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PHENOTYPIC, GENOTYPIC CORRELATION AND PATH COEFFICIENT FOR SEVERAL TRAITS OF MAIZE UNDER WATERED AND WATER STRESS (AGRONOMIC TRAITS)

Banan Hassan Hadi*, Wajeeha Abed Hassan and Kareema Mohamad Wuhaib

Field Crop Dept. College of Agricultural Engineering Sciences, University of Baghdad, Iraq.

Abstract

An experiment was conducted in the field of Crop Science - Department - College of Agriculture University of Baghdad, during the spring and fall season of 2013, by using two treatments of irrigation, watered and water stress. The randomized complete block design was used with four replications. The objectives of experiment were to estimate the phenotypic, genotypic, environmental correlations with direct and indirect effects for several traits of maize. Results indicate that all genetic correlations were more than phenotypic correlation. These correlations were changed due to change in seasons and irrigation treatment. The highest value of genetic correlation and direct effect is for the trait ear height 0.5840 and 1.5063, and for number of leaves plant^{-1} 0.8698 and 0.7829, in spring and watered treatment, 0.3124 and 0.5614 for number of leaves plant^{-1} in water stress in same season. In fall season the highest genetic correlation and direct effect is for dry weight in both treatment 0.9756 and 1.4767for irrigation and 0.8766 and 73.128 for water stress. It can be concluded that these traits were important selection criteria for increasing the yield to improve the maize.

Key words : Maize, Yield, direct effect, genetic correlation.

Introduction

Selection generally involves several traits. When the selection is for just single quantitatively varying trait, in fact, selection with regard to a set of mutually correlated traits. Selection, indeed, is often indirect. Breeders, select among candidates on the basis of observed phenotypic values, whereas the trait of interest concerns the genotypic values underlying the observed phenotypic values. The selected traits is the trait as observed under the macro-environmental conditions applying to the population subjected to selection, and the other traits is the same trait but then as expressed under different macro-environmental conditions. (Bos and Caligari, 2008)

The coefficient measures the degree of linear relationship between two traits. Association of phenotypic values for different traits is one of the characteristic features of traits with quantitative traits. This association maybe due to a functional relationship between different traits, pleiotropy and / or linkage are genetic causes for the occurrence of association of phenotypic values for different quantitative traits; and variation in environmental condition that induces correlation of the phenotypic values for different traits. In genetically homogeneous plant material the coefficient of phenotypic correlation between two traits equal to the correlation of the environmental deviations. The phenotypic correlation in a genetically heterogeneous population depends on both the genetic and environmental correlation. Indirect selection is always applied as the selection for some traits involves phenotype values, whereas the target of the selection is improvement with regard to genotypic values. Application of indirect selection is thus no way to avoid. (Bos and Caligari, 2008).

The drought has been estimated to cause annual maize yield loss of 24 million tons in the developing world (Edmedes *et al.,* 1995). Drought occurring at flowering leads to greater yield losses than when it occurs at other developmental stages (Grant *et al.,* 1989). Water deficit lasting only one or two days during tasseling of pollination may cause as much as 22% reduction in yield (Hall *et al.,*1984). Many breeders have focused on lessen the effects of drought at flowering and during grain filling because maize is most vulnerable to drought at these times. Drought stress leads to a delay in silking resulting

***Author for correspondence :** E-mail : bhd.1970@yahoo.com

in an increase in the anthesis to silking interval (ASI), incomplete or nil fertilization and decreased or nil grain development (Hall *et al.,*1981). Estimates of phenotypic and genotypic correlation between traits for different plant and ear traits provided information effectiveness of selection for different traits and/or combinations of traits (Hallauer, 2007) Correlation between traits are frequent feature of plant breeding (Simmonds, 1979). In genetic studies it is necessary to distinguish two causes of correlation between traits, genetic and environmental (Falconer and Mackay, 1997). The objectives of this experiment are to estimate the genetic, phenotypic, environment and path coefficient for several traits of maize (*Zea mays* L.) for some selective criteria from the synthetic cultivar, Ibaa 5012, under watered and water stress treatments (5 and 10 days intervals).

Materials and Methods

The experiment was conduct at the field of the Dept. of Field Crop -Coll. of Agric.-Univ. of Baghdad. Seeds of some selective criteria from 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 correlation genotypic and path coefficient for ten traits: days to tassling, days to silking, plant height, ear height, leaves number, leaves area, days to maturity, total dry matter, crop growth rate and yield plant, using Singh and Chaudhary, (1985) parameters.

