Journal of Plant Production

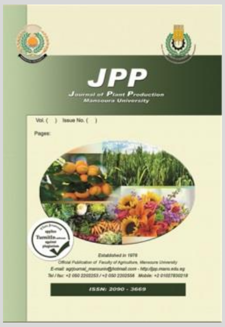
Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Path-Coefficient Analysis and Correlation Studies on Grain Yield and its Components of some Bread Wheat Genotypes under Three Irrigation Treatments

Cross Mark

Abd El-Dayem, S. M. A.[1] ; Y. A. EL-Gohary[1*] and Hoda E. A. Ibrahim[2]

[1]Wheat Research Dep., Field Crops Research Institute, ARC, Giza, Egypt.
[2]Central Lab. For Design and Statistical Analysis Research, ARC. Giza.



ABSTRACT

A split-plot field experiment with three replications was performed at the experimental Farm of Etay El- Baroud Agricultural Research Station, El- Behera Governorate during 2018/2019–2019/2020 seasons to determine optimum irrigation treatments for achieving the highest grain yield of some bread wheat genotypes and determining selection criteria for improving grain yield per plant. The three irrigation treatments i.e. I_1= Irrigation at tillering + elongation stage, I_2 = Irrigation at tillering + elongation + booting stage, I_3 = Irrigation at tillering+ elongation + booting + heading occupied the main plots and six wheat genotypes i.e.; Misr 2, Gemmeiza 11, Misr 1, Shandweel 1, Line 1 and Line 2 were in sub plots. Sowing of cultivar Misr 1 under the second irrigation treatment gave the highest number of spikes/m^2 (454.33 spike), number of kernels/spike (56.17 kernel), grain yield (25.48 ardab/fed), and harvest index (38.89%), hence it was the best recommendation for wheat growers. Water Use Efficiency (WUE) was recorded the highest values (1.23) at I_1 for Misr 1, which produced the highest grain yield and water use efficiency. Number of kernels/spike (0.61) followed by spike length (0.1846) had the largest direct effect on grain yield, hence, hence they are considered as the best selection traits for improving grain yield as reveled by path analysis. Moreover, multivariate analysis indicated that number of kernels/spike, number of spikes/m^2, spike length and 1000-kernel weight could be the reliable criteria for selecting better genotypes in second irrigation treatment (I_2).

***Keywords**:* Bread wheat genotypes, irrigation treatments, grain yield and its attributes, multivariate analysis

INTRODUCTION

Wheat (*Triticum aestivum* L.) is considered as the most essential cereal crop in the world, especially in Egypt. It plays a major role in the economy to reduce the gap between food production and food import (Alam *et al*., 2008). Water is one of the basic needs for healthy plant. Wheat growth, production and quality are a greatly affected by water deficit (Sio-Se Mardeh *et al*., 2006). Thus, proper irrigation, away from excessive irrigation or water stress, is very necessary to rapid grain filling through better development process and gave good grain weight a high grain yield (Hussain *et al*., 2004). Similarly, Irrigation applying at suitable growth periods had positively effect on grain yield (Wajid *et al*., 2002). In case of excessive irrigation during critical growth stages is detrimental to the production in terms of insect infestation, disease, and deterioration of quality, which was earlier reported by Bonfil *et al*. (2004), and consequently a decrease in grain yield. On the other hand, water stress is a major problem that restricts plant growth (physiological and biochemical) functions, literally result in low grain yield, which was earlier reported by Yang *et al*. (2004) and Hussain *et al*. (2004). Wheat yield increased by 94% of tillers of irrigated plants compared to 79% of the stressed plants, and grain yield reduced to 65% in the stressed treatment compared with irrigated one as stated by Karim *et al*. (2000), Mishra *et al*. (1998). Sufficient irrigation at all critical growth stages of wheat including crown root initiation, tillering, jointing, flowering, booting and grain development stage gave a good wheat yield (Bankar *et al*., 2008).

Selection criteria play an essential role in improving grain yield, which was earlier reported by Mohamed (1999) via correlation and Stepwise multiple linear regression, and Dewey and Lu (1959) and Leilah and Al-Khateeb (2005) by path analysis. So, it is necessary to estimate correlation, stepwise regression, and path analysis.

The objectives of this study was aimed to determine selection criteria for improving grain yield via multivariate analysis and identify effect of different irrigation treatments on grain yield and its attributing traits as well as water use efficiency in wheat, and hence determine the best irrigation treatment to obtain a high grain yield of evaluated wheat genotypes.

MATERIALS AND METHODS

A field trial was conducted at Etay El- Baroud Agricultural Research Station, El- Behera governorate during 2018-2019 and 2019-2020 seasons. Six wheat genotypes which listed in Table (1) were used.

Randomized Complete Block Design with split plot arrangement was used for performing this study. Treatments were consisted of three irrigation treatments i.e.; I_1= Irrigation at tillering + elongation stage, I_2 = Irrigation at tillering + elongation + booting stage, I_3 = Irrigation at tillering+ elongation + booting + heading (recommended), were placed in main plots. Each irrigation treatment was surrounded by 10 meters width border. And the six genotypes (Misr 2, Gemmeiza 11, Misr 1, Shandweel 1, Line 1 and Line 2) were kept in sub plots. Experiment was replicated three times having plot size of 4.2 m^2 (6 rows with 4 m Long and 0.2 m apart). The crop was sown in the last week of November 2018

*** Corresponding author.**
E-mail address: yasser2wheat@gmail.com
DOI: 10.21608/jpp.2021.54735.1010

and 2019. All the other cultural practices were done as recommended for wheat. Soil sample from the experimental site was taken to determine the texture of the soil, water table level was measured also (Table 2).

Table 1. Genotypes name, pedigree and origin.

Genotype No.	Name	Pedigree	Origin
1	Misr 2	SKAUZ/BVA92.	Egypt
2	Gemmeiza 11	Bow"S"/Kvz"S"//7c/seri82/3/Giza168/Sakha61	Egypt
3	Misr 1	OASIS/KAUZ//4*BCN/3/2*PASTOR.	Egypt
4	Shandweel 1	SITE//MO/4/NAC/TH.AC//3*PVN/3/MIRLO/BUC.	Egypt
5	Line 1	KAUZ//ALTAR84/AOS/3/MILAN/KAUZ/4/HUITES.	Mexico
6	Line 2	KAUS*2/TRAP//KAUZ/3/PASTOR/4/SKAUZ*2/SRAM.	Mexico

Table 2. Physical analysis and water table depth of the experimental site.

Physical analysis	Season	Value
Clay %	1st	55.32
	2nd	53.52
Silt %	1st	24.86
	2nd	24.63
Sand %	1st	19.82
	2nd	21.85
Texture	1st	Clayey
	2nd	Clayey
Water table depth (cm)	1st	165
	2nd	169

Data were recorded on days to heading (HD), Days to physiological maturity (MD), Biological yield (kg/plot), plant height (cm), No. of spikes/m^2, spike length (cm), No. of kernels/spike, 1000-kernel weight (g), straw yield (kg/plot), harvest index (%) and grain yield (ardab/feddan) using standard procedures.

