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1.3. EVALUATION OF SOME MAIZE VARIETIES TO SOIL MOISTURE STRESS

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ABSTRACT

Crop production in arid and semi-arid regions faces the challenge to ensure high yields with limited supply of water. This raises the question to which extent irrigation supply can be reduced without detriment to yield. Field experiments were carried out at the Agriculture Research and Experimental Center Faculty of Agriculture Moshtohor, Banha Univ. in 2008 and 2009 seasons to study the performance of 5 maize varieties i.e., S.C. Hitec, S.C.10, T.W.C Hitec, T.W.C 324 and Giza 2 under 4 soil moisture content at 100, 80, 60 and 40 % of the field capacity (FC) of the soil. A split plot arrangement of a randomized complete block design with three replications was used with soil moisture content as main plots and maize varieties as subplots. The obtained results could be summarized as follows: Increasing soil moisture content from 40 to 100 % FC caused a significant growth, yield and yield components characters with insignificant differences between 80 and 100% of field capacity in some traits. S.C.10 significantly surpassed other varieties in growth characters, yield and yield components. Significant effect of interaction between soil moisture content (irrigation levels) and maize varieties was obtained for growth, yield and yield components except No. of ears/ plant, ear length, No. of rows/ear, ear grains weight, grain yield /plantand shelling% in the combined analysis. Grain yield per feddan was positively and high significantly correlated with, plant height, ear height, stem diameter, No of ears/plant, ear weight, ear length, No. of rows/ear, No. of grains/row, ear grain weight, 100-grain weight and grain yield/plant.

INTRODUCTION

In Egypt great attention has been paid to increase maize total production. This could be achieved by using high yielding cultivars.Egypt lies in arid and semi-arid regions. Field crop production in such soils is faced by the prevalence of a number of rather extreme and detrimental conditions i.e., limited water supply and drought conditions. Irrigating for maximum crop yield and quality is often a matter of correct amounts, it is necessary to have a good understanding of the crop water needs.

Water supply is limiting factor for crop production. Growth of maize was best when irrigation with water equivalent to 75% field capacity but the optimum yields and nutrient uptake were obtained when irrigating with water equivalent to 100% of field capacity (Mbagwu & Osuigwu, 1985).Patel *et al.,*(1985) reported that maximum grain yield and greater Water use efficiency (WUE) were achieved when irrigating to 100% of field capacity. Nour El-Din *et al.* (1986) found that decreasing available moisture content in root zone significantly impaired maize yield, El Refaie *et al.* (1988) concluded that seasonal water consumptive use values for maize were 58.3, 54.9 and 46.1 cm^3 when irrigated at 25, 50 and 75% deficit from the available water, respectively. El-Ganayni *et al.* (2000) showed that shortening irrigation intervals delayed flowering, decreased 100-kernels weight of maize. On the other hand, increasing the available soil moisture depletion to 20% gave the highest grain yield, followed by 35 and 50%. Adeniran (2004) found that the highest yield of maize (7.54 kg/ha.) was obtained with 80% moisture of the field capacity. Also, Ibrahim *et al.* (2005) showed that the irrigation of maize plants at 50% available soil moisture depletion (ASMD) achieved a significant increase for plant height, ear length, 100-kernels weight and grain and straw yields/fad, as well as water use efficiency as compared with the other treatments (30 and 70% ASMD). El-Sayed (2006) indicated thatirrigation maize plants at 25% available soil moisture depletion (ASMD) gave the highest values for plant height and ear length, while 50% ASMD gave the highest values for 100-grain weight, ear weight and ear and grain yields/fad; on the other hand, irrigation at 75% ASMD gave the highest values for shelling percentage and protein percentage in the two seasons. Soliman (2006) found that increasing irrigation levels from 40 % to 80 % of ASMD gives significant for growth, yield and yield components with insignificant differences between 60% and 80 % of ASMD.In this connection, maize cultivars differ in grain yield and yield components as reported by El-Bana (2001); El-Wakil (2002); Hamed (2003); El-Aref *et al* (2004); Nofal *et al* (2005); Moser*et al* (2006); Atta (2007) and Hassan *et al* (2008).

The aim of this investigation was to study the effect ofsoil moisture content on yield and yield componentsof five maize varieties.