Results and Discussion

Correlations in spring (irrigation)

The data of phenotypic correlation were presented in (Table 1). As is evident from the table, all phenotypic between grains yield of maize and other traits were positive except the days to tasseling, days to silking and days to physiological maturity it was negative. The highest value of positive correlation with yield traits was for crop growth rate 0.893 followed by dry weigh 0.821 and number of leaves 0.814. While the highest value of negative correlation was for days to tasseling -0.741 followed by days to physiological maturity -0.716. Falconer and Mackay(1997) illustrates that some genes may increase both traits, while others increase one (cause appositive correlation) and reduce the other (negative one). Highly significant correlation coefficient were found for grain yield per ear with plant height and ear height (Abou-Deif, 2007).

The phenotypic correlation between traits of maize with each other showed positive and negative correlation. The highest significant positive phenotypic correlation was between days to tasseling with plant height (-0.706) and ear height (-0.568). Langade *et al.,* (2013) found significant and negative association between ear height and days to 50% tasseling; ear height and days to 50% silking.

Most of phenotypic correlations of silking were negative with other traits, except days to physiological maturity was positive and high (0.776).

The highest phenotypic correlation between plant height and ear height was 0.868 while the highest one was 0.507 between ear heights with crop growth rate. Number of leaves associated positive with dry weight (0.555) and with crop growth rate (0.642), but it was negative with leaves area (0.164) and with days to physiological maturity (-0.620).

Leaves area associated positively with dry weight (0.516) and crop growth rate (0.415). Conversely the days to maturity exhibited negative correlation with dry weight (-0.414) and (-0617) with crop growth rate. The dry weight have the highest correlation 0.972, it's the highest phenotypic correlation was found among all traits.

As shown in table 2, all values of genetic correlation of the traits of maize are higher than the phenotypic correlation values, except for the value of the association of the leaf area was low, due to high value of the environmental correlation (0.569) which had the effect of reducing the genetic correlation (Table 3). The highest value of correlation found between grain yield of maize with crop growth rate 0.936 followed by dry weight 0.871, and number of leaves 0.869. While the highest negative correlation between yield with days to silking -0.889 and with days to physiological maturity (-0.780). Also found the highest positive correlation between plant height with ear height (0.984) and 0.978 between dry weight and crop growth rate. The highest negative correlation is -885 between days to tasseling with plant height and -859 between days to silking with number of leaves, followed by days to silking with crop growth rate -0.743 and between days to tasseling with ear height and -0.677 between number of leaves with days to maturity. The positive and significant correlation between two traits of maize shows that the increase in one of the two traits

Table 1: Phenotypic correlations of studied traits of maize under the adequacy of irrigation in spring season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.1979-	0.0084-	0.0852	0.3805	0.1888	0.1189-	0.5682-	0.7058-	0.1268	1.000	Days to tasseling
0.7408-	0.6849-	0.5597-	0.7756	0.0557	0.7585-	0.2065-	0.2378-	1.000		Days to silking
0.4159	0.3498	0.2915	0.4517-	0.2321	0.1829	0.8675	1.000			Plant height
0.5487	0.5066	0.4804	0.4163-	0.4035	0.2239	1.000				Ear height
0.8136	0.6415	0.5547	0.6195-	0.1639-	1.000					Leaves number
0.2631	0.4149	0.5157	0.1011	1.000						Leaves area
0.7164-	0.6169-	0.4194-	1.000							Days to maturity
0.8209	0.9728	1.000								Total dry matter
0.8930	1.000									Crop growth rate
1.000										Yield

Table 2: Genotypic correlations of studied traits of maize under the adequacy of irrigation in spring season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.2039-	0.0083-	0.1109-	0.5154	0.2154	0.1763-	0.6921-	0.8847-	0.2514	1.000	Days to tasseling
0.8897-	0.7425-	0.6168-	0.8779	0.1516	0.8588-	0.3277-	0.2531-	1.000		Days to silking
0.4742	0.3650	0.3047	0.5057-	0.3393	0.1780	0.9836	1.000			Plant height
0.5840	0.5465	0.5166	0.4964-	0.5381	0.2195	1.000				Ear height
0.8698	0.6643	0.5792	0.6766-	0.2176-	1.000					Leaves number
0.2146	0.4868	0.6462	0.2773	1.000						Leaves area
0.7804-	0.6487-	0.4779-	1.000							Days to maturity
0.8707	0.9782	1.000								Total dry matter
0.9359	1.000									Crop growth rate
1.000										Yield