Water use efficiency (WUE)

Water use efficiency in the present work, refers to the amount of wheat grains (kg) produced due to one m^3 of consumed water, which estimated according to Vites (1965) as follow:

$$\mathbf{WUE}= \frac{\text{grain yield}}{\text{consumptive use m3/feddan}}$$

The total water amount consumptive (including sowing irrigation) at the first (I$_1$), second (I$_2$) and third irrigation (I$_3$) treatments were 1700, 2150 and 2600 m^3/ feddan respectively.Total rainfall received (mm) during wheat growing season (November-May) over the two seasons (2018/2019 and 2019/2020) at the experimental site (latitude 30.89º N and longitude 30.64º E) were measured and showed in Table 3.

Table 3. Total rainfall received during 2018/2019 and 2019/2020 wheat growing seasons

Seasons	Precipitation (mm)
2018/2019	36.1
2019/2020	114.8
Mean	75.45

Statistical analysis

Data were statistically analyzed by using Fisher's analysis of variance and means of treatment were compared by using least significant difference (LSD) test at 5% probability level (Steel and Torrie 1984).

Combined analysis of variance was computed over two seasons according to Snedecor and Cochran (1981). Since, prior to perform combined analysis (Levene, 1960), satisfy the assumption of homogeneity of variances was confirmed.

Simple correlation coefficients as described by Snedecor and Cochran (1981), stepwise multiple linear regression and path coefficient analysis (Dewey and Lu, 1959) were performed using GenStat and SPSS packages.

RESULTS AND DISCUSSION

Analysis of variance

The data in Table 4 indicated that mean irrigation treatments were highly significant for all studied traits in both seasons, except for number of spike/m^2 and 1000-kernel weight in the first season in addition to plant height in the second season.

Table 4. Mean squares of irrigation treatments, wheat genotypes and their interaction for all the studied traits in 2018-2019 (1st) and 2019-2020 (2nd) seasons

Season	S.O.V	df	Means of squares										
			(HD)	(MD)	Ph.	SL.	S/m^2	K/S	1000-K.W	G.Y/ fad.	Str. plot	B.Y /plot	HI
1st	Replication	2	19.91	73.02	57.37	6.75	11841.8	127.58	25.56	17.167	2.54	5.11	1.019
2nd			85.85	3.389	224.16	14.34	1415.4	0.25	3.55	0.01	8.93	8.92	79.645
Comb.			22.23	30.79	122.19	16.23	2710	69.52	10.69	0.25	3.22	3.30	38.44
1st	Irrigation (I)	2	56.13**	67.46**	21.95*	4.49**	4110.0	15.33*	43.88	94.99**	6.70**	24.90**	56.21**
2nd			22.24*	15.06*	14.09	5.70**	52934.4**	533.41**	94.91**	132.91**	5.67**	43.64**	49.79**
Comb.			72.34**	70.45**	24.64	10.16**	43115**	363.94**	133.91**	5.78	11.37**	67.15**	91.09**
1st	Error$_a$	4	0.35	0.24	2.79	0.06	631.2	2.11	7.31	1.15	0.06	0.17	0.73
2nd			1.29	1.78	12.09	0.23	565.4	5.59	0.14	0.42	0.18	0.23	0.95
Comb.			1.01	1.07	11.50	0.1244	573	6.53	3.213	0.026	0.101	0.20	1.25
1st	Genotypes (G)	5	48.25**	134.46**	753.24**	2.33**	3455.5**	21.23*	169.94**	11.35**	0.51**	1.4**	5.40**
2nd			121.66**	47.41**	188.06**	1.96**	1709.0*	84.99**	190.96**	0.61	0.07	0.12	0.91
Comb.			153.59**	163.06**	837.51**	4.026**	4295**	31.19**	357.86**	0.190**	0.294*	0.759**	5.15**
1st	I×G	10	0.796**	2.75**	7.68*	0.073	649.0	11.96	4.24	4.03**	0.16*	0.56**	1.18
2nd			1.17	2.30	1.61	0.27	326.8	8.26	3.26**	1.45	0.21	0.32	0.94
Comb.			1.06	4.55**	5.80	0.1574	457	4.14	2.85	0.056	0.154	0.393*	0.64
1st	Error$_b$	30	0.204	0.43	2.74	0.08	564.9	8.15	4.71	1.32	0.07	0.17	1.04
2nd			1.35	1.63	8.56	0.34	544.5	5.57	0.39	0.82	0.13	0.19	1.13
Comb.			0.78	1.039	5.60	0.139	571	5.57	2.364	0.032	0.085	0.153	1.24

HD: Days to heading MD: Days to physiological maturity Ph: Plant height SL: Spike length S/m^2: No. of spikes/m^2 K/S: No. of kernels/spike G.Y/fad.: Grain yield /feddan Strw.Y/plot.: Straw yield/plot B.Y/fad.: Biological yield/plot HI: Harvest index

**** and * = indicates significant at 0.01 and 0.05 of probability level, respectively.**

Mean square due to genotypes were highly significant for all studied traits in both seasons, except for biological yield/plot, straw yield/plot, grain yield/fed and harvest index in the second season. The significance of genotypes mean square may be due to the wide diversity between these genotypes in their pedigree and country origin (Table 1). Mean square due to the interaction between irrigation treatments and wheat genotypes were highly significant for heading and maturity date as well as plant height in the first season and for biological and straw yield/plot as well as grain yield/fed in the second season. In all others traits the insignificance of interaction were presented. The significance of the interaction mean square in these traits indicated that all tested genotypes will differ in their response to irrigation treatments. The findings indicated that mean square due genotypes, irrigation treatments and their interactions were significant ($p \geq 0.05$) in most studied traits as a clear evidence about the wide diversity between all tested genotypes, where these genotypes will showed a differ response under different irrigation treatments. These findings are in agree with those of El Hwary, and Yagoub (2011) found that irrigation treatments, wheat genotypes and their interaction significantly affected most studied traits, where the higher values was obtained with irrigation every 7days compared to irrigation every 10 days. In study of Baloch *et al.* (2014) who found that irrigation, wheat genotypes and their interaction had significant effect on performance of most studied traits.

Yield and yield attributes of wheat genotypes as affected by irrigation treatments:

Days to heading (HD): Days to heading did not reach significant among various irrigation treatments, but significant differences achieved among various genotypes (Table 5). The interaction between Misr 2 and I_3 gave the highest value for days to physiological maturity (Table 6).

