trait of total dissolved solids (TSS) has a positive, significant genetic correlation with total yield trait, amounting to r = 0.387.

Phenotypic correlations between studied trait pairs

It appears from Table 6, the trait of head length has been related to positive phenotypic correlation with each of weight of the head, the diameter of the inner stem, with the length and diameter of outer leaf, and with the total yield per unit area. There also appeared to be significant positive phenotypic correlations for the trait of head diameter with each of the length. The inner stem only, and the weight of the head has been significantly positively correlated to both the inner stem diameter and with length and diameter of outer leaf. There was a significant positive phenotypic correlation for the inner stem diameter with the length and diameter of the outer leaf, with values of 0.344 and 0.363, respectively. While the internal leg length trait was associated with a positive, significant phenotypic correlation with total yield per unit area, and its value has been 0.369. The outer leaf length was significantly positively correlated with the outer leaf diameter, reaching r=0.610. Falconer (1989) called the program that includes improving the characteristics of quantity and productivity, which is done through the selection of alternative characteristics through indirect selection for these characteristics ,

Table 3: The genetic parameters for cabbage genotypes growing season autumn 2021 *.

Genetic parameters	X1	X 2	X3	X4	X 5	X6	X7	X8	X 9
δ2g	16.5093	10.655	0.339	0.445	6.591	8.771	0.972	0.001	36.896
δ2P	17.4434	11.4142	0.4086	0.5536	7.1717	9.1355	1.1405	0.0519	43.7106
Pcv	20.712	23.040	33.085	22.197	16.804	17.170	13.019	5.699	15.979
Gcv	20.150	22.261	30.186	19.901	16.109	16.824	12.018	0.791	14.661
H^2 B.S	0.946	0.933	0.829	0.803	0.919	0.960	0.852	0.019	0.844
G.A.	33.99	21.94	0.698	0.916	13.577	18.066	2.002	2.031	75.996
GA as percentage of mean (%)	81.875	72.734	17.546	13.276	41.357	49.827	11.849	0.025	89.177

*1=Length of the head(cm), 2=Head diameter(cm), 3=Head weight(kg), 4=diameter of inter stem(cm), 5=length of inter stem, 6= length of outer leaf(cm), 7= diameter of outer leaf, 8= TSS, 9= Total yield (ton ha^{-1})

Table 4: Genotypic Correlation among cabbage traits.

	x1	X 2	x3	x4	x5	X 6	x7	x8	x9
x1	1.000								
x2	0.086^{NS}	1.000							
x3	0.694^{**}	0.372^{*}	1.000						
x4	0.646^{**}	0.015^{NS}	0.594^{**}	1.000					
x5	0.171^{NS}	0.314^{NS}	0.437^{*}	0.199^{NS}	1.000				
x6	0.851^{**}	0.053^{NS}	0.568^{**}	0.364^{*}	0.110^{NS}	1.000			
x7	0.727^{**}	0.116^{NS}	0.517^{**}	0.312^{NS}	-0.109^{NS}	0.793^{**}	1.000		
x8	0.121^{NS}	-0.020^{NS}	0.180^{NS}	0.105^{NS}	0.080^{NS}	0.171^{NS}	0.108^{NS}	1.000	
x9	0.281^{NS}	0.004^{NS}	0.301^{NS}	-0.037^{NS}	0.496^{**}	0.253^{NS}	0.170^{NS}	0.387^{*}	1.000

*1=Length of the head(cm), 2=Head diameter(cm), 3=Head weight(kg), 4=diameter of inter stem(cm), 5=length of inter stem, 6= length of outer leaf(cm), 7= diameter of outer leaf, 8= TSS, 9= Total yield (ton ha^{-1})

Table 5: Phenotypic correlation among cabbage traits

	x1	**x2**	**x3**	**x4**	**x5**	**x6**	**x7**	**x8**	**x9**
x1	1.000	0.097^{NS}	0.466^{**}	0.426^{**}	0.139^{NS}	0.780^{**}	0.560^{**}	0.000^{NS}	0.133^{NS}
x2		1.000	0.224^{NS}	0.021^{NS}	0.253^{*}	0.011^{NS}	0.054^{NS}	-0.156^{NS}	0.067^{NS}
x3			1.000	0.410^{**}	0.217^{NS}	0.377^{**}	0.346^{**}	0.023^{NS}	0.130^{NS}
x4				1.000	0.063^{NS}	0.344^{**}	0.363^{**}	0.144^{NS}	-0.151^{NS}
x5					1.000	0.017^{NS}	-0.092^{NS}	0.055^{NS}	0.369^{**}
x6						1.000	0.610^{**}	0.025^{NS}	0.071^{NS}
x7							1.000	0.025^{NS}	-0.010^{NS}
x8								1.000	0.127^{NS}
x9									1.000