Table 3: Environmental correlations of studied traits of maize under the adequacy of irrigation in spring season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.1908-	0.0121-	0.1030-	0.1282-	0.1451	0.2689	0.0408-	0.1622	0.3300-	1.000	Days to tasling
0.1556	0.3861-	0.2230-	0.3581	0.1617-	0.1313-	0.3646	0.1650-	1.000		Days to silking
0.1154-	0.1961	0.1559	0.1610-	0.0479-	0.2474	0.1067	1.000			Plant height
0.2968	0.1699	0.1819	0.0288-	0.1050	0.2924	1.000				Ear height
0.0883	0.2228	0.1066	0.2777-	0.0226-	1.000					Leaves number
0.5691	0.3943	0.2612	0.3102-	1.000						Leaves area
0.3536-	0.5109-	0.0097	1.000							Days to maturity
0.0948	0.8514	1.000								Total dry matter
0.2747	1.000									Crop growth rate
1.000										Yield

leads to an increase in the other traits, but the negative and significant correlation means the increase or decrease in one of the two traits will lead to decrease or increase in the other traits. Results revealed that grain yield showed negative significant correlation with plant height (Al-Naggar *et al.,* 2014). Magnitudes of genotypic correlation were found to be higher than phenotypic correlations; grain yield was positively and significantly associated with plant height and ear height (Reddy and Jabeen, 2016).

Path coefficient

Direct or indirect effects are categorized as follows ¡ negligible when values are between 0.00-0.09, low when

Table 4: Path coefficient of some traits of maize yield under the adequacy of irrigation in spring season of 2013.

Total Effects	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.2039-	0.0003-	0.0580-	0.2067-	0.0044	0.1380-	1.0425-	0.4665	0.0000-	0.7707	Days to tasseling
0.8897-	0.0244-	0.3223	0.3521-	0.0031	0.6724-	0.4936-	0.1335	0.0000-	0.1938	Days to silking
0.4742	0.0120	0.1592-	0.2028	0.0069	0.1394	1.4816	0.5272-	0.0000	0.6818-	Plant height
0.5840	0.0179	0.2700-	0.1990	0.0109	0.1718	1.5063	0.5187-	0.0000	0.5334-	Ear height
0.8698	0.0218	0.3027-	0.2713	0.0044-	0.7829	0.3306	0.0939-	0.0000	0.1359-	Leaves number
0.2146	0.0160	0.3377-	0.1112-	0.0202	0.1703-	0.8106	0.1789-	0.0000-	0.1660	Leaves area
0.7804-	0.0213-	0.2498	0.4010-	0.0056	0.5297-	0.7477-	0.2667	0.0000-	0.3972	Days to maturity
0.8707	0.0321	0.5226-	0.1917	0.0131	0.4534	0.7782	0.1607-	0.0000	0.0855	Total dry matter
0.9359	0.0328	0.5112-	0.2601	0.0099	0.5200	0.8232	0.1925-	0.0000	0.0064-	Crop growth rate
0.0346										Residual effects

Table 5: Phenotypic correlations of studied traits of maize under the inadequacy of irrigation in spring season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.1597-	0.2739	0.1062	0.7269	0.5832	0.0143-	0.2575-	0.3267-	0.2549-	1.000	Days to tasseling
0.4896-	0.2029	0.4046-	0.3701-	0.1753-	0.0737	0.6675	0.5472	1.000		Days to silking
0.2032-	0.1737	0.4370-	0.4063-	0.6321-	0.1505-	0.5243	1.000			Plant height
0.4078-	0.0839	0.1298-	0.3535-	0.2414-	0.0834	1.000				Ear height
0.2943	0.5433	0.6002	0.0789	0.1802	1.000					Leaves number
0.1261-	0.0420	0.2629	0.5800	1.000						Leaves area
0.0362-	0.2053	0.2730	1.000							Days to maturity
0.3316	0.8602	1.000								Total dry matter
0.3321	1.000									Crop growth rate
1.000										Yield

Table 6: Genotypic correlations of studied traits of maize under the inadequacy of irrigation in spring season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.1866-	0.2834	0.1783	0.9951	0.8515	0.0207-	0.2747-	0.4558-	0.3877-	1.000	Days to tasseling
0.5236-	0.2523	0.4642-	0.4243-	0.1784-	0.0804	0.7995	0.6034	1.000		Days to silking
0.1882-	0.2385	0.5121-	0.4406-	0.7558-	0.1617-	0.6136	1.000			Plant height
0.4655-	0.0634	0.1735-	0.4124-	0.3203-	0.0945	1.000				Ear height
0.3124	0.6031	0.6457	0.0849	0.2234	1.000					Leaves number
0.1341-	0.0965	0.2643	0.6622	1.000						Leaves area
0.0816-	0.2254	0.2629	1.000							Days to maturity
0.3654	0.8846	1.000								Total dry matter
0.4126	1.000									Crop growth rate
1.000										Yield