Plant height (cm): All genotypes improved growth with each irrigation treatments, but maximum plant height was recorded in Line1 which increased by 16.81% more than other genotypes. Irrigation treatments also differed from one to another in affecting plant height. Crop plants irrigated with I_1 recorded significantly shorter plants as compared to plants irrigated with I_2, and I_3 (Table 5). Interaction between genotypes and irrigation treatments were significant. At I_2 plant height increased by 21.42 % for Line 2 (Table 6). All genotypes increased in plant height by applying irrigation at all critical growth stages which might be due to the variation of genetic character among different genotypes as well as with healthier plant growth with sufficient availability of nutrients having no moisture stress. Concerning spike length, among the main effects line 1 and I_2 were the best treatment (Table 5), while the best interaction was obtained by planting line 1 under I_3 (Table 6).

Number of spikes/m^2: Maximum percent increase in number of spikes per meter square (11.76% and 8.47%) was recorded by Misr1 and Line1, respectively as compared with Gemmeiza 11. Irrigation treatments also affected the number of spikes significantly. Treatment I_3 recorded maximum increment in number of spikes/m^2 (16.00%) followed by I_2 (15.82%) as compared with I_1 where only one irrigation was applied. Interaction between genotypes and irrigation treatments were significant. At I_2, cultivar Line 1 gave the highest value.

Regarding No. of kernels/spike, among the main effects Misr1 and I_2 were the best treatment (Table 5) and the interaction between each of them (Misr1 and I_2) was the highest value (56.17) (Table 6).

1000-kernel weight (g): The1000-kernel weight for various genotypes differed significantly. The cultivar Gemmeiza 11 produced highest 1000-kernel weight. Plants irrigated with treatment I_2 resulted in maximum 1000-kernel weight. As a combined effect of genotypes and irrigation treatments, Gemmeiza11 produced highest 1000-grain weight at third irrigation treatment (Table 6). Higher 1000-kernel weight with third irrigation treatment may be due to the more translocation of photo-synthates towards grain due to the sufficient amount of water in root zone.

Grain yield (ardab/fed.): Maximum grain yield was recorded by Misr 1 which was 23.21 ardab/feddan. Among irrigation treatments, I_2 increased grain yield by (23.5%) followed by I_3 by (18%) over I_1 treatment (Table 5). Interaction between genotypes and irrigation treatments was significant for grain yield (Table 6 and Figure 1). At I_2, cultivar Misr 1 increased yield by (42.3%) over I_1. Highest grain yield in Misr 1might be due to the increase in number of spikes/m^{-2} and with higher1000-kernel weight.

Biological yield and Straw yield: Among the main effects, Line1 and irrigation 3 produced higher biological yield and straw yield (Table 5). As a combined analysis, planting Misr 1 under I_3 gave the highest biological yield meanwhile, planting line 1 under 1_3 recorded the highest value of straw yield (Table 6).

Harvest index (%): Maximum harvest index (37.06%) was recorded at I_2 and Misr1 (36.72%), as well as planting Misr1 under I4 (35.62%). meanwhile, minimum harvest index was recorded (27.24%) at I1. Where, differences among genotypes for harvest index were non-significant.

Our results revealed that all wheat growth and yield traits significantly differ under all irrigation treatments. The significantly differ in these traits almost, due to the wide differ between all tested genotypes and the stage of water deficit. Several studies explored the influenced of wheat traits under different water deficit stages. In the study of Rajaram (2001) large decreased in grain yield by 12% achieved under water deficit during germination and development of seedling stage. While, under limited water treatment (Larbi and Mekliche, 2004), wheat grain yield might be negative affected approximately 26-74% due to minimum plant population at tillering stages. Shamsi *et al.* (2010) revealed that the most critical and sensitive stage in wheat is booting stage, which reduced the grain yield by 38%. While, Nawaz *et al.* (2015) confirmed that the second important reproductive stage after booting and most sensitive is heading stage under drought which minimized the yield by 58-91%. The critical period in wheat life is flowering or anthesis stage from the beginning to the end of the flowering period, where pollination and fertilization happen during this period (Cattivelli *et al.* 2008). Water shortage at the reproductive growth stages called as terminal drought and anthesis is the prominent in this regard and reduced the yield approximately 18-58% (Jatoi *et al.* 2011). Also, early grain formation happens during the milk stage (Gupta *et al.* 2001). The developing endosperm starts as a milky fluid that increases in solids as the milk stage progresses (Eskandari and Kazemi 2010). Grain size rapidly increases during this stage (Gu´oth *et al.* 2009). At the primary milk stage the grain is almost grown to its full length and is one tenth of its final weight. Filling continues, and by the medium milk stage, 11 to 16 days after flowering, the grain is half grown. Drought reduced the grain yield about 9-35% under this stage of wheat (Shamsi and Kobraee 2011).

Our results are in the same line with those obtained by El Hwary and Yagoub (2011) who showed that there were considerable differences in the studied traits due to irrigation intervals (7,10, 14, 21 and 28 days), except for days to fifth leaf stage and harvest index in the first season and number of plant/m^2 in second season, where the irrigation every 7days gave higher values, slightly different from 10 days. The results showed highly significant differences in treatments effects on biomass, straw and grain yield, harvest index, water use efficiency and protein content. In general irrigation every 7 and 10 days gave the highest protein content, grain, straw yield and field water use efficiency, but for economics trait irrigation every 10 days is recommended. Irrigation every 14 have no remarkable effect, on the other hand irrigation every 21, and 28 days must be avoided under this semi-arid condition. Also, Baloch *et al*. (2014) revealed that wheat crop irrigated five times resulted maximum plant height (86.206 cm), tillers m^2 (402.11), spike length (12.040 cm) spikelet's spike^{-1} (18.979), grains spike^{-1} (47.099), seed index (44.580 g), biological yield, (13732 kg ha^{-1}), grain yield (6999.30 kg ha^{-1}) and harvest index (50.95%) in contrast to four irrigations and three irrigations. While, Leghari *et al*. (2017) reported irrigation treatments had significantly affected plant height. Moreover, Islam *et al*. (2018) reported that wheat yield increased with increasing irrigation treatments.

Table 5. Yield and yield attributes of wheat genotypes as influenced by different irrigation treatments (combined over 2018-19 and 2019-20 seasons).

Varieties	Days to heading (HD)			Days to physiological maturity (MD)			plant height (cm)			Spike length (cm)		
	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.
Irrigation												
I1	104.83	99.2	102.00	139.72	138.16	138.94	107.68	106.7	107.19	10.41	11.4	10.92
I2	107.61	96.28	101.94	142.11	139.44	140.78	109.59	109.76	109.68	11.34	12.4	11.89
I3	108.11	97.33	102.72	143.56	139.32	141.44	107.68	110.22	108.95	11.19	12.3	11.77
LSD(p=0.05)	0.55	1.054	NS	0.45	1.234	0.643	1.544	NS	1.492	0.23	11.6	0.293
Genotypes												
Misr 2	111.22	101.56	106.72	146.78	142.66	144.72	105.29	109.39	107.36	10.65	11.6	11.10
Gemmeiza 11	105.33	98.32	101.83	142.89	137.99	140.50	107.29	107.21	107.25	11.14	11.99	11.56
Misr 1	104.89	96.33	100.61	138.44	136.22	137.33	102.56	105.99	104.30	10.40	11.9	11.15
Shandweel 1	105.89	94.11	100.00	137.89	138.00	137.94	101.65	105.42	103.54	10.59	11.74	11.17
Line 1	107.44	99.89	103.67	145.67	141.55	143.61	126.43	115.5	120.97	11.66	12.82	12.24
Line 2	106.33	94.67	100.50	139.11	137.29	138.22	106.67	109.75	108.21	11.43	12.4	11.92
LSD(p=0.05)	0.43	1.118	1.066	0.63	1.23	1.008	1.593	2.82	2.536	0.27	0.56	0.429

Table 5. Cont.

