Estimation of some genetic parameters in maize under adequacy and insufficient water .

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Abstract:

Afield experiment was conducted during two season , spring and fall 2013 in the Field of Crop Science Dept. – College of Agriculture – University of Baghdad . The objective of this experiment are to estimate the genetic parameters , broad sense heritability and co-heritability for several traits of maize (Zea mays L.) for the synthetic cultivar , Ibaa 5012 , under watered and water stress treatments (5 and 10 days intervals) by using randomized complete block design with four replications . Genotypic , phenotypic and environmental variation ($\boldsymbol{\sigma}^2 g$, $\boldsymbol{\sigma}^2 p$, $\boldsymbol{\sigma}^2 e$) genotypic and phenotypic coefficient of variation (GCV , PCV) and broad sense heritability were estimated for ten traits : traits : days to anthesis , days to silking , plant height , ear height , number of leaves , leaf area , days to physiological maturity , dry weight , crop growth rate and grains yield . The results showed that genetic variance for most traits more than environment . GCV values for all traits very closed from PCV , that means the traits were under genetic control .All values of broad sense heritability for both seasons and irrigation treatment are high . The highest value was for the dry weight , crop growth rate, grain yield and number of leaves in two season under irrigated , while in water stress , in addition to these traits the days to physiological maturity . It can conclude that the change in the plant environment due to water stress caused a change in the genetic parameters of the studied traits , especially the change in the amount of genetic variance and the environmental variance , it increased the values of some parameters of the traits and reduced to some others . This led to a change in the values of heritability and co-heritability .

Key words : Maize , yield , heritability , co-heritability , water stress .

تقدير بعض المعالم الوراثية في الذرة الصفراء تحت كفاية وعدم كفاية الماء

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المستخلص:

نفذت تجربة حقلية للموسمين الربيعي والخريفي 2013 في قسم المحاصيل الحقلية – كلية الزراعة – جامعة بغداد. هدفت التجربة الى تحديد بعض المعايير الوراثية فضلا عن التوريث بالمعنى الواسع والتوريث المشترك لبعض صفات الذرة الصفراء لصنف اباء 5012 تحت معاملات الري الكامل ونقصه (5 و10 ايام بين رية واخرى) باستخدام تصميم القطاعات العشوائية الكاملة RCBD باربعة مكررات . تم تقدير التباينات الوراثية والمظهرية والبيئية) $(\sigma^2 g\ ,\ \sigma^2 p\ ,\ \sigma^2 e)$ ومعامل التغاير الوراثي GCV ومعامل التغاير المظهري PCV والتوريث بالمعنى الواسع والتوريث المشترك لعشرة صفات :عدد الايام من الزراعة الى 50% تزهير ذكري و50% تزهير انثوي وارتفاع النبات وارتفاع العرنوص وعدد الاوراق ومساحتها وعدد الايام الى النضج الفسلجي والوزن الجاف ومعدل نمو المحصول وحاصل النبات الفردي . اظهرت النتائج ان التباينات الوراثية لمعظم الصفات المدروسة كانت اعلى من التباينات البيئية . كانت قيم التوريث بالمعنى الواسع لكلا الموسمين ولكلا معاملتي الري عالية . كانت أعلى القيم للتوريث لصفة الوزن الجاف ومعدل نمو المحصول وحاصل الحبوب وعدد الاوراق للموسمين في معاملة الري. تقاربت قيم GCV من قيم PCV لمعظم الصفات وهذا يشير الى ان الصفات واقعة تحت التأثير الوراثي للجينات . كل قيم التوريث بالمعنى الواسع لكلا الموسمين ولكلا معاملتي الري كانت عالية. كانت اعلى قيم للتوريث للوزن الجاف ومعدل نمو المحصول ،وبذلك نستنتج ان التغير المتمثل بشد الماء لبيئة النبات كان له تاثير في تغييرقيم المعالم الوراثية للصفات المدروسة لا سيما في مقدار التباين الوراثي والتغاير البيئي ، فزاد منها لبعض الصفات فيما انخفض لصفات اخرى مما ادى تغيير قيم التوريث والتوريث المشترك.