MATERIALS AND METHODS

This investigation was conducted at the Agricultural Research and Experimental Center of the Faculty of Agriculture, Moshtohor, Kalubia Governorate, Benha University, Egypt, in 2008 and 2009 seasons, to study the effect of 4 soil moisture content (irrigation levels) at 100% (I_1), 80% (I_2), 60 % (I_3) and 40 % field capacity (I_4) on yield and yield components for five maize varieties Single cross 10 (S.C. 10), Single cross Haitec (S.C. Haitec), Three way cross Haitec (T.W.C. Haitec), Three way cross 324 (T.W.C. 324) and synthetic variety Giza 2 (G 2).

The soil type was clay with pH value of 8.06 and 8.02 in the first and second growing seasons, respectively. The experimental sites were preceded by clover in the two seasons. Maize hybrids namely S.C. Haitec and T.W.C. Haitec were developed by Haitec Company.Maize varieties namely S.C. 10, T.W.C. 324 and Giza 2 were developed by Maize Research Section, Field Crops Research Institute, ARC, Giza, Egypt.

In each experiment, 20 treatments which were the combination of four soil moisture content and five maize varieties are tested in a split plot design with three replicates. soil moisture content were devoted to the main plots, while maize varieties were assigned to the sub-plots. Each sub-plot was 10.5 m^2 (1/400 fed.) consisting of 5 ridges, 3.0 m long and 0.7 m width while, the distance between plants was 25 cm.

Moisture content and water consumptive use per unit area were calculated according to the equation described by Israelsen and Hansen (1962).The quantities of the applied water per irrigation for each experimental plot were estimated properly through an accurate portable water pump connected with a meter of 0.1 liter sensitivity. The physical properties of experimental soil site i.e. field capacity, wilting point percentage; available moisture and bulk density were determined and recorded. The average values of these measurements at different soil depths down to 45 cm are presented in Table (1).

Table 1. Physical properties of the experimental soil site in 2008 and 2009 seasons

2008 season				2009 season			
Field capacity %	Available water %	Wilting point %	Bulk density ($g\ cm^{-3}$)	Field capacity %	Available water %	Wilting point %	Bulk density ($g\ cm^{-3}$)
44.65	25.40	19.25	1.24	44.81	25.23	19.58	1.23
41.50	23.65	17.85	1.28	42.21	24.11	18.10	1.26
39.40	22.46	16.94	1.33	39.85	22.82	17.03	1.30
41.85	23.83	18.00	1.28	42.29	24.05	18.23	1.26

At planting, super phosphate (15.5%), at a rate of 30 kg P_2O_5/fad was applied. Maize grains were planting on 15th and 25th May in the first and second seasons, respectively. Thinning took place 21 days after sowing to secure one healthy plant per hill. All recommended cultural practices for the region were followed in both seasons.

Studied attributes

At harvest tenindividual plants were taken at random from middle ridge each sub-plot to determine plant height (cm), ear height (cm), stem diameter (cm), No of ears /plant, ear weight (g), ear length (cm), ear diameter (cm), No. of rows/ear, No. of grains/ row, ear grain weight (g), 100-grain weight (g), shelling percentage and grain yield/plant (g). Grain yield/feddan (kg) was determined on the whole sub plot basis. The grain yield was adjusted to 15.5% moisture content.

Analysis was done for the data of variance of each season separately and combined analysis of variance for two seasons was conducted testing the error homogeneity according to Gomez and Gomez (1984). L.S.D test at 0.05 level of probability was used to compare between means.

RESULTS AND DISCUSSION

Effect of soil moisture content:

Data presented in (Tables 2, 3, 4, 5 and 6) showed the effect of soil moisture content (irrigation levels) on yield and yield attributes of maize in the two seasons and their combined analysis. Soil moisture content had significant effects in both seasons and their combined analysis on plant height, ear height, stem diameter, ear weight, ear length, ear diameter, No. of rows/ear, No. of grains/row, ear grain weight,100-grain weight, grain yield/plant and grain yield/feddan. These characters were increased with increasing soil moisture content from (I_4) 40% to (I_1) 100% of field capacity with no significant differences between 100% and 80% of field capacity in ear weight in the combined analysis, ear diameter in the first season and No. of rows/earin the first and second seasons. The relative increase (combined data) due to increasing soil moisture content from I_4 to I_1 were 13.5, 15.0, 20.7, 11.2, 27.4, 21.1, 4.0, 40.1, 13.7, 27.8, 10.0 and 19.7% in plant height, ear height, stem diameter, ear weight, ear length, ear diameter, No. of rows/ear, No. of grains/row, ear grain weight, 100-grain weight, grain yield/plant and grain yield/feddan, respectively.Results in (Tables, 3) indicated that increasing soil moisture content from 1_4 (40% FC) to I_1 (100 % FC) did not significantly affect No. of ears/plantin the second season, combined data revealed that, maximum average of No. of ears/plant (1.13 ear) was recorded when soil moisture content was I_1 (100% FC), while minimum average of No. of ears/plant (1.08 ear) was recorded when soil moisture content was 1_4 (40% FC). The decreases in yield and yield attributes due to maize irrigate at 1_4(40% FC) may be due to changes patterns of plant growth and development.