Varieties	No. of spikes /m^2			No. of kernels /spike			1000-kernel weight (g)			Grain yield (ardab/fed.)		
	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.
Irrigation												
I1	381.4	358.8	370.13	52.33	41.64	46.98	46.13	43.43	44.78	19.29	19.6	19.445
I2	410.4	446.94	428.67	53.89	52.2	53.00	48.74	48.79	48.77	22.99	24.72	23.855
I3	403.4	455.37	429.39	53.96	51.46	52.71	48.91	48.72	48.82	22.51	23.01	22.76
LSD(p=0.05)	23.25	22.00	14.93	1.344	2.19	1.999	NS	48.07	0.581	0.99	0.53	0.778
Genotypes												
Misr 2	409.8	424.54	417.17	52.60	46.82	49.71	42.48	40.55	41.52	22.07	22.3	22.19
Gemmeiza 11	372.8	398.85	385.83	56.16	46.89	51.53	53.55	52.37	52.96	22.13	22.59	22.36
Misr 1	427.9	434.5	431.22	51.53	53.5	52.50	51.21	49.37	50.29	23.51	22.89	23.2
Shandweel 1	387.2	425.9	406.56	53.27	48.51	50.89	43.33	40.92	42.13	20.02	21.75	20.89
Line 1	404.6	432.46	418.50	53.58	46.74	50.16	47.99	47.9	47.95	23.75	21.59	22.67
Line 2	388.3	405.92	397.11	53.23	47.94	50.58	49.02	50.75	49.89	22.32	21.9	22.11
LSD(p=0.05)	22.88	22.47	21.21	2.748	2.27	2.103	2.09	0.61	0.569	1.11	NS	0.975

Table 5. Cont.

Varieties	Straw yield (kg/plot)			Biological yield (kg/plot)			Harvest index(%)		
	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.	2018/19	2019/20	Comb.
Irrigation									
I1	6.34	7	6.67	9.48	9.88	9.68	35.58	35.54	35.56
I2	6.74	7.33	7.04	11.1	12.2	11.67	37.56	36.56	37.06
I3	7.04	8.67	7.86	11.8	12.8	12.29	34.17	32.59	33.38
LSD(p=0.05)	0.22	0.39	0.182	0.38	0.44	0.34	0.79	0.90	0.261
Genotypes									
Misr 2	7.77	6.68	7.23	10.9	11.6	11.22	35.07	35.96	35.52
Gemmeiza 11	7.84	6.59	7.22	10.9	11.7	11.26	35.98	34.65	35.32
Misr 1	7.67	6.7	7.19	11.0	11.5	11.26	36.99	36.45	36.72
Shandweel 1	7.47	6	6.74	10.0	11.7	10.83	34.99	34.18	34.59
Line 1	7.93	6.91	7.42	11.1	11.8	11.43	34.88	34.66	34.77
Line 2	7.84	6.84	7.34	10.9	11.7	11.31	34.71	35.44	35.1
LSD(p=0.05)	0.26	NS	0.253	0.39	NS	0.405	0.98	NS	0.855

Table 6. Interaction effect of wheat genotypes with irrigation treatments on yield and yield attributes (combined over2018/ 19 and 2019/ 20 seasons).

Varieties	Irrigation											
	Days to heading (HD)			Days to physiological maturity (MD)			plant height			Spike length		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Misr 2	105.83	106.67	107.67	144.67	144.00	145.50	108.17	107.37	106.53	10.59	11.34	11.37
Gemmeiza 11	103.17	100.66	101.67	140.33	141.33	139.83	107.66	107.53	106.57	11.01	11.85	11.82
Misr 1	103.50	99.00	99.33	135.33	137.83	138.83	101.40	108.19	103.34	10.43	11.63	11.38
Shandweel 1	98.83	100.67	100.50	136.17	138.33	139.33	101.27	104.38	104.96	10.46	11.75	11.30
Line 1	101.50	104.17	105.33	141.33	144.50	145.00	117.76	122.96	122.17	11.47	12.59	12.67
Line 2	99.17	100.50	101.83	135.83	138.67	140.17	106.87	107.63	110.12	11.53	12.18	12.06
LSD (p=0.05)		1.846			1.746			4,392			0.743	

Table 6. Cont.

Varieties	Irrigation											
	No. of spikes /m^2			No. of kernels/spike			1000-kernel weight			Grain yield		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Misr 2	396.33	427.66	427.50	46.15	50.93	52.03	40.29	42.40	41.88	19.73	23.41	23.46
Gemmeiza 11	348.67	410.50	398.33	48.93	52.85	52.80	50.71	53.84	54.32	19.70	23.89	23.47
Misr 1	390.67	454.33	448.67	48.1	56.17	53.21	47.45	51.83	51.59	21.29	25.48	22.85
Shandweel 1	371.00	415.50	433.17	46.45	52.98	53.25	37.86	43.57	44.95	17.91	22.68	22.07
Line 1	353.17	463.33	439.00	46.48	52.55	51.45	44.58	49.48	49.79	20.16	24.47	23.37
Line 2	361.00	400.67	429.67	45.73	52.52	53.48	47.75	51.51	50.42	18.41	24.77	23.14
LSD (p=0.05)		36.74			3.643			0.992			1.688	

Table 6. Cont.