كلمات مفتاحية: Maize ، الحاصل ، التوريث، التوريث المشترك، شد الماء

Introduction

Maize is one of C_4 plants , it is physiologically more efficient , has higher grain yield and a widely adaptation over wide range of environmental conditions . Breeding for high yielding crops requires information about the nature and magnitude of variation in the available material, relationship of yield with other traits and the extent of environmental impact on the expression of these traits, whereas grain yield is quantitative and polygenically controlled, effective yield improvement simultaneous improve yield components are imperative. To enhance the yield, genetics parameters and correlation between yield and yield components a successful program should be developed to improve plant productivity to develop high yielding inbred and hybrids. There is limited information on how selection may affect an ergonomically important pathway for any crop. These pathways may hold the subscription of artificial selection and may lock genetic variation in contrast to rest of the genome. The drought has been estimated to cause annual maize yield loss of 24 million tons in the developing world (7). Drought that occurs at flowering leads to a significant reduction in the yield than when it occurs at other developmental stages (8). Water deficit lasting only one or two days during tasseling of pollination may cause as much as 22% of reduction in yield (10). Many breeders have focused on alleviating the effects of drought at flowering and period of grain filling because maize is most vulnerable to drought at this period of time. Drought stress leads to a delay in silking resulting in an increase in the anthesis-to-silking interval, incomplete or nil fertilization and decreased or nil grain development (11). Co-heritability values depended up on the material select. Though, selection criteria on the basis of high co-heritability value appear by a few traits pairs involving yield was formed. (20). Heritability provides the precise information about the degree to which a given trail is controlled by inheritance. If provides confidence in selection strategies and the breeder has often exploited it, to combine desirable attributes in crop plants . (20). The objectives of this experiment are to estimate the genetic parameters , broad sense heritability and co-heritability for several traits of maize (Zea mays L.) for the synthetic cultivar , Ibaa 5012 , under watered and water stress treatments (5 and 10 days intervals).

Material and methods:

The experiment was conduct at the field of the Dept. of Field Crop -Coll. of Agric.-Univ. of Baghdad. Seeds of synthetic cultivar Ibaa 5012 were planted during spring and fall season of 2013,in 17 March for spring and in 18 July for fall season. Plant spacing distance was (70×25cm). Under watered and water stress levels (5 and 10 days intervals) by using randomized complete block design with four replications. The calcium superphosphate 45% P_2O_5 with 200 kg.ha^{-1} were added at soil preparation ,Nitrogen fertilizer 46% with 400 kg.ha^{-1} was supplied three times at planting ,elongation stage and before flowering.

At harvesting, 10 plants were taken to determine Genotypic , phenotypic and environmental variation ($\boldsymbol{\sigma^2} g$, $\boldsymbol{\sigma^2} p$, $\boldsymbol{\sigma^2} e$) genotypic and phenotypic coefficient of variation (GCV , PCV) and broad sense heritability for ten traits : days to anthesis , days to silking , plant height , ear height , number of leaves , leaf area , days to physiological maturity , dry weight , crop growth rate and grains yield (gm)

Singh and Chaudhary (21).

$\sigma^2\ g\ = \frac{MSV - MSE}{r}$

$\sigma^2\ E$ = MSE

$\sigma^2\ P\ = \sigma^2\ g + \sigma^2\ e$

.$h^2_{b.s}$=(δ^2 g / δ^2 p) ×100

PCV= ($\sqrt{\sigma^2\ p}$ / $\bar{x}$)×100

GCV =($\sqrt{\sigma^2\ g}$ /$\bar{x}$)*100

Results and Dissection:

Standard Error (SE) and Coefficient of Variation (CV) in water in the spring season

Table 1. illustrated that all standard error and coefficient of variation were very low . This indicate that the data are homogenous and symmetrical , therefore , it is statistically acceptable , they are less than 20% .