the values range from 0.10- 0.19, moderate for values between 0.20- 0.29, high for values 0.30- 0.99 and values more than 1.00 are categorized as very high (Lenka and Mishra, 1973). Dependent on this categorized, the ear height showed very high and positive direct effect (1.506), number of leaves and days to tasseling showed positive and high direct effect (0.7829 and 0.7707). The traits days to silking, leaf area and crop growth rate recorded negligible positive direct effects, less than 0.09. The traits plant height; days to physiological maturity and dry weight were exhibited negative and high values of direct effect. In spite of the days to tasseling have appositive and high value of direct effect, the total effect was negative and low, because the negative indirect effects via ear height,

Table 7: Environment correlations of studied traits of maize under the inadequacy of irrigation in spring season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.0890-	0.2819	0.1676-	0.2550-	0.1821-	0.0346	0.2316-	0.0730	0.2233	1.000	Days to tasseling
0.1887-	0.1672	0.1347	0.1614	0.1613-	0.0543-	0.2550-	0.1322	1.000		Days to silking
0.3188-	0.2427	0.1353	0.1316-	0.0565	0.0273-	0.0153-	1.000			Plant height
0.0049-	0.2092	0.1861	0.0981	0.1237	0.0733-	1.000				Ear height
0.0025	0.3380	0.2643-	0.0569-	0.4684-	1.000					Leaves number
0.0777-	0.2647	0.2646	0.0167	1.000						Leaves area
0.4137	0.0422	0.3756	1.000							Days to maturity
0.0239	0.6835	1.000								Total dry matter
0.2748-	1.000									Crop growth rate
1.000										Yield

Table 8: Path coefficient of some traits of maize yield under the inadequacy of irrigation in spring season of 2013.

Total Effects	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.1866-	0.0381	0.0079	0.6757-	0.1366	0.0116-	0.0956	0.2128-	0.3086	0.1267	Days to tasseling
0.5236-	0.0339	0.0207-	0.2881	0.0286-	0.0451	0.2781-	0.2817	0.7959-	0.0491-	Days to silking
0.1882-	0.0321	0.0228-	0.2992	0.1212-	0.0908-	0.2135-	0.4668	0.4803-	0.0578-	Plant height
0.4655-	0.0085-	0.0077-	0.2800	0.0498-	0.0531	0.3479-	0.2865	0.6363-	0.0348-	Ear height
0.3124	0.0811-	0.0288	0.0577-	0.0358	0.5614	0.0329-	0.0755-	0.0640-	0.0026-	Leaves number
0.1341-	0.0130	0.0118	0.4497-	0.1604	0.1254	0.1080	0.3528-	0.1420	0.1079	Leaves area
0.0816-	0.0303	0.0117	0.6790-	0.1062	0.0477	0.1435	0.2057-	0.3377	0.1261	Days to maturity
0.3654	0.1189-	0.0446	0.1785-	0.0424	0.3625	0.0604	0.2391-	0.3695	0.0226	Total dry matter
0.4126	0.1345-	0.0394	0.1530	0.0155-	0.3386	0.0220-	0.1113-	0.2008	0.0359-	Crop growth rate
0.6023										Residual effects

Table 9: Phenotypic correlations of studied traits of maize under the adequacy of irrigation in fall season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.1459-	0.3289-	0.1698-	0.4376	0.2041-	0.2333-	0.6693-	0.6291-	0.5194	1.000	Days to tasseling
0.5491-	0.5674-	0.5380-	0.0056-	0.3010-	0.2893-	0.5592-	0.4127-	1.000		Days to silking
0.2036	0.3446	0.1628	0.3682-	0.2350	0.2826	0.8873	1.000			Plant height
0.2374	0.4205	0.2113	0.4498-	0.2716	0.5771	1.000				Ear height
0.1458-	0.0204-	0.2148-	0.5701-	0.1582-	1.000					Leaves number
0.4467	0.5124	0.5114	0.2357	1.000						Leaves area
0.4349	0.1480	0.4142	1.000							Days to maturity
0.9632	0.9339	1.000								Total dry matter
0.9109	1.000									Crop growth rate
1.000										Residual effects

no. of leaves, days to maturity, dry weight, days to silking and crop growth rate; low positive indirect effect through leaf area, only positive indirect effect via plant height. Plant height of maize showed negative direct effect, but the total effect was positive, due to high indirect effect via ear height. Also the direct effect for dry weight was negative, but the total effect was positive and high, due to high positive indirect effect via ear height (0.7782) and no. of leaves (0.4534) and low other positive values via days to tasseling, leaf area, days to physiological maturity and crop growth rate. Crop growth rate showed low direct effect (0.0328) but the total effect was very high because the high indirect effect via ear height 0.8232 and no. of leaves 0.5200. The contribution of these studies