Varieties	Irrigation								
	Straw yield			Biological yield			Harvest index (%)		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Misr 2	6.58	6.98	8.12	9.89	11.31	12.45	36.55	35.98	34.04
Gemmeiza 11	6.70	7.03	7.94	9.65	11.59	12.52	35.38	37.33	33.24
Misr 1	6.71	7.28	7.59	9.78	11.99	12.01	37.42	38.89	33.84
Shandweel 1	6.38	6.52	7.31	9.35	11.16	11.97	34.46	36.26	33.02
Line 1	7.09	6.97	8.18	9.96	11.93	12.42	34.74	36.83	32.75
Line 2	6.54	7.46	8.02	9.47	12.06	12.40	34.86	37.09	33.36
LSD (p=0.05)		0.438			0.701			1.48	

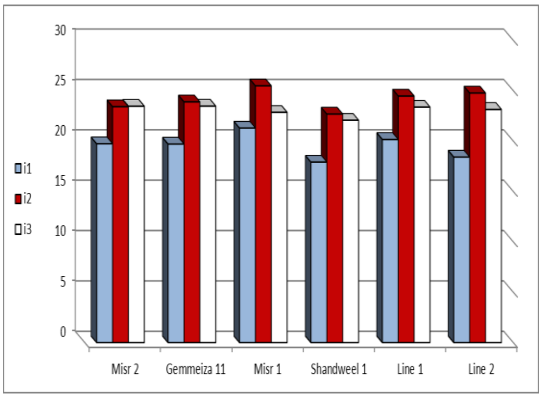


Fig 1. Interaction effect of wheat varieties and irrigation treatments on grain yield

Water use efficiency

Water use efficiency (WUE) as affected by different irrigation treatments are presented in Table 7 and fig. 2. The results showed that WUE gave high values under I_1 and I_2 compared to I_3 results, which compatible with results of Mandal *et al.* (2005). WUE decreased with I_3 compared to I_1 and I_2. WUE often considered an important determinant of yield under stress and even as a component of crop drought tolerance. In addition, water utilization efficiency is a useful measure evaluating irrigation practice, particularly under deficit irrigation technique, where irrigation water is cycle short. Such measured illustrated the crop performance as irrigation water required for crop yield potentiality.

Table 7. Water use efficiency (WUE) of wheat genotypes as affected by water irrigation in combined grown seasons.

WUE (kg of grain/m^3)				
Varieties	Irrigation			Mean
	I_1	I_2	I_3	
Misr 2	1.16	1.09	0.90	1.05
Gemmeiza 11	1.15	1.11	0.90	1.06
Misr 1	1.23	1.19	0.88	1.11
Shandweel 1	1.05	1.05	0.85	0.99
Line 1	1.19	1.14	0.90	1.08
Line 2	1.08	1.15	0.89	1.04
Mean	1.15	1.12	0.89	1.05

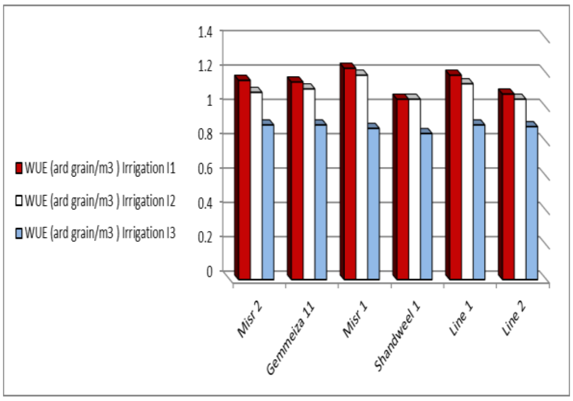


Fig 2. Water use efficiency of wheat varieties as affected by water irrigation treatments

Sowing genotypes Misr 2 and Line 2 under I_1 and I_2 respectively, were of the best cases. These results are in agreement with Al-Molhem (2016) and Gameh *et al.* (2017).

It is important to indicate that genotype Misr 1 expressed high grain yield under I_1 and I_2 treatments. This genotype could be considered promising source under different irrigation conditions. Thamer *et al*. (2019) indicated that limited irrigation during the flowering stage gave the highest field and crop water use efficiency values of 1.33 and 1.27 K.g.m^{-3}. On the other hand, treatment limited irrigation during the elongation stage gave the lowest field and crop water use efficiency values of 1.08 and 1.18 K.g.m^{-3}.

Multivariate analysis

Simple Correlation Coefficients

Simple correlation coefficients between wheat grain yield and its attributing traits are presented in Table 8. In case of irrigation treatment 2 (I_2) at tillering + elongation + booting stage, the grain wheat yield demonstrated the most progressive correlation with number of spikes/m^2 (0.425**), spike length (0.476**) and 1000-kernel weight (0.438**). With an increase in irrigation treatments, in case of irrigation treatment 3 as tillering + elongation + booting + heading, No. of spikes/m^2 had the most positive association with grain yield (0.357**) and spike length (0.381**). The traits might be improved with the continuation of irrigation. On the whole, to have irrigating to the end of the season did not show a negative effect. It might be attributed to differences in flowering stages between the main stems and tillers, compensating for the negative effects. Similar results were obtained by, Mehmet and Yildirim (2006) who, found that positive and significant association was found between yield and plant density, plant height, grain number per spike, grain weight per spike and 1000 kernels weight. Grain yield was negatively and significantly associated with time to heading in wheat. Also, Khan and Dar (2010) indicated that, seed yield was significantly and positively correlated with number of spikelets plant^{-1}, followed by number of effective tillers and 100-seed weight at both phenotypic and genotypic levels. Seed yield exhibited a significant negative association with number of seeds spikelet^{-1} at genotypic level. Among the significant correlation, the association of days to 75% spike emergence with days to maturity and 100-seed weight were significant and positive, but were negative and significantly associated with number of seeds spikelet^{-1} and number of grains spike^{-1}. Similarly, the associations of spike length with number of seeds spikelet^{-1}, and number of spikelets plant^{-1} and number of effective tillers were negative and significant. The association of number of spikelets plant^{-1} with number of effective tillers was also positive and highly significant. Fellahi *et al.* (2013) indicated that grain yield was positively correlated with number of spike per plant.

Table 8. Simple correlation coefficients between grain yield and some traits for wheat genotypes under different irrigation treatments.

Level of irrigation	Days to heading (HD)	Days to physiological maturity (MD)	No. of spikes /m^2	Spike length (cm)	plant height (cm)	No. of kernels /spike	1000-kernel weight
I_1	-0.068	0.176	0.223	0.182	0.119	-0.115	0.232
I_2	-0.129	0.013	0.425**	0.476**	0.170	0.040	0.438**
I_3	-0.018	0.206	0.357**	0.381**	0.230	-0.003	0.287

***, ** and ns indicates significant at the 0.05 and 0.01 level of probability and insignificant, respectively.**

Stepwise Regression Analysis

According to Agrama (1996) and Seyed *et al.* (2015) a step-wise regression can reduce the effect of significantly non-important traits in regression model. In this respect, traits which gave valuable variations of dependent variables could be determined (table 9). The results of a step-wise regression in the (I_1) that days to heading and spike length (85.24) had the greatest effect on grain yield, but in (I_2), spike length (74.83) had the greatest effect on grain yield, while (I_3) number of kernels/spike, spike length and 1000-kernel weight had the greatest effect on grain yield, which gave the same results reported in the simple correlation. This finding necessitates the control of an increase in spike length, number of kernels/spike and1000-kernel weight under different irrigation treatments. Also, days to heading has a very important role.

Table 9. A stepwise regression analysis between grain yield and some attributes traits for wheat genotypes under different irrigation treatments.