*1=Length of the head(cm), 2=Head diameter(cm), 3=Head weight(kg), 4=diameter of inter stem(cm), 5=length of inter stem, 6= length of outer leaf(cm), 7= diameter of outer leaf, 8= TSS, 9= Total yield (ton ha^{-1})

. This program requires studying the genetic and phenotypic correlations between the productivity yield and its components, as the characteristics of quantity are affected by a large number of genes, which may interact synergistically with their influence on Two traits, or they work in opposition Antagonistically, thus relying on genetic correlation resulting from the diversity of the effect of Pleiotropy genes in breeding and improvement programs for good productive traits in plants.Our results have been consistent with (Kibar *etal*., 2014; Kaur *etal.*, 2018),) who indicated that the total yield of the head of Allah has significant genetic and phenotypic correlations with the characteristics of head diameter, length, and weight.

Conclusions

Draw the conclusion from the research that there have been significant differences between the genotypes (varieties) in attributes that were examined. Rubull variety produced the highest total yield (tons/ha), whereas Brotes variety excelled in terms of head height, head weight, outer leaf diameter, inner stem diameter, and TSS. All studied traits had percentages of heritability in its general sense exceeding 70%, with the exception of TSS trait, and the total yield was significantly correlated both genetically and phenotypically with some of the studied traits.

Acknowledgments

The authors express their gratitude to Univ. of Mosul's Agriculture and Forestry College for providing the necessary resources, which greatly improved the caliber of the work that was given.

References

Adeniji, B. I.; M. O. Swai; I. Oluoch; R. Tanyongana and A. Aloyce (2010). Evaluation of head yield and participatory selection of horticultural characters in cabbage (*Brassica oleraceae* var. capitata). Journal of Plant Breeding and Crop Science Vol. 2(8), pp. 243-250.

Ali, A. K. Ab. (1999). Heterosis and gene action in *Zea mays* L.. Ph. D. Thesis, college of agriculture and forestry, Mosul University, Iraq.

Ali, H.A.Ob.; M.H.Z. Eldekashy and E. A. El-G., Soher (2012). Evaluation Trial of Some Ecotypes of Balady Cabbage (*Brassica oleraceae* var. *Capitata* L.) Under Sohag Conditions. Journal of Horticultural Science & Ornamental Plants 4 (1): 84-88.

Al-Hassan, Ahmed Abdel Moneim (2002). Production of cabbage vegetables, Arab House for Publishing and Distribution, Egypt, 326.

Allard, R. W. (1960). Principle of Plant Breeding. John Willey Sonc. Inc. New York PP:345.

Al-Saeedy, Abde. H. and R. S. Abdel-Qader (2000). Evaluation of some cabbage varieties under condition of medial region of Iraq. Iraqi Journal Agriculture, 5(6): 40-45. (In Arabic).

Cruz, C. D. (2013). Genes. A software package for analysis in experimental statistics and quantitative genetics.Acta Scientarum. 35(3): 271-276, Available from:http:// periodicos.uem. br/ojs/index. Php/ ActaSciAgron/article/view/ 21251.

Esho, K. B. (2005). Effect of planting date on the yield of three cultivars of cabbage in north of Iraq. Iraqi Journal Agriculture, 10(1): 59-68.

Falconer, D.C. and T.F.C. Mackary (1996). Introduction to quantitative genetic,(4th edition). John Wiley and Sons, New York

Israt Jahan Eva, I.J.; B. Hossai and G. M. Mohsin (2020). Varietal screening of cabbage (*Brassica oleracea* var.*capitata* L.) in coastal area of Bangladesh. International Journal of Natural and Social Sciences, 7(2): 70-76

Ji L., Jia Z., Sun D., 2005. Correlation and path coefficient analysis of traits in early-maturing cabbage. Tianjin Agr. Sci., 11, 635.

Johnson, H. W.; H. F. Robinson, and R. F. Comstock,(1955). Genotypic and phenotypic correlation in soybean and their implication in selection. Agronomy Journal, 47: 477-483.