Table 10: Phenotypic correlations of studied traits of maize under the adequacy of irrigation in fall season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.1699-	0.3559-	0.1970-	0.4756	0.2147-	0.3698-	0.8171-	0.7568-	0.6328	1.000	Days to tasling
0.6534-	0.6883-	0.6175-	0.0055	0.6782-	0.3328-	0.6237-	0.4585-	1.000		Days to silking
0.2400	0.3894	0.1967	0.4240-	0.1391	0.3079	0.9031	1.000			Plant height
0.2701	0.4708	0.2411	0.5013-	0.2415	0.6246	1.000				Ear height
0.1467-	0.0241-	0.2194-	0.5897-	0.2944-	1.000					Leaves number
0.8188	0.8945	0.9173	0.4970	1.000						Leaves area
0.4459	0.1679	0.4197	1.000							Days to maturity
0.9756	0.9650	1.000								Total dry matter
0.9369	1.000									Crop growth rate
1.000										Residual effects

Table 11: Environment correlations of studied traits of maize under the adequacy of irrigation in fall season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.0299	0.2228-	0.0466	0.3351	0.2455-	0.0555-	0.0850-	0.1876-	0.1511	1.000	Days to tasseling
0.2591	0.1122	0.0419-	0.1300-	0.0857	0.0472-	0.3162-	0.2584-	1.000		Days to silking
0.0893-	0.0939	0.2356-	0.0270	0.4307	0.1697	0.8292	1.000			Plant height
0.1257-	0.0523	0.1607-	0.0106	0.4316	0.2378	1.000				Ear height
0.1220-	0.0529	0.0231-	0.0325	0.0306	1.000					Leaves number
0.1350-	0.1019	0.0846-	0.3040-	1.000						Leaves area
0.0686-	0.3047-	0.1275	1.000							Days to maturity
0.0067-	0.1617	1.000								Total dry matter
0.3503	1.000									Crop growth rate
1.000										Yield

Table 12: Path coefficient of some traits of maize yield under the adequacy of irrigation in fall season of 2013.

Total Effects	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.1699-	0.1459	0.2910-	0.0235	0.0149	0.1465-	0.5576	0.4882-	0.0819-	0.0958	Days to tasseling
0.6534-	0.2821	0.9119-	0.0003	0.0469	0.1318-	0.4256	0.2958-	0.1295-	0.0607	Days to silking
0.2380	0.1596-	0.2905	0.0210-	0.0096-	0.1220	0.6163-	0.6451	0.0593	0.0725-	Plant height
0.2701	0.1930-	0.3546	0.0248-	0.0167-	0.2474	0.6824-	0.5826	0.0807	0.0783-	Ear height
0.1467-	0.0009	0.3240-	0.0292-	0.0204	0.3962	0.4262-	0.1987	0.0431	0.0354-	Leaves number
0.8188	0.3666-	1.3545	0.0246	0.0692-	0.1166-	0.1648-	0.0897	0.0878	0.0206-	Leaves area
0.4459	0.0688-	0.6198	0.0495	0.0344-	0.2336-	0.3421	0.2736-	0.0007-	0.0456	Days to maturity
0.9756	0.3955-	1.4767	0.0208	0.0635-	0.0869-	0.1639-	0.1269	0.0799	0.0189-	Total dry matter
0.9369	0.4099-	1.4250	0.0083	0.0619-	0.0096-	0.3213-	0.2512	0.0891	0.0341-	Crop growth rate
					0.0356					Residual effects

traits of maize in yield is 97%. While the residual effect was 3%. Data showed that the no. of rows per ear, leaf area index had positive direct and indirect effects on grain yield (Moualla *et al.*, 2011).

Days to silking had largest direct effect on grain yield/ plant (Reddy and Jabeen, 2016). Crop growth rate exhibited positive direct effect in yield in fall season under 400 kg N ha.$^{-1}$, in spring the highest direct effect was to some of traits of maize. Result showed that studied traits contributed with 99% and 85% of yield variance at spring and fall under 200 kg N ha.$^{-1}$ and 99% and 93% under 400 kg N ha.$^{-1}$ respectively (Wuhaib *et al.*, 2018).