Level of irrigation	step	Variable entered	R-Square	Standard Error	R-Sq(adj)	Grain yield models (best prediction equation)
I1	1	X1	49.36	0.971	36.70	Grain yield= -12.78 +0.32 x1
	2	X4	85.24	0.605	75.40	Grain yield= -30.84+0.34**x1+1.40**x4
I2	1	X4	74.83	0.562	68.54	Grain yield= -2.329+0.567**x4
I3	1	X6	68.96	0.782	61.21	Grain yield= 2.473+0.387**x6
	2	X4	91.63	0.469	86.04	Grain yield= -11.019+0.382**x6+1.17*x4
	3	X7	98.99	0.199	97.48	Grain yield= -8.834+0.291**x6+0.89**x4+0.116**x7

X1= **Days to heading (HD),** X4**= Spike length (cm),** X6**= No. of kernels/spike,** X7**=1000-kernel weight**

Path analysis

To better clarify the results of simple correlations and regression, and also to identify direct and joint effects of yield components on grain yield, path analysis was applied following the method used by (Dewey and Iu. 1959). As presented in Table 10, the greatest direct effect on grain yield was observed in number of kernels/spike (0.61) of grain yield variations, which compatible with the findings of Singh *et al*. (2010). In this context, number of kernels/spike (0.48) via number of kernels/spike, number of spikes (0.12) via number of kernels/spike and days to physiological maturity (0.114) via plant height had indirect positive effects on grain yield. Spike length, number of spikes/m^2 and thousand kernel weight had the positive direct effect. These results were similar with the report of Jag Shoran *et al.* (2000), and Habibi (2011).

Totally, simple correlation, a stepwise regression and path analysis concluded that number of kernels/spike, number of spikes, spike length and thousand kernel weight could be recommended as the best selection criteria for improving grain yield in irrigation treatment 2 (I_2).

Our results are in the same line with those obtained by Mehmet and Yildirim (2006) indicated that plant height and grain weight spike^{-1} had positive direct effect on grain yield and negative direct effect was observed in time to heading, which correlated with significant with grain yield, hence these yield components may be a good selection criteria to improve wheat yield genotypes. Majumder *et al*. (2008) showed that harvest index, days to maturity and spikes per plant had positive and higher indirect effect on grain yield through grains per spike. Thus, selection for spring wheat yield via these traits would be effective in improving grain yield.

Ramazan (2009) found that grain number per spike, 1000-grain weight, plant height and test weight had valuable direct effect on grain yield. Khan and Dar (2010) revealed that positive direct effect on grain yield was highest through number of spikelets plant^{-1}, followed by number of grains spike^{-1} and 100-seed weight; whereas protein content followed by number of seeds spikelet^{-1} and number of effective tillers exhibited high direct effect in the negative direction on grain yield plant^{-1}

Table 10. Direct and indirect effects of some yield components on grain yield based on path analysis.

	Days to physiological maturity	No. of spikes/m^2	Spike length	plant height	No. of kernels /spike	1000-kernel weight	Correlation with grain yield
Days to physiological maturity	0.1072	0.0572	0.0387	-0.0157	0.0746	-0.0183	0.244
No. of spikes/m^2	0.0668	0.1580	0.0538	-0.0062	0.4822	0.0313	0.786**
Spike length	0.0666	0.0793	0.1846	-0.0177	0.3502	0.0804	0.743**
plant height	0.1139	0.0382	0.0746	-0.0254	0.0348	0.0289	0.265
No. of kernels/spike	0.0225	0.1247	0.0614	-0.0015	0.6112	0.0767	0.895**
1000-kernel weight	-0.0238	0.0348	0.0606	-0.0052	0.3294	0.1422	0.538**
Residual effect 0.358							

Statements: underlined numbers indicate direct effects.

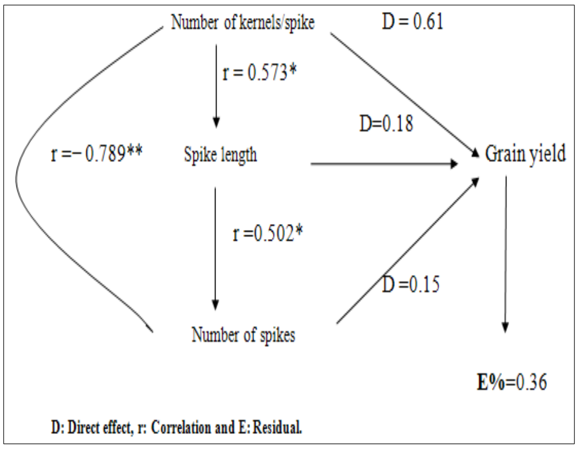


Figure 3. Path coefficient values estimated for some yield components of wheat

The coefficient of determination and relative importance according to path analysis for grain yield and its related traits are shown in Table (11). The results revealed that the greatest parts of grain yield variation were accounted by the direct effects of number of kernels/spike (35.81), days to physiological maturity) (3.27) and number of spikes (2.39). The great contribution of these traits on grain yield, hence the facility of visually selecting using these traits as selection criteria in wheat selection program.

Regarding the relative importance for the components of joint effects, it appeared that the highest value was observed for the indirect effect of number of spikes on grain yield through its association with number of kernels/spike (14.61%) followed by the joint effect of number of kernels/spike via 1000-kernel weight (8.98%).

Also, considerable values of relative importance were registered for the joint effects of spike length via number of kernels/spike (7.19%). Small values of relative importance ranging from 0.06% to 1.36% were obtained by the other direct and indirect effects, which are not covered by this study.

Totally, the studied characters explained (87.69%) of grain yield variation. Accordingly, the residual component (12.31%) may be attributed to unknown variation (random error), human errors during measuring traits and/or some other traits that were not under consideration in the present investigation. According above mentioned, path coefficient analysis gave somewhat a different picture than correlation coefficient did.

Table 11. The coefficient of determination (CD) and relative importance (RI %) according to path analysis of grain yield and its components in wheat.

Characters		CD	RI %
Direct effects			
X1.Days to physiological maturity		0.0341	3.2662
X2.No. of spikes /m2		0.0250	2.3942
X3.Spike length		0.0115	1.1012
X4.plant height		0.0006	0.0620
X5.No. of kernels/spike /spike		0.3735	35.8099
X6.1000-kernel weight		0.0202	1.9394
Total direct effect		0.4649	44.5730
Indirect effects			
X1 via	X2	0.0211	2.0246
	X3	0.0143	1.3693
	X4	-0.0058	0.5553
	X5	0.0275	2.6389
	X6	-0.0068	0.6494
X2 via	X3	0.0170	1.6302
	X4	-0.0019	0.1865
	X5	0.1524	14.6112
	X6	0.0099	0.9481
X3 via	X4	-0.0038	0.3637
	X5	0.0751	7.1964
	X6	0.0172	1.6514
X4 via	X5	-0.0018	0.1699
	X6	-0.0015	0.1408
X5 via	X6	0.0937	8.9838
Indirect total (absolute)		0.4067	43.1193
Total (direct + indirect)		0.9057	87.6923
Residuals		0.1284	12.3077
Absolute total		1.0341	100.00

CONCLUSION

It was concluded that three irrigations (I_2) at various growth stages and grain development are needed for wheat to obtain maximum yield, irrigation treatment I_2 and cultivar Misr1 increased yield by (42.3%), water use efficiency was recorded the highest values at I_1 and I_2 , and Misr 1 produced the highest values of grain yield and water use efficiency. Simple correlation, a step-wise regression and path analysis concluded that number of kernels/spike, number of spikes/m^2, spike length and 1000-kernel weight could be recommended as the best selection criteria for improving grain yield of evaluated wheat genotypes in irrigation treatment I_2. Therefore, direct selection using these traits during wheat breeding programs would be useful for wheat yield improvement.