In general, the aforementioned results of soil moisture stress, increasing or decreasing soil moisture stress, may be attributed to the unbalanced soil water-air relations that lead to reducing the photosynthesis activity and unbalanced relations between plant hormones and biological processes in the whole plant organs, Igbadun and Oyebode (2000). These adverse conditions in the treated soils are undoubtedly of great importance throughout the vegetative growth and dry matter accumulation in the maize plants.

These results are in agreement with those obtained by Nour El-Din *et al.* (1986), El Refaie *et al.* (1988), El-Ganayni *et al.* (2000), Adeniran (2004), Ibrahim *et al.* (2005), El-Sayed (2006) and Iqbal *et al*. (2010). Who used water supply ranged from 100% water required to maintain soil at field capacity (FC) to 40% of FC.

Table 2. Plant height, ear height and stem diameter of maize as affected by soil moisture content and varieties in 2008(S1), 2009(S2) and combined analysis.

Treatments	Plant height (cm)			Ear height (cm)			Stem diameter (cm)		
	S1	S2	Comb	S1	S2	Comb	S1	S2	Comb
Soil moisture content (I)									
I_1	311.6	303.6	307.6	141.7	137.0	139.3	2.52	2.38	2.45
I_2	299.8	290.5	295.2	131.2	128.9	130.0	2.34	2.23	2.28
I_3	290.3	276.8	283.6	127.8	124.2	126.0	2.19	2.08	2.14
I_4	276.4	265.6	271.0	122.5	119.8	121.1	2.08	1.97	2.03
L.S.D at 5%	3.5	3.9	2.3	1.3	2.1	1.1	0.06	0.06	0.04
Varieties (V)									
S.C. 10	308.5	296.4	302.5	137.2	132.0	134.6	2.45	2.31	2.38
S.C. haitic	290.8	283.2	287.0	133.5	131.0	132.2	2.35	2.24	2.30
T.W.C.haitic	283.8	275.1	279.5	127.0	126.0	126.5	2.20	2.10	2.15
T.W.C. 324	288.5	277.0	282.8	126.5	124.1	125.3	2.25	2.10	2.18
Giza 2	301.0	288.8	294.9	129.7	124.1	126.9	2.15	2.07	2.11
L.S.D at 5%	4.8	3.5	2.9	1.9	2.5	1.6	0.08	0.06	0.05

I_1=100% field capacity, **I_2**= 80% field capacity, **I_3**= 60 % field capacity, **I_4**= 40% field capacity

Table 3. No. of ears/plant, ear weight and ear length of maize as affected by soil moisture content and varieties in 2008(S1), 2009(S2) and combined analysis.

Treatments	**No. of ears/plant**			**Ear weight (g)**			**Ear length (cm)**		
	S1	**S2**	**Comb**	**S1**	**S2**	**Comb**	**S1**	**S2**	**Comb**
Soil moisture content (I)									
I_1	1.18	1.13	1.16	276.6	266.2	271.4	21.6	20.2	20.9
I_2	1.16	1.10	1.13	270.3	261.0	265.6	20.4	18.7	19.6
I_3	1.13	1.10	1.11	262.4	256.0	259.2	18.8	16.8	17.8
I_4	1.09	1.08	1.08	248.8	239.4	244.1	17.2	15.7	16.4
L.S.D at 5%	**0.08**	**N.S**	**0.06**	**3.5**	**3.7**	**7.5**	**0.8**	**0.8**	**0.5**
Varieties (V)									
S.C. 10	1.28	1.19	1.23	278.0	270.1	274.0	21.9	20.0	21.0
S.C. haitic	1.18	1.10	1.14	273.5	266.0	269.7	20.5	18.6	19.5
T.W.C.haitic	1.05	1.06	1.06	257.8	250.7	254.2	18.5	17.2	17.9
T.W.C. 324	1.10	1.09	1.10	254.5	244.0	249.2	18.3	16.6	17.5
Giza 2	1.08	1.06	1.07	258.8	247.5	253.1	18.4	16.7	17.6
L.S.D at 5%	**0.04**	**0.07**	**0.04**	**2.8**	**2.6**	**6.0**	**0.6**	**0.5**	**0.4**

I$_1$=100% field capacity, **I**$_2$= 80% field capacity, **I**$_3$= 60 % field capacity, **I**$_4$= 40% field capacity

Table 4. Ear diameter, No. of rows/ear and No. of grains/row of maize as affected by soil moisture content and varieties in 2008(S1), 2009(S2) and combined analysis.