Kaur, M.; S. Chadha; N. Kumar; N. Sehgal and S. Kanwa (2018). Characters Association and Path Analysis among CMS and SI Based Cabbage Hybrids under Mid Hill Conditions of Himachal Pradesh, India. *Int. J. Curr. Microbiol. App.Sci* (2018) *7*(1): 424-430. https://doi.org/10.20546/ijcmas.2018.701.049.

Kibar1, B; O. Karaağaç and H. Kar (2015). Heterosis for yield contributing head traits in cabbage (Brassica oleracea var. capitata). Cien. Inv. Agr. 42(2):205-216. DOI: 10.4067/S0718-16202015000200007

Kibar1, B.; O. Karaagaç and H. Kar (2014). Correlation and path coefficient analysis of yield componenets in cabbage (*Brassica oleracea* var. *capitata* L.). Acta Sci. Pol., Hortorum Cultus 13(6): 87-97.

Al-Mukhtar, Faisal Abdel-Hadi (1988). Inheritance and breeding of horticultural plants. Ministry of Higher Education and Scientific Research, University of Baghdad, House of Wisdom, Baghdad, Iraq, pp: 232 (In Arabic)

Mather, K. & J. K. Jinks (1982). Biometrical Genetics. 3td Printing. Cornell Univ. press-Ithaca. New Work.

Matlob, A. N.; Ez. S. Muhammed and K. S. Abdol.(1989). Vegetable Production (part 1, 2). Ministry of High Education and Scientific Research, Mosul University, Iraq (In Arabic).

Meena M.L., Ram R.B., Rubee L., (2009). Genetic variability and correlation studies for some quantitative traits in cabbage (*Brassica oleracea* var. *capitata* L.) under Lucknow conditions. Prog. Hort., 41, 89–93.

Meena M.L., Ram R.B., Rubee L., Sharma S.R., 2010. Determining yield components in cabbage (*Brassica oleracea* var. *capitata* L.) through correlation and path analysis. Int. J. Sci. Nat., 1, 27–30.

Obiadalla-Ali, H.A.; M.H.Z. Eldekashy and E.A. El-Gendy, Soher (2012). Evaluation Trial of Some Ecotypes of Balady Cabbage (Brassica oleraceae var. Capitata L.) Under Sohag Conditions. Journal of Horticultural Science & Ornamental Plants 4 (1): 84-88,

Pathak, S., J. Kumar, V. Sagar, and S. Verma. (2007). Heterosis and combining ability for marketable yield and component traits in cabbage (Brassica oleracea var capitata). Indian Journal of Agricultural Sciences 77: 97-100.

SAS (2001). Statistical analysis system. SAS Institue. Inc. Cary, N.C.27511. U.S.A.

Shrestha, S. L. (2019). Performance Evaluation of Cabbage (Brassica *oleracea Capitata*) Cultivars in Mid-hills of Nepal for Winter Season Production. International journal of Horticulture, Agriculture and Food science,3(2):91-96. https://dx.doi.org/10.22161/ijhaf.3.2.7

Sharma K.C. (2010). Genetic variability, characters association and path analysis in exotic lines of cabbage under mid hill, sub-humid conditions of Himachal Pradesh. J. Hill Agr. 1, 146–150.

Singh, B.K., S.R. Sharma, and B. Singh. (2009). Heterosis for antioxidants and horticultural traits in single cross hybrids of cabbage (Brassica oleracea var. capitata). Indian Journal of Agricultural Sciences 79: 703-708.

Singh B.K., Sharma S.R., Kalia P., Singh B. (2010). Character association and path analysis of morphological and economic traits in cabbage (*Brassica oleracea* var. *capitata* L.). Indian J. Agr. Sci., 80, 116–118.

Steel, R.G.D. and J.H. Torrie (1980). Principles and Procedures' of Statistics. A Biometrical Approach. McGraw Hill Book Company Inc., New York. USA.

Walter, A.B.(1975).Manual of Quantitative Genetic (3rd edition).Washington StdeUniv. Press, USA.

Watt, B.; A.L. Merrill (1963). Composition of foods, U.S. Deprt. Agric., Agric. Handbook No. 8, pp:190.

Welsh, J. R. (1981). Fundamentals of Plant Genetics and Breeding. John Wiley and Sons, Inc. New York. U.S.A.