REFERENCES

Agrama H.A.S. (1996): Sequential path analysis of grain yield and its components in agriculture and biology Journal of North America, 79:244-253.

Alam M. S., Rahman A. H.M.M., Nesa M.N., Khan S. K., and Siddique N.A. (2008). Effect of source and/or sink restriction on the grain yield in wheat. Journal of Applied Sciences, 4, 258-261.

Al-Molhem Y.A. (2016) Effect of Irrigation Treatment on Growth and Yield of Wheat (*Triticum aestivum* L.) Under Alhasa Conditions J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 7 (9): 665 -668.

Baloch Sana U., L.I.U. Li-jun, M. N. Kandhroo, S. Fahad, S. AL-Sabiel,; S.K. Baloch, and S.A. Badini (2014). Effect of different irrigation schedules on the growth and yield performance of wheat (*Triticum aestivum* L.) varieties assessment in District Awaran (Balochistan). Journal of Biology, Agriculture and Healthcare. 4(20):5-17.

Bankar K. B., Gosavi S.V. and Balsanen V.K. (2008). Effect of different irrigation treatment on growth and yield of wheat crop varieties," Inter. J. Agri. Science, 4: 114-118.

Bonfil D. J., Karnieli A., Raz M., Mufradi I., Asido S., Egozi H., Hoffman A. and Schmilovitch A. (2004). Decision support system for improving wheat grain quality in the Mediterranean area of Israel,'' Field Crop Research, 89: 153-163.

Cattivelli L., Rizza, F., Badeckc, F.W. Mazzucotelli, E., Mastrangelo, A.M., Franciaa, E., Mar`ea, C., Tondellia, A., and Stanca, A.M. (2008). Drought tolerance improvement in crop plants: An integrated view from breeding to genomics. Field Crops Research, 105, 1-14.

Dewey D.R., Lu K.H. (1959) A correlation and path-coefficient analysis of components of crested wheatgrass seed production. Agron. J 51:515-518.

El Hwary E. B. A. and Samia O. Yagoub (2011). Effect of different irrigation intervals on wheat (*Triticum aestivum* L) in semi-arid regions of Sudan. J. Sci. and Tech., 12 (03): 75-83.

Eskandari H. and Kazemi, K. (2010). Response of different bread wheat (Triticum aestivum L.) genotypes to post-anthesis water deficit. Notulae Scientia Biologicae, 2, 49-52.

Fellahi Z., A. Hannachi, H. Bouzerzour and A. Boutekrabt (2013). Correlation between traits and path analysis coefficient for grain yield and other quantitative traits in bread wheat under semi-arid conditions. Journal of Agriculture and Sustainability, 3(1): 16-26.

Gameh, M.A., E.M. Ahmed, K.A. Mohamed and M.A.M. Ahmed (2017). Effect of different dates and irrigation treatments on growth, yield and consumptive use of some wheat varieties under Sohag Governorate conditions. Assiut J. Agric. Sci., (48) (1): (374-393)

Gu´oth A., Tari I., Gall´e A., Csisza´r J., P´ecsv´aradi A., Cseuz L. and Erdei L. (2009). Comparison of the drought stress responses of tolerant and sensitive wheat cultivars during grain filling: changes in flag leaf photosynthetic activity, ABA levels, and grain yield. Journal of Plant Growth Regulator, 28, 167-176.

Gupta, N. K., Gupta, S., and Kumar, A. (2001). Effect of water stress on physiological attributes and their relationship with growth and yield of wheat cultivars at different stages. Journal of Agronomy and Crop Science, 186, 55-62.

Habibi G. (2011): Influence of drought on yield and yield components in white bean. Agriculture and Biology Journal of North America, 79:244-253.

Hussain A., Ghaudhry M. R., Wajad A., Ahmed A., Rafiq M. Ibrahim, M. and Goheer A.R. (2004) Influence of water stress on growth, yield and radiation use efficiency of various wheat cultivars. Int. J. Agric. Biology, 6:1074 -1079.

Islam ST, MZ Haque, MM Hasan, ABMMM Khanand UK Shanta. (2018). Effect of different irrigation levels on the performance of wheat. Progressive Agriculture 29 (2): 99-106

Jag Shoran A., Hariprasad S., Kant L., Mani V.P. and Chaudhan V.S. (2000): Association and contribution of yield attributes to seed yield in wheat under varying environments in northwestern hills. Crop Research Hissar. 25:47-49.

Jatoi W.A., Baloch M.J., Kumbhar M.B., Khan N.U. and Kerio, M.I. (2011). Effect of water stress on physiological and yield parameters at anthesis stage in elite spring wheat cultivars. Sarhad Journal of Agriculture, 27: 59-65.

Karim A., Hamid A. and Lalic A. (2000). Grain growth and yield Performance of wheat under subtropical conditions: II. Effect of water stress at reproductive stage. Cereal Res. Commun. 1-2: 101-107.

Khan M. H. and A. N. Dar (2010). Correlation and path coefficient analysis of some quantitative traits in wheat. African Crop Science Journal, 18(1): 9-14.

Larbi A. and Mekliche A. (2004). Relative water content (RWC) and leaf senescence as screening tools for drought tolerance in wheat. International Centre for Advanced Mediterranean Agronomic Studies, 60, 193-196.

Leghari S.J. Leghari, Z.A. Khokhar, A.A. Soomro, G.M. Laghari, M.N. Kandhro and K.B. Laghari (2017). Effect of irrigation treatments on growth and yield ofwheat variety Benazir. Sci. Int.(Lahore),29(3),781-785.

Leilah A.A. and S.A. Al-Khateeb (2005) Statistical analysis of wheat yield under drought conditions. J Arid Environ 61:483-496.

Levene H. (1960). Robust tests for equality of variances. In Ingram Olkin, Harold Hotelling, Etalia, Stanford University press. Pp. 278-292.

Majumder D.A.N., A.K.M. Shamsuddin, M.A. Kabir and L. Hassan (2008). Genetic variability, correlated response and path analysis of yield and yield contributing traits of spring wheat. J. Bangladesh Agril. Univ. 6(2): 227–234.