Components of variance

All genetic variations ($\boldsymbol{\sigma^2} g$) for all traits were more than environmental variations ($\boldsymbol{\sigma^2 e}$), and closed the phenotypic variation ($\boldsymbol{\sigma^2 p}$), indicated that all traits are genetically controlled and that environmental variation have little effect (table1). The highest percentage of genotypic variation to the environment was for crop growth rate 22.12 followed by dry matter weight 22.030, and the less one was for number of leaves per plant.

Baktash and Wuhaib(4) found that the environmental variances were lower than genotypic , for three season in most the studied traits. Hadi and Wuhaib,(9) illustrated that the genetic variation for most traits more than environment. Abed, et al., (1) found that all values of $\boldsymbol{\sigma^2}$g were more than $\boldsymbol{\sigma^2}$e , and it is closed of $\boldsymbol{\sigma^2}$p. Wuhaib , (22) found that the phenotypic genotypic and environment variance was 7608.66 , 7514.68 and 46.99 respectively for dry weight.

Phenotypic (PCV) and genotypic (GCV) coefficient of variation

As we show in the table 1 the genotypic coefficient variation (GCV) was very closed of phenotypic coefficient variation (PCV) for all traits, indicated that the environmental variation has little effect on these traits, and they are genetically controlled . The homogeneity between PCV and GCV for all traits indicating that selection would be effective . The highest value for PCV and GCV is for grain yield 18.28 and 17. 49 fowolled by crop growth rate 12.17 and 11.91 then ear height 11.649 and 10.74, respectively . The lowest value was for days to silking 2.94 and 2.624 respectively.

Genotypic coefficient of variation (GCV) was range between 37 for grain yield/plant to 14.9 for plant height , while phenotypic coefficient variation (PCV) rang from 37.5 for grain yield/plant to 18.1 for plant height (2,16,18) . Alan, et al.,(3) illustrated that number of leaves per plant revealed highest genotypic and phenotypic coefficient of variation values . Highest PCV and GCV were observed for days to 50% tasseling and silking .

All heritability values for all traits were high. The highest value was for crop growth rate and dry weight, (0.96) . Followed by number of leaves per plant (0.94) and (0.92) for grain yield. The lowest value was for leaves area (0.58) . High heritability were observed for days to 50% tasseling (14). Heritability for days to anthesis were above 60% (15). Heritability broad sense range from 87.4% for number of leaves to 99.12% for plant height (23). Hadi and Wuhaib (9) pointed out that the broad sense of heritability was 97% for ear height in high level of nitrogen fertilizer and plant density. Leaves area in low density; crop growth rate in low level of nitrogen fertilizer and plant density . Abed et al.,(1) found that the broad sense heritability for all traits were high.

Table 1: Genetic parameters of studied traits in maize under the sufficient of irrigation in spring season for year 2013.

Traits	$\bar{x}$	S.E	C.V	σ^2g	σ^2e	σ^2p	σ^2g/σ^2e	P.C.V	G.C.V	$h^2_{.b.S}$
Day to tussling	70.95	0.671	1.891	6.116	1.800	7.916	3.398	3.966	3.486	0.77
Day to silking	76.10	0.502	1.319	3.987	1.007	4.994	3.952	2.937	2.624	0.80
Plant height	146.78	1.565	2.133	76.04	9.802	85.84	7.758	6.312	5.941	0.89
Ear height	80.28	1.810	4.509	74.34	13.10	87.44	5.672	11.649	10.74	0.85
Leaves number	10.96	0.003	1.907	0.0007	0.00001	0.0008	7.000	7.806	7.569	0.94
Leaf area	0.374	0.217	3.655	0.257	0.188	0.445	1.366	6.083	4.623	0.58
Day to maturity	101.85	0.721	1.417	8.774	2.0815	10.86	4.218	3.235	2.908	0.81
Total dry matter	230.62	2.561	2.221	578.0	26.24	604.2	22.03	10.66	10.43	0.96
Crop growth rate	2.269	0.029	2.517	0.073	0.003	0.076	22.12	12.17	11.91	0.96
Yield (gm)	106.58	2.817	5.286	347.7	31.74	379.5	10.95	18.28	17.49	0.92

Co-heritability

To increase the efficiency of selection co-heritability is assessed . It is a better genetic parameter than genetic correlation because it take account of environmental variance which is also component of phenotypic variance to which selection is used (17).