Table 13: Genotypic correlations of studied traits of maize under the inadequacy of irrigation in fall season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.3958	0.0334-	0.0723-	0.2272-	0.1552	0.3298	0.3317-	0.3892-	0.4647-	1.000	Days to tasseling
0.2343	0.0658-	0.1213-	0.3416-	0.7398-	0.2406-	0.0079	0.2835-	1.000		Days to silking
0.1235-	0.0683-	0.0970	0.8746	0.2109	0.2015-	0.8541	1.000			Plant height
0.3889-	0.2622-	0.1125-	0.7119	0.0194	0.2227-	1.000				Ear height
0.5200	0.2703	0.2289	0.1954-	0.2273	1.000					Leaves number
0.5479	0.6443	0.6839	0.4596	1.000						Leaves area
0.1622	0.2798	0.4393	1.000							Days to maturity
0.8766	0.9852	1.000								Total dry matter
0.9055	1.000									Crop growth rate
1.000										Yield

Table 14: Phenotypic correlations of studied traits of maize under the inadequacy of irrigation in fall season of 2013.

Total Effects	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.0336	0.0350-	0.0678-	0.1894-	0.1474	0.2901	0.2501-	0.3595-	0.2096-	1.000	Days to tasseling
0.2101-	0.0716-	0.1141-	0.2716-	0.5024-	0.2144-	0.0322	0.2345-	1.000		Days to silking
0.0986-	0.0715-	0.0849	0.7959	0.2050	0.1508-	0.7534	1.000			Plant height
0.3240-	0.2357-	0.0971-	0.6402	0.0348	0.1757-	1.000				Ear height
0.4968	0.2616	0.2156	0.1982-	0.1970	1.000					Leaves number
0.5000	0.5736	0.6162	0.4357	1.000						Leaves area
0.1664	0.2693	0.4335	1.000							Days to maturity
0.8645	0.9843	1.000								Total dry matter
0.8914	1.000									Crop growth rate
1.000										Yield

Table 15: Environmental correlations of studied traits of maize under the inadequacy of irrigation in fall season of 2013.

Yield	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.0020	0.1237-	0.1175-	0.0028-	0.1234	0.1262	0.0037-	0.2598-	0.4423	1.000	Days to tasseling
0.1783-	0.2992-	0.2344-	0.0469	0.2875	0.1399-	0.1118	0.066-	1.000		Days to silking
0.2401	0.2210-	0.1382-	0.0489	0.1730	0.3340	0.2165	1.000			Plant height
0.3023	0.0001-	0.0912	0.1533	0.1079	0.1718	1.000				Ear height
0.0341	0.0643	0.0219-	0.2408-	0.0363-	1.000					Leaves number
0.0973	0.2873-	0.1294-	0.2874	1.000						Leaves area
0.2279	0.0369-	0.3807	1.000							Days to maturity
0.3041	0.9050	1.000								Total dry matter
0.2251	1.000									Crop growth rate
1.000										Yield

Wuhaib *et al.,*(Wuhaib *et al.*, 2017) found that the days to physiological maturity was correlated negatively and high significant phenotypic and genotypic correlation with yield. Highest significant and positive correlation were found between days to 50% tasseling and days to 50% silking followed by association of ear height and plant height (Langade *et al.*, 2013). Highly significant correlation coefficients were found for grain yield per ear with plant height, and ear height (Abou-Deif, 2007).

Correlations in spring season under water stress

In this environmental, all values of phenotypic correlation was change. All values were reduced and

Table 16: Path coefficient of some traits of maize yield under the inadequacy of irrigation in fall season of 2013.

Total Effects	Crop growth rate	Total dry matter	Days to maturity	Leaves area	Leaves number	Ear height	Plant height	Days to silking	Days to tasseling	Traits
0.0396	2.3434	5.2952-	1.9563	0.1394	0.0578	0.7424	1.0471	0.3559-	0.5956-	Days to tasseling
0.2344-	4.6225	8.8792-	2.9415	0.6641-	0.0422-	0.0184-	0.7627	0.7659	0.2768	Days to silking
0.1235-	4.7967	7.1028	7.5305-	0.1893	0.0353-	1.9709-	2.6901-	0.2172-	0.2318	Plant height
0.3839-	2.404	2.2337-	1.1300-	0.0174	0.0390-	0.3075-	0.2977-	1.0061	1.1916	Ear height
0.5200	1.977-	1.760	1.6826	0.2041	0.1752	0.5139	0.5420	1.1843-	1.1965-	Leaves number
0.3480	5.232-	9.872	3.9578-	0.8977	0.0398	0.0448-	0.5672-	0.5666-	0.0925-	Leaves area
0.221	1.644-	6.862	2.601-	0.7126	0.0342-	1.6428-	2.3527-	0.2616-	1.135	Days to maturity
0.8766	3.162-	7.2183	3.7824-	0.6139	0.0401	0.2595	0.2610-	0.0929-	0.0431	Total dry matter
0.9055	5.20-	7.133	2.4095-	0.5784	0.0474	0.6049	0.1838	0.0504-	0.0199	Crop growth rate
0.4380										Residual effects