Treatments	Ear diameter (cm)			No. of rows/ear			No. of grains/row		
	S1	S2	Comb	S1	S2	Comb	S1	S2	Comb
Soil moisture content (I)									
I1	5.29	5.28	5.28	13.0	12.8	12.9	48.6	47.1	47.9
I2	5.28	5.14	5.21	12.6	12.5	12.6	45.9	44.2	45.1
I3	4.95	4.91	4.93	12.4	12.3	12.3	39.5	37.4	38.4
I4	4.33	4.40	4.36	12.4	12.4	12.4	35.7	32.7	34.2
L.S.D at 5%	0.06	0.05	0.04	0.4	0.3	0.2	1.3	1.9	1.0
Varieties (V)									
S.C. 10	5.27	5.02	5.15	12.7	12.5	12.6	46.4	44.2	45.3
S.C. haitic	5.11	4.95	5.03	12.4	12.4	12.4	45.0	43.7	44.3
T.W.C.haitic	4.86	5.05	4.95	12.3	12.3	12.3	40.8	38.3	39.5
T.W.C. 324	4.77	4.91	4.84	12.5	12.7	12.6	39.9	37.7	38.8
Giza 2	4.79	4.72	4.75	13.0	12.7	12.9	40.1	37.8	39.0
L.S.D at 5%	0.07	0.06	0.06	0.5	0.2	0.3	1.1	1.4	0.9

I$_1$=100% field capacity, **I**$_2$= 80% field capacity, **I**$_3$= 60 % field capacity, **I**$_4$= 40% field capacity

Table 5. Ear grain weight, shelling% and 100-grain weight of maize as affected by soil moisture content and varieties in 2008(S1), 2009(S2) and combined analysis.

Treatments	Ear grain weight (g)			Shelling%			100-grain weight (g)		
	S1	S2	Comb	S1	S2	Comb	S1	S2	Comb
Soil moisture content (I)									
I1	235.8	232.7	234.3	85.2	87.5	86.3	35.2	33.7	34.5
I2	228.6	226.8	227.7	84.6	86.9	85.7	33.4	32.0	32.7
I3	220.8	217.6	219.2	84.1	85.0	84.5	31.5	29.6	30.5
I4	208.1	204.0	206.1	83.6	85.2	84.4	28.6	25.5	27.0
L.S.D at 5%	3.8	2.9	2.1	0.7	1.0	0.5	1.1	0.8	0.6
Varieties (V)									
S.C. 10	232.8	228.8	230.8	83.7	84.6	84.2	34.8	32.7	33.7
S.C. haitic	229.5	226.5	228.0	83.8	85.1	84.5	33.4	31.5	32.4
T.W.C.haitic	220.0	217.9	218.9	85.3	86.8	86.1	31.8	29.7	30.7
T.W.C. 324	218.0	214.7	216.4	85.6	88.0	86.8	30.5	28.3	29.4
Giza 2	216.4	213.5	215.0	83.6	86.2	84.9	30.3	28.7	29.5
L.S.D at 5%	2.0	1.8	1.3	1.3	1.2	2.1	0.7	0.9	0.6

I$_1$=100% field capacity, **I**$_2$= 80% field capacity, **I**$_3$= 60 % field capacity, **I**$_4$= 40% field capacity

Table 6. Grain yield/plant and grain yield/Fed of maize as affected by soil moisture content and varieties in 2008(S1), 2009(S2) and combined analysis.