Table 2. indicated that the grain yield show positive co-heritability with all traits . The highest co-heritability was between grain yield and days to silking and plant height (1.027). Fowolled by dry weight (0.993), number of leaves (0.992). This

means that these traits contribute to the increase the grain yield. The lowest value of co-heritability was for leaves area (0.593).

Also, in table 2. We can find that all co-heritability values among all other traits were positive and high. This indicated that these traits are more influenced in yield. These values of co-heritability ranged from 1.873 between leaves area and days to physiological mature, to 0.872 between crop growth rate and leaves area. The highest value of co-heritability was found between ear height and test weight (20).

Table 2: Co-heritability of studied traits in maize under the sufficient of irrigation in spring season for year 2013.

Traits	Day to tassling	Day to silking	Plant height	Ear height	Leaves number	Leaf area	Day to maturity	Total dry matter	Crop growth rate	Yield (gm)
Day to tussling	1.000	1.557	1.037	0.987	1.263	0.762	1.070	1.120	0.858	0.867
Day to silking		1.000	0.895	1.307	0.981	1.847	0.909	0.963	0.948	1.027
Plant height			1.000	0.984	0.888	1.045	0.947	0.962	0.961	1.027
Ear height				1.000	0.876	0.935	0.988	0.969	0.973	0.939
Leaves number					1.000	0.978	0.952	0.990	0.983	0.992
Leaf area						1.000	1.873	0.931	0.872	0.593
Day to maturity							1.000	1.002	0.925	0.938
Total dry matter								1.000	0.962	0.993
Crop growth rate									1.000	0.982
Yield (gm)										1.000

Effect of water stress on SE and CV :

Table 3. Showed that the all values of SE and CV have changed. Some have increased such as days to tasseling , dry weight , crop growth rate and grain yield , and others have been reduced (the remaining traits) . This change is due to the effect of drought on plant .

Effect of water stress on variation components

Also, note from table 3 that the components of variance have also changed. All values of phenotypic variance decrease except days to tasseling and number of leaves were increase . The genotypic variance of the four traits increased (days to tasseling, days to silking , leaves area and days to physiological maturity) . Decreased genetic variance of dry weight and crop growth rate due to increased environmental variability . All this change in genetic and phenotypic variation occurred due to changes in environmental condition due to water stress .

It can be noted that the number of leaves per plant is a genetic traits rarely affected by environmental conditions , as its genetic and phenotypic composition has not changed, its genetic and phenotypic variation in the case of normal irrigation and under water stress . Genetic variance and broad sense heritability for grain yield was less at the more drought-affected sites for two cultivars, while increased for anthesis-silking interval for both population (15) . Selection for reduced anthesis-silking interval has been more effective than selection for grain yield under drought stress conditions (6).

So, the GCV (7.69) was very close to the phenotypic coefficient variation (7.64) , and the heritability was high (0.99) . All values of PCV and GCV under water stress differed from their values under normal irrigation, its increased for some traits such as days to tasseling , silking , days to physiological maturity and grains yield , and decreased their values to other traits.

Based on this results the heritability for these trait changed also . The heritability for days to silking , number of leaves , leaves area and days to physiological maturity were increased while for other traits were decreased under water stress, especially grain yield it decreased from (0.92) to (090) . Kirigwi et al.,(13) got on low heritability for drought tolerance and lack of effective selection approaches limit development of resistance crop cultivars to environmental stress.

Table 3:Genetic parameters of the studied traits in maize under insufficient water for the spring season for year 2013.