most of them became negative table 5 this negative and reduce in values is due to effect of water stress, which lead to change in environmental. The highest phenotypic correlation was 0.860 between dry weight with crop growth rate followed by days to tasseling with days to physiological maturity (0.727), days to silking with ear height (0.668), and number of leaves with dry weight (0.600).

Values of genetic correlation estimated for all pairs of traits are presented in (Table 6). As showed in this table, all values of genetic correlation were reduced and most of them became negative also. The highest genetic correlation with grain yield of maize was 0.413 while it was 0.936 under irrigation treatment, and became negative with plant height, ear height and leaf area. Inter-traits genetic correlations revealed that dry weight gave significant and positive correlation with crop growth rate (0.885). Days to tasseling exhibited significant and positive genetic correlation with leaf area (0.852) and days to maturity (0.995). Also days to silking showed significant and positive correlation with ear height (0.799) and plant height (0.603). Plant height correlated with ear height positive and significant (0.614). no. of leaves showed positive and high significant with dry weight (0.646) and crop growth rate (0.603). leaf area correlated positive and significant with days to physiological maturity (0.662) only. The highest negative correlation was 0.756 between plant height and leaf area. The highest reduction of grain yield was observed in drought condition compared to normal irrigation (Mostafavi *et al.*, 2013).

Path coefficient

The data of direct and indirect effect are presented in table 8. As we note from the results of the table that it has changed from the results of the normal irrigation treatment for the same season. Although the direct effect for days to tasseling was positive, the total effect was negative. This is due to negative indirect effect via days to physiological maturity, plant height and number of leaves; and the positive indirect effect via other traits was very low. Days to silking exhibited negative direct effect and total effect because most of indirect effect is negative. Even though the direct effect of plant height is positive, the total effect is negative because the negative in direct effect via six traits, only two traits positive. Ear height and days to physiological maturity showed both of direct and total effect negative, due to most of indirect effect is negative. Number of leaves exhibited both of direct and total effect is positive. In spite of most of indirect effect is negative. This means it is very important as an selection criterion to increase the grain yield of maize. The number of leaves is a genetic characteristic that is not significantly affected by the environment much as we can see from table 7, because the value of environmental correlation is very low (0.0025). Although of the positive direct effect (0.1604) for leaf area, the total effect is negative due to high negative indirect effect via plant height (-0.3528) and via days to physiological maturity (-0.4497), and low values of positive indirect effect via other traits. Days to maturity showed high negative value of direct effect -0.679 and negative value for total effect, although all indirect effect was positive (only plant height indirect effect was negative). The genetic and phenotypic correlation for this trait of maize was negative also and the environment correlation was high and positive. The trait dry weight exhibited positive direct effect, but it is very low, however, total effect was positive and high due to the high and positive of indirect effect via days to silking 0.3695, number of leaves 0.3625, and positive via days to tasseling, ear height and leaf area. The total effect for crop growth rate was positive in spite of the negative value of direct effect was negative, this was due to the positive indirect effect via number of leaves (0.3386), days to silking (0.2008), days to

physiological maturity (0.1530) and dry weight (0.0394).

These results showed that all these traits of maize contributed to the varianc of the yield by 40%, while the residual was the contribution 60% for other traits not studied.

Correlations in watered treatment in Fall season

In this season, the phenotypic and genotypic correlation for traits, days to tasseling, days to silking, plant height, ear height and leave area were decrease, while for dry weight and crop growth rate were increase, whilst the trait, days to physiological maturity became positive after it was as negative as its value had been increased than in the previous season. Also, the environmental correlation values have changed this season from the previous season. The highest values for phenotypic and genotypic correlation with grain yield of maize were for dry weight (0.9632 and 0.9756) and crop growth rate (0.9109 and 0.9369). The genetic correlation value more than the value of phenotypic correlation, means that these two traits are genetically controlled and best selection criteria to improve the grain yield. As the correlation between traits have change with each other. The highest value of genetic correlation is (0.9650) between dry weight with crop growth rate, and (0.9173) with leaf area, followed by plant height with ear height (0.9031). while the high value of negative correlation is (-0.7568) between days to tasseling with plant height, followed between days to silking with crop growth rate, dry weight leaf area and ear height. While the high positive value of phenotypic correlation between each two traits is 0.9339 between dry weight with crop growth rate followed 0.8873 between pant height with ear height, while the negative high value of phenotypic correlation is 0.6693 and -0.6291 between days to tasseling with ear height and plant height.