Treatments	Grain yield/plant (g)			Grain yield/Fed(Kg)		
	S1	S2	Comb	S1	S2	Comb
Soil moisture content (I)						
I1	282.3	277.2	279.7	3480.0	3317.6	3398.8
I2	275.0	270.5	272.7	3328.6	3202.3	3265.4
I3	267.9	262.8	265.3	3131.4	3020.6	3076.0
I4	256.8	251.6	254.2	2860.0	2816.6	2838.3
L.S.D at 5%	3.5	4.4	2.5	60.0	59.0	37.0
Varieties (V)						
S.C. 10	280.4	274.4	277.4	3400.7	3280.8	3340.7
S.C. haitic	274.5	270.1	272.3	3366.6	3229.2	3297.9
T.W.C. haitic	267.7	263.5	265.6	3055.9	3000.4	3028.1
T.W.C. 324	265.2	259.6	262.4	3075.0	2962.5	3018.7
Giza 2	264.6	259.9	262.2	3101.8	2973.4	3037.6
L.S.D at 5%	2.3	2.5	1.7	44.0	43.0	30.0

I_1=100% field capacity, I_2= 80% field capacity, I_3= 60 % field capacity, I_4= 40% field capacity

Varietal differences.

Results in (Tables 2, 3, 4, 5 and 6) indicated that maize varieties exhibited significant differences for grain yield and all studied yield attributes in both seasons and their combined.The combined analysis data in Table (2) revealed that, S.C.10 hybrid significantly surpassed other varieties in plant height, ear height and stem diameter of maize. S.C.10 gave the highest values of plant height (302.5 cm) followed by Giza 2 variety (294.9 cm), ear height (134.6 cm), followed by S.C. haitic (132.2 cm) and stem diameter (2.38 cm) followed by S.C. haitic (2.30 cm), while T.W.C. haitic had shorter plants (279.5cm), T.W.C. 324 gave the lowest value of ear height (125.3 cm) and Giza 2 gave the lowest value of stem diameter (2.11 cm). The average of both seasons data in Table (3) demonstrate that S.C.10 produce highest values of No. of ears/plant, ear weight and ear length of maize follow by S.C. haitic. Combined data given in Table (4) showed significant differences among maize varieties in each of ear diameter, No. of rows/ear and No. of grains/row. It is clear from Table (4) that S.C.10 significantly surpassed other varieties in ear diameter and No. of grains/row. Meanwhile, Giza 2 variety significantly surpassed other varieties in No. of rows/ear.Data in (Tables 5 and 6)show effect of the varietal differences on weight of grains/ear, shelling percentage, 100-grain weight, grain yield/plant and grain yield/

feddan of maize were significantly affected by the five maize varieties under study. Maize hybrid S.C.10 gave highest mean values of the above mentioned parameters except shelling%. These differences may be due to the genetical differences between the five studied maize varieties. The results of varietal differences in yield and yield attributes in this study are in agreement with those obtained byEl-Bana (2001); El-Wakil (2002); Hamed (2003); El-Aref *et al.* (2004); Nofal *et al.* (2005); Moser*et al.* (2006); Atta (2007) and Hassan *et al.* (2008).

Interaction effect

Significant effect of interaction between irrigation levels and maize varieties was obtained for growth, yield and yield components except No. of ears/plant, ear length, No. of rows/ear, ear grains weight, grain yield/plant and shelling% in the combined analysis (Table 7). This result indicates that the maize varieties responded similarly to the irrigation levels. For eight exceptional traits, significant interaction indicates that factors were not independent in their effect, the simple effects of a factor differ and the magnitude of any simple effect depends upon the level of the other factor of the interaction term. Where factors interact, a single factor experiment will lead to disconnect and possibly misleading information. With regard to plant height, ear height, stem diameter, ear weight, ear diameter, No. of grains/row, 100-grain weight and grain yield/fed S.C. 10 gave the highest values followed by S.C. haitic at I_1 treatment (100% FC). The significance of this interaction may be due to the different responses of each hybrid to the different irrigation levels.

Correlation study

The simple correlation coefficients between some possible pairs of the studied maize traits of the combined analysis are presented in Table (8). Grain yield per feddan was positively and high significantly correlated with, plant height, ear height, stem diameter, No of ears/plant, ear weight, ear length, No. of rows/ear, No. of grains/row, ear grain weight, 100-grain weight and grain yield/plant. Therefore, selection for each of these traits is more effective for obtaining new higher yielding hybrids. Also, significant positive phenotypic correlation values were observed between grain yield/plant and each of the other yield components. These results might indicate that selection for high values of the characters are more effective for increasing grain yield per fed. and plant. Significant positive phenotypic correlation values were found between ear grain weight and each of plant height, ear height, stem diameter, No of ears/plant, ear weight, ear length, No. of rows/ear, No. of grains/row, 100-grain weight and grain yield/plant indicating that selection for these traits are very effective for increasing grains weight/ear. Similar results were obtained by Hamed (2003).