Traits	$\bar{x}$	S.E	C.V	σ^2g	σ^2e	σ^2p	$\sigma^2 g/\sigma^2 e$	P.C.V	G.C.V	$h^2_{.b.S}$
Day to tussling	73.97	1.018	2.752	7.804	4.144	11.947	1.884	4.673	3.776	0.65
Day to silking	79.12	0.394	0.996	5.4594	0.621	6.081	8.786	3.116	2.953	0.90
Plant height	137.81	0.899	1.305	20.68	3.236	23.914	6.402	3.549	3.300	0.86
Ear height	71.76	0.990	2.760	22.45	3.921	26.366	5.724	7.156	6.603	0.85
Leaves number	11.295	0.002	0.880	0.0007	0.00001	0.0007	7.000	7.690	7.639	0.99
Leaf area	0.334	0.157	2.773	0.482	0.098	0.580	4.911	6.742	6.146	0.83
Day to maturity	107.72	0.586	1.088	15.163	1.373	16.536	11.07	3.775	3.615	0.92
Total dry matter	223.53	3.229	2.889	388.42	41.716	430.14	9.311	9.278	8.817	0.90
Crop growth rate	2.082	0.034	3.298	0.030	0.005	0.035	6.468	9.007	8.382	0.87
Yield (gm)	89.23	2.826	6.333	284.57	31.936	316.51	8.910	19.937	18.905	0.90

Effect of water stress on co-heritability

Co-heritability values have change under water stress as the values of genetic parameters have changed (table ,4) . Some of these values (grain yield with days to silking

, and height of plant) became negative after all were positive under normal irrigation . Other negative values of co-heritability values have also shown some other traits due to changing environmental condition resulting from drought . The highest positive value was 1.949 between crop growth rate and leaves area . The highest positive value of co-heritability was found 2.047 between grain yield and days to physiological maturity . This means that the physiological maturity contributes to the increase and is dependent on the increase the grain yield .

Table 4: Co-heritability of studied traits in maize under in drought in spring season for year 2013.

Traits	Day to tassling	Day to silking	Plant height	Ear height	Leaves number	Leaf area	Day to maturity	Total dry matter	Crop growth rate	Yield (gm)
Day to tussling	1.000	1.165	1.048	0.796	1.164	1.0756	1.059	1.289	0.778	0.896
Day to silking		1.000	0.972	1.047	1.027	0.879	01.040	1.033	1.096	0.961
Plant height			1.000	1.004	0.992	1.014	0.966	1.036	1.188	0.817
Ear height				1.000	1.039	1.081	1.031	1.172	0.648	0.996
Leaves number					1.000	1.122	1.024	1.016	1.026	0.999
Leaf area						1.000	0.997	0.871	1.948	0.919
Day to maturity							1.000	0.877	0.978	2.046
Total dry matter								1.000	0.909	0.992
Crop growth rate									1.000	1.096
Yield (gm)										1.000

Standard error and coefficient of variation under normal irrigation in the fall season :

As we note in spring season , the standard error (SE) and coefficient of variation (CV) was very low , indicated that the data are homogenous , close to the mean . The data is also statistically acceptable because it is less than the permissible limit . However , most of these values have been higher than in the spring season except leaves area , days to maturity and grain yield that have increased slightly .

Components of variance

The results of components of variance are presented in table 5. The genetic variance for all traits is very closed from phenotypic variance, indicated that all these traits are genetically controlled , excepted for leaves area whose genetic variation was far from its phenotypic variation , due to the high value of environmental variation , which accounted for more than half of the phenotypic variation .

In this season , all values of phenotypic and genotypic variance were collected more than their values for the previous season , while the environmental variance values for all traits decreased . On the other hand , genetic variation has decreased and the environmental variance of leaf area has increased .

Phenotypic and Genotypic coefficient variance :

As we note from table 5, all vales of GCV were vary closed from PCV , indicated that genetic makeup of these traits contributes significantly to the representation of the phenotypic and that they are genetically controlled and that the effect of the environment is slightly , except for the leaves area as mentioned above , so the broad sense heritability was less than the rest of traits, while the broad sense heritability was high for the rest of the traits , was the highest 99% for dry weight/plant , followed by grains yield/plant 98% . In this season, the broad sense heritability for number of leaves , days to physiological maturity , dry weight and grains yield were increase than the previous season, while for rest traits were decreased . Baktash andWuhaib ,(4) indicated that fall planting populations showed a high response in detecting heritability from planting in spring . Hassan et al.(12) reported that the narrow sense heritability was 37.27% 33.59% and 48.57% .