Mandal K.G., K.M. Hati, A.K. Misra, K.K. Bandyopadhyay and Mohanty M. (2005). Irrigation and nutrient effects on growth and water-yield relationship of wheat (*Triticum aestivum* L.) in Central India. J. Agron Crop Sci. 191: 416 – 425.

Mehmet A. and T. Yildirim (2006). Path coefficient analysis of yield and yield components in bread wheat (*Triticum aestivum* L.) genotypes. Pak. J. Bot., 38(2): 417-424.

Mishra R.K., Pandey N., Pandey V.K., Chaudhary S.K. and Palival A.K. (1998). Effect of nitrogen and irrigation scheduling on biomass accumulation and net primary productivity in wheat. *Adv. Pl. Science,* 11(1): 99-103

Mohamed N.A. (1999). Some statistical procedures for evaluation of the relative contribution for yield components in wheat. Zagazig J. Ag. Res. 26 (2): 281-290.

Nawaz H., Hussain N. and Yasmeen A. (2015). Growth, yield and antioxidants status of wheat (*Triticum aestivum* L.) cultivars under water deficit conditions. Pak. J. Agric. Sci. 52, 953-959.

Rajaram S. (2001). Prospects and promise of wheat breeding in the 21st century. Euphytica, 119, 3-15.

Ramazan D. (2009). The correlation and path coefficient analysis for yield and some yield components of durum wheat (Triticum turgidum var. durum L.) in west Anatolia conditions. Pak. J. Bot., 41(3): 1081-1089.

Seyed Mehdi Mirtaheri, Farzad Paknejad and Marieh Behdad (2015). The application of the multivariate analysis method for some traits in wheat under drought stress, Journal of Agricultural Sciences. 60, (4): 407-417

Shamsi K. and S. Kobraee (2011). Bread wheat production under drought stress conditions. Annual Biology of Research, 2, 352-358.

Shamsi K., Petrosyan M., Noor-Mohammadi G. and Haghparast R. (2010).The role of water deficit stress and water use efficiency on bread wheat cultivars. Journal of Applied Biosciences, 35, 2325-2331.

Singh B.N., Vishwakarma S.R. and Kumar Singh V. (2010): Character association and path analysis in elite lines of wheat (Triticum aestivum L.). Plant Archives 10:845-847.

Sio-Se Mardeh A., Ahmadi A., Poustini K., and Mohammadi, V. (2006). Evaluation of drought resistance indices under various environmental conditions. Field Crops Research, *98(2-3)*:222-229.

Snedecor, G.W. and W.G. Cochran (1981). Statistical Methods. 7th Edition. Iowa State University Press, Iowa. USA.

Steel R.G.D. and J.H. Torrie. (1984). Principles and procedures of statistics. McGraw Hill Book Co.,Inc., Singapore; pp.172-177.

Thamer T.Y., Nadine Nassif, Amira Haddarah and A.H. Almaeini (2019). Effect of deficient irrigation on consumptive use of wheat (*Triticum aestivum.* L) in arid and semi-arid areas. International J. Recent Technology and Engineering (IJRTE); 8(1-4):730-735.

Vites G. Jr. (1965). Increasing water use efficiency by soil management. In W.H. Pierre, D. Kirkhan, J. Pesek and R. Shaw (Eds.). "Plant Environment and Efficicient Water Use". Amer. Soc. Agron. Madison, Wisc.,PP: 259-247.

Wajid, A., Hussain, A., Maqsood, M., Ahmad, A. and Awais, M., (2002). Influence of sowing date and irrigation levels on growth and grain yield of wheat. Pak. J. Agri. Science, 39(1): 22-24

Yang J. C., Zhang J.H., Ye Y.X., Wang Z.Q. Zhu Q.S. and Liu L.J. (2004). Involvement of Abscisic and ethylene in the responses of rice grains to water stress during filling. Plant Cell Environment, 27(8): 1055-1064.

دراسة الارتباط ومعامل المرور لمحصول الحبوب ومكوناته لبعض التراكيب الوراثية من قمح الخبز تحت ثلاثة معاملات من الرى

صبحى محمد عبدالدايم[١] ، ياسر أحمد الجوهرى[١] و هدى السيد العربى إبراهيم[٢]
[١]قسم بحوث القمح – معهد بحوث المحاصيل الحقلية – مركز البحوث الزراعية
[٢]المعمل المركزى لبجوث التصميم والتحليل الإحصائى

تم تنفيذ تجربة حقلية فى تصميم القطع المنشقة من ثلاث مكررات فى المزرعة البحثية بمحطة البحوث الزراعية بإيتاى البارود بمحافظة البحيرة خلال الموسمين الزراعيين ٢٠١٩/٢٠١٨ و ٢٠٢٠/٢٠١٩ وذلك لتحديد معاملة الرى (irrigation treatment) المثلى للحصول على أعلى انتاجية من محصول الحبوب لستة تراكيب وراثية من قمح الخبز، وتحديد مدى الارتباط ما بين المحصول والصفات المرتبطة به. حيث وضعت معاملات الرى الثلاث I_1 (الرى فى مرحلتى التفريع والاستطالة)، I_2 (الرى فى مراحل التفريع ,الاستطالة والإنتفاخ) وI_3 (الرى فى مراحل التفريع ,الاستطالة ,الإنتفاخ ومرحلة طرد السنابل) فى القطع الرئيسية و تم وضع ٦ تراكيب وراثية من قمح الخبز هى (مصر٢, جميزة١١, مصر١, شندويل١, سلالة١ وسلالة٢) فى القطع الشقية . خلصت النتائج إلى التوصية بزراعة الصنف مصر١ ومعاملته بمعاملة الرى الثانية I_2 (الرى فى مراحل التفريع ,الاستطالة والإنتفاخ) حيث أنه قد أعطى أعلى القيم لكل من عدد السنابل/م٢ (٤٥٤,٣٣), عدد الحبوب بالسنبلة (٥٦,١٧) وأعطى أعلى إنتاجية (٢٥,٤٨ أردب/فدان) و سجل أعلى نسبة لدليل الحصاد ٣٨,٨٩%. كما أوضحت النتائج أن أعلى قيمة لكفاءة إستخدام المياه (١,٢٣) سجلت للصنف مصر١ تحت مستوى الرى الأول I_1 الذى سجل أيضا أعلى محصول للحبوب. أظهرت نتائج تحليل المسار أن أهم تأثير على محصول الحبوب في كل المعاملات التي تم اختبارها مرتبطًة هو صفة عدد حبوب السنبلة و تمثل ٨٩,٥٪ من تغيرات محصول الحبوب ، ٦١٪ منها هو التأثير المباشر لهذه الصفة على محصول الحبوب. كما أظهر التحليل المتعدد للمتغيرات أن صفات عدد الحبوب بالسنبلة، عدد السنابل/م٢ ، طول السنبلة وصفة وزن الألف حبة تعتبر معايير انتخابية لانتخاب أفضل التراكيب الوراثية من القمح تحت ظروف معاملة الرى الثانية I_2.