Table7. Effect of the interaction between soil moisture content and maize varieties on yield and yield components (combined analysis over two seasons 2008 and 2009).

Soil moisture content / Varieties	I_1	I_2	I_3	I_4	I_1	I_2	I_3	I_4
	Plant height (cm)				**Ear height (cm)**			
S.C. 10	316.3	309.6	300.1	283.8	144.8	138.1	132.1	123.3
S.C. haitic	303.0	294.6	280.0	270.5	142.0	135.3	130.1	121.6
T.W.C. haitic	294.5	283.1	274.5	265.8	134.1	128.6	123.5	120.0
T.W.C. 324	311.6	286.6	273.0	260.0	137.8	122.8	121.3	119.5
Giza 2	312.5	301.8	290.3	275.0	138.0	125.3	123.1	121.3
L.S.D. at 5%	**5.8**				**3.1**			
	Stem diameter (cm)				**Ear weight (g)**			
S.C. 10	2.61	2.50	2.25	2.18	286.0	278.0	272.0	260.3
S.C. haitic	2.56	2.40	2.15	2.08	281.8	273.8	269.1	254.3
T.W.C. haitic	2.31	2.18	2.11	2.00	264.1	261.8	252.6	238.5
T.W.C. 324	2.48	2.18	2.08	1.98	261.6	255.8	249.0	230.6
Giza 2	2.28	2.16	2.10	1.90	263.6	258.8	253.3	237.0
L.S.D. at 5%	**0.10**				**9.0**			
	Ear diameter (cm)				**No. of grains/row**			
S.C. 10	5.46	5.35	5.13	4.65	51.1	49.8	42.5	37.8
S.C. haitic	5.43	5.23	4.95	4.53	52.5	49.1	40.3	35.5
T.W.C. haitic	5.23	5.28	4.98	4.33	45.1	43.0	37.6	32.5
T.W.C. 324	5.13	5.15	4.81	4.28	46.0	41.3	35.5	32.5
Giza 2	5.16	5.05	4.78	4.03	44.6	42.1	36.3	32.8
L.S.D. at 5%	**0.09**				**1.8**			
	100-grain weight (g)				**Grain yield (kg/fed)**			
S.C. 10	37.6	36.0	31.6	29.8	3626.6	3525.0	3220.0	2991.5
S.C. haitic	35.6	33.8	31.5	28.8	3576.6	3480.1	3190.0	2945.0
T.W.C. haitic	33.5	31.5	30.6	27.5	3250.6	3090.1	2983.5	2788.3
T.W.C. 324	32.6	31.0	29.1	25.0	3270.0	3095.1	2973.5	2736.6
Giza 2	33.0	31.1	29.8	24.1	3270.0	3137.0	3013.1	2730.3
L.S.D. at 5%	**1.2**				**61.0**			

$I_{1=}$100% field capacity, $I_{2=}$ 80% field capacity, $I_{3=}$ 60 % field capacity, $I_{4=}$ 40% field capacity.

Table 8. Correlation coefficient between yield and some yield components of maize varieties(Combined over the two seasons 2008 and 2009).

Yield components	1	2	3	4	5	6	7	8	9	10	11
Grain yield (kg/fed)	0.849**	0.938**	0.951**	0.760**	0.947**	0.943**	0.421**	0.975**	0.971**	0.961**	0.971**
1- Plant height (cm)	1.000	0.863**	0.854**	0.617**	0.792**	0.847**	0.680**	0.853**	0.832**	0.865**	0.856**
2- Ear height (cm)		1.000	0.946**	0.690**	0.868**	0.938**	0.498**	0.936**	0.929**	0.925**	0.919**
3- Stem diameter (cm)			1.000	0.768**	0.873**	0.934**	0.476**	0.954**	0.931**	0.933**	0.932**
4- No of ears plant				1.000	0.793**	0.800**	0.291*	0.676**	0.706**	0.927**	0.728**
5- Ear weight (g)					1.000	0.944**	0.323*	0.906**	0.951**	0.956**	0.940**
6- Ear length (cm)						1.000	0.426**	0.939**	0.960**	0.971**	0.947**
7- No. of rows/ear							1.000	0.431**	0.382*	0.411**	0.457**
8- No. of grains/row								1.000	0.974**	0.961**	0.953**
9- Ear grains weight (g)									1.000	0.989**	0.968**
10- Yield /plant (g)										1.000	0.976**
11-100-grain weight (g)											1.000

*, ** indicates significant at $P < 0.05$ and 0.01, respectively

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