Table 5: Genetic parameters of studied traits in maize under the adequacy of irrigation in fall season for year 2013.

Traits	$\bar{x}$	S.E	C.V	σ^2g	σ^2e	σ^2p	$\sigma^2 g/\sigma^2 e$	P.C.V	G.C.V	$h^2_{.b.S}$
Day to tussling	**57.58**	0.719	2.499	6.872	2.069	8.942	3.321	5.194	4.553	0.77
Day to silking	**60.55**	0.630	2.082	5.044	1.589	6.633	3.174	4.254	3.709	0.76
Plant height	**167.45**	2.710	3.236	106.07	29.370	135.44	3.612	6.950	6.150	0.78
Ear height	**98.03**	2.669	5.446	138.62	28.503	167.13	4.863	13.187	12.010	0.83
Leaves number	**13.867**	0.004	1.948	0.002	0.0001	0.002	20.00	10.212	10.025	0.96
Leaf area	**0.447**	0.195	2.817	0.072	0.153	0.225	0.474	3.421	1.941	0.32
Day to maturity	**98.80**	0.373	0.754	20.428	0.556	20.983	36.741	4.636	4.575	0.97
Total dry matter	**370.53**	3.190	1.722	4382.2	40.704	4422.9	107.66	17.948	17.866	0.99
Crop growth rate	**3.721**	0.081	4.364	0.395	0.025	0.422	15.800	17.450	16.895	0.94
Yield (gm)	**157.49**	2.112	2.682	1090.8	17.843	1108.6	61.133	21.142	20.971	0.98

Co-heritability

Table 6 illustrated the values of co-heritability between yield and other traits, and between each of these traits . All values of heritability between yield and other traits were positive , and the highest value was found between grain yield/plant and leaf area/plant . As well , all values of heritability between each of traits were positive , except the value between days to physiological maturity and days to silking . All values of co-heritability between grains yield/plant and other traits were higher than the co-heritability values for the same traits of the spring season . While the co-heritability values between most traits were higher than the co-heritability values for the same traits of the spring season.

Table 6: Co-heritability of studied traits in maize under adequacy of irrigation in fall season for year 2013.

Traits	Day to tassling	Day to silking	Plant height	Ear height	Leaves number	Leaf area	Day to maturity	Total dry matter	Crop growth rate	Yield (gm)
Day to tussling	1.000	0.932	0.933	0.975	0.984	0.523	0.940	1.013	0.919	1.013
Day to silking		1.000	0.857	0.886	0.985	1.115	-0.833	0.997	1.024	1.029
Plant height			1.000	0.820	0.947	0.297	1.006	1.065	0.968	1.026
Ear height				1.000	0.968	0.460	1.002	1.030	0.987	1.028
Leaves number					1.000	1.030	1.002	0.998	1.124	0.980
Leaf area						1.000	1.172	1.013	0.959	1.032
Day to maturity							1.000	0.995	1.084	1.003
Total dry matter								1.000	0.996	1.000
Crop growth rate									1.000	0.988
Yield (gm)										1.000

Standard Error and coefficient of variation under water stress in fall season .

Most SE and CV values for most traits have decreased in this season , while the other traits increased . Although these traits were all within the statistically permissible limit . (Table 7) Hassan et al.(12) found that the CV and SE values were decreased under un sufficient water .

Components of variance under water stress in fall season .

As we not from table 7 that all genetic variance values are close to the phenotypic values . This means that all traits are genetically controlled , and that environmental variance has little effect on traits . Five of these traits (days to silking , leaf area , dry weight, crop growth rate and grains yield) increased their genetic variability in this season from the previous season , while five other decreased , due to different environmental conditions from season to season . The highest value of genetic variance was for dry matter 4970.9 followed for grains yield 1319.9 , while , the lowest value was for the number of leaves (0.001) . The highest value of σ^2 g/σ^2 e was for dry weight followed by crop growth rate . There for , the two traits achieved the highest value of heritability (0.99) , followed by grains yield which achieved (0.97) . All values of rest traits were high , its ranging from o.70 for the days to silking to 0.94 for the days to physiological maturity . Most value of heritability decreased under water stress compared with their values for the previous season (watered) . Some researchers (Blum) ,(5); Rosielle and Hamblin,(19); Bolanos and Edmeades , (6). Have explained that the genetic variance and broad sense heritability of grain yield often decline with increasing moisture stress . When selection for reduced anthesis-silking interval has been more effective than selection for grain yield under drought stress condition (6) . Hassan et al.(12) found that the narrow sense heritability for four population after three cycle of selection under sufficient water were 37.27%, 33.59% , 48.57% and 28.42% , but under un sufficient water became 44.48%, 49.05% , 31.16% and 55.62% .