Path coefficient

Data of direct, indirect and total effect are presented in table 8. The values of these parameters are changed in this season from the previous season and from watered treatment, the highest and positive direct effect and total effect is 1.4767 for dry weight. This means that this trait is a best criterion for selection to improve and increased the grain yield. Also, the trait plant height gave positive high value of direct effect 0.6451 and positive value for total effect 0.2380. Days to tasseling have low positive value for direct effect and negative for total effect due to negative indirect effect via plant height, dry weight, number of leaves and days to silking. Although the direct effect for number of leaves is positive 0.3962, the total effect is negative -0.1467 due to negative indirect effect via ear height, dry weight, days to tasseling and days to physiological maturity. The value of direct effect for ear height is negative and high -0.6824, but the total effect is positive because the indirect effects of it via plant height, number of leaves, dry weight and days to silking are positive (0.5826, 0.2474, 0.3546 and 0.0807). In spite of the negative value of direct effect for leaf area and crop growth rate, (0.0692, 0.4099) however the total effect is positive and high (0.8188 and 0.9369), due to very high positive indirect effect via dry weight (1.3545, 1.4250) and positive via days to physiological maturity, plant height and days to silking. Even though the direct effect for days to maturity is positive but very low, the total effect is high and positive too, because the positive indirect effect via dry weight is high 0.6198 beside the positive indirect effect via ear height 0.3421 and days to tasseling 0.0456. The direct effect and total effect for days to silking is negative due to very high negative indirect effect (-0.9119) via dry weight beside two other negative value via number of leaves and plant height.

In this season, dry weight can be considered an important selection criterion for increasing the yield, because of the significant contribution to the variance of the yield (Hadi and Wuhaib, 2010).

Correlations in water stress treatment of the Fall season

All data for this treatment are changed from other data in watered and water stress of spring season and watered treatment in Full season (Table 13, 14, 15). Season of them have increased and others have decreased, some have become negative others have become positive. The highest values of phenotypic and genotypic correlation were of crop growth rate, dry weight, leaf area and number of leaves of maize (0.8914, 0.9055), (0.8645, 0.8766), (0.5000, 0.5479) and (0.4968, 0.5200) respectively. These data illustrate that these traits genetically controlled because their genetic correlation are higher that their phenotypic correlation. The highest phenotypic and genotypic correlation value between the pairs of traits (0.9843, 0.9852) between dry weight with crop growth rate, followed by plant height with days to physiological maturity (0.7959, 0.8746) and with ear height (0.7534, 0.8541) respectively.

Path coefficient

(Table 16) showed the direct, indirect and total effects for several traits of maize, the highest and positive value of direct effect is for dry weight (7.218), for this, the total effect is positive and high (0.8766). Leaf area exhibited positive high value for direct and total effect (0.8977, 0.348), and positive high value of indirect effect

via dry weight. Days to tasseling showed negative direct effect -0.5956, but the total effect is positive due to positive indirect effect via most of traits. Conversely, the direct effect of days to silking is positive and high 0.7659, but the total effect is negative because the negative indirect effect via ear height, number of leaves, leaf area and dry weight. Plant height and ear height showed negative and high value for direct effect and total effect due to negative indirect effect via four traits. The direct and total effect of number of leaves is positive (0.1752), 0.5157) beside the five positive indirect effect. The direct effect of days to physiological maturity and crop growth rate is negative and high (-3.782, -3.162), but the total effect for both is positive (0.221, 0.9055), this due to high positive indirect effect via dry weight, leaf area and dray to tasseling for days to maturity, and dry weight, leaf area, number of leaves, ear height, plant height and days to tasseling for crop growth rate.

All these traits contributed 56% to the variance of the yield, while the contribution of the other factors was 44%.

Conclusion

It can be concluded from these data that genetic, phenotypic, environmental correlation and path coefficient have changed as the environment changes (season and irrigation treatment). The highest value of genetic correlation and direct is for the trait ear height and number of leaves plant^{-1}, in spring and watered treatment, and number of leaves plant^{-1} in water stress for same season. In Fall season the highest genetic correlation and direct effect is for dry weight in both treatment watered and water stress. These three traits can be considered an important selection criteria for increasing the yield.

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