Table 7: Genetic parameters of studied traits in maize under insufficient water for the fall season for year 2013.

Traits	$\bar{x}$	S.E	C.V	σ^2g	σ^2e	σ^2p	$\sigma^2 g/\sigma^2 e$	P.C.V	G.C.V	$h^2{}_{b.S}$
Day to tussling	**58.88**	0.726	2.465	5.852	2.1065	7.958	2.778	4.792	4.109	0.74
Day to silking	**62.60**	0.635	2.028	3.794	1.611	5.406	2.355	3.714	3.112	0.70
Plant height	**144.5**	1.610	2.229	69.234	10.369	79.603	6.683	6.174	5.758	0.87
Ear height	**76.50**	1.713	4.481	52.229	11.737	63.966	4.449	10.460	9.452	0.82
Leaves number	**13.94**	0.004	2.291	0.001	0.0001	0.001	10.00	8.957	8.859	0.93
Leaf area	**0.362**	0.153	2.189	0.470	0.093	0.563	5.043	5.383	4.917	0.83
Day to maturity	**101.10**	0.451	0.293	13.229	0.815	14.04	16.235	3.707	3.598	0.94
Total dry matter	**330.00**	3.605	2.183	4970.9	51.976	5022.9	95.638	21.463	21.351	0.99
Crop growth rate	**3.26**	0.034	2.064	0.430	0.005	0.434	86.600	20.206	20.101	0.99
Yield (gm)	**131.9**	3.159	4.788	1319.9	39.904	1359.8	33.077	27.948	27.535	0.97

Co-heritability under water stress in fall season

Table 8 illustrate the co-heritability estimates. The grain yield exhibited positive coheritability with all the traits, and all of them were high . The highest was found between grain yield and plant height (1.151) . This means that all studies traits contribute to the increase the grain yield . The co-heritability between all studied traits was positive, the highest value was between days to anthesis and days to silking (1.593) followed by number of leaves and plant height (1.205) .

Table 8: Co-heritability of studied traits in maize under insufficient water for the fall season for year 2013.

	Day to tassling	Day to silking	Plant height	Ear height	Leaves number	Leaf area	Day to maturity	Total dry matter	Crop growth rate	Yield (gm)
Day to tussling	1.000	1.593	0.866	0.997	0.943	0.825	0.998	0.909	0.814	0.995
Day to silking		1.000	0.945	0.187	0.909	1.127	1.023	0.886	0.767	0.921
Plant height			1.000	0.956	1.205	0.876	0.995	1.060	0.886	1.151
Ear height				1.000	1.107	0.460	0.975	1.041	1.000	1.069
Leaves number					1.000	1.019	0.925	1.003	0.994	0.997
Leaf area						1.000	0.935	1.009	1.021	0.986
Day to maturity							1.000	0.979	1.003	0.944
Total dry matter								1.000	0.990	0.994
Crop growth rate									1.000	0.996
Yield (gm)										1.000

Conclusion

As we note from the results that all studied traits have positive contribution in increasing the yield , whether watering or water stress . All traits genetically controlled, evidenced by rise in genetic variance values of environmental variance , the approximation of the genetic coefficient variance from the phenotypic coefficient variance , and the high heritability values , particularly the dry matter and crop growth rate . The change in the plant environment due to water stress caused change in the genetic parameters of the studied traits, especially the change in the amount of genetic variation and the environment mental variance , increased to some traits or decreases of other . This in turn led to a change in heritability and change in relations between co-heritability of traits.

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