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Influence Different Level of Humic Acid and Irrigation Regime on Seed Yield and Morphological Traits of Corn under Warm and Dry Climate Condition

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ABSTRACT

In order to evaluation effect of different level of humic acid affected drought stress on seed yield, its components and morphological traits of corn a research farm was conducted according split plot experiment based randomized complete blocks design at three replication during 2015 year. Main factor included four irrigation regimes (90mm, 110mm, 130mm and 150mm evaporation from pan class A) and four level of humic acid belonged to subfactor (non-application or control, 20, 30 and 40 $L.ha^{-1}$). According result of analysis of variance effect of different irrigation regime and humic acid on all measured traits (instead number of row per ear) was significant but interaction effect of treatments was not significant. Mean comparison result indicated 90 mm evaporation treatment had highest amount of plant height (191 cm), leaf area index (4.1), ear diameter (8.1 cm), ear length (21.4 cm), number of row per ear (14), number of seed per row (40), seed weight (338 gr), seed yield (7120 $kg.ha^{-1}$), biologic yield (1650 $kg.ha^{-1}$) and harvest index (48.6 %), instead ear length loses. Also among different level of humic acid 40 $L.ha^{-1}$ had similar trend and was superior in all measured traits. It should be noted that the amount of organic matter in the soil, type and texture of the soil can be effective on grades of stress, and for each climate and region, the level of water stress and the optimum amount of humic acid can be different. Finally according result of this research irrigation at 90 mm evaporation from pan class A led to achieve highest seed yield and with 40 $L.ha^{-1}$ humic acid treatments can be advised for studied region.

Keywords*: Drought stress, Maize, Organic manures.*

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INTRODUCTION

Across the globe today, corn is a direct staple food for millions of individuals and, through indirect consumption as a feed crop, is an essential component of global food security (Campos *et al.*, 2004). In Iran water is a scarce resource due to the high variability of rainfall. The effects of water stress depend on the timing, duration and magnitude of the deficits (Pandey *et al.*, 2001). It causes stress in plants and is not only caused by the reduction of rainfalls and great heat, but in the cases where there is moisture in the soil, this moisture cannot be used for plants for some reasons such as excessive soil salinity or soil frost, and plants will be stressed (Baydar and Erbas, 2005; Borrell *et al.*, 2008). All organic manures improve the behaviors of several elements in soils through that active group (Humic acids; HA) which have the ability to retain the elements in complex and chelate form. These materials release the elements over a period of time and are broken down slowly by soil microorganisms. The extent of availability of such nutrients depends on the type of organic materials and microorganisms (Ghavidel Shahraki *et al.,* 2017). Humic acid well known in controlling, soil-borne diseases, improves the physical, chemical and biological properties of the soil and influences plant growth, soil health and nutrient uptake by plants, mineral availability, fruit quality, etc. Humic substances are recognized as a key component of soil fertility properties, since they control chemical and biological properties of the rhizosphere (Trevisan *et al*., 2009; Mauromicale *et al*., 2011). Humic acid is water-soluble organic acid naturally present in soil organic matter. It can be recognized that humic substances (HS) have many beneficial effects on soil structure and soil microbial populations, as well as, increase modify mechanisms involved in plant growth stimulation, cell permeability and nutrient uptake causing increases (Atiyeh *et al*., 2000; Rahmat *et al*., 2010). Application of the humic acid had statistically significant effect on Mg, Fe and Mn uptake. Humic acid raised the dry weight and N, P, K, Ca, Mg, Na, Fe, Cu, Zn and Mn uptake of plants at non limed pots and the amounts were found high at 0.1 % dose of humic acid. The second dose (0.2 %) was found much more effective on dry weight and nitrogen uptake at high lime conditions (Katkat *et al*., 2009). The mechanism of humic acid activity in promoting plant growth is not completely known, but several explanations have been proposed by some researchers such as increasing cell membrane permeability, oxygen uptake, respiration and photosynthesis, phosphate uptake, and root cell elongation (Turkmen *et al*., 2004). Also Delfine *et al*. (2005) investigated the effect of application of humic acid on growth and yield of durum wheat. Moreover, they specified that the application of humic acid caused a transitional production of plant dry mass with respect to unfertilized control. Aiyafar *et al*. (2015) by evaluate the effect of water deficit stress and humic acid on intervals seed yield and its components of black cumin reported with increasing irrigation intervals from 6 to 12 days, biological yield, 1000-seed weight and seed yield were decreased. Also application of humic acid increased plant height, number of capsule per plant, number of leaf per plant, number of seed per plant, biological yield, 1000- seed weight, seed yield, essential oil percentage and essential oil yield. Tohidi Moghadam *et al*. (2014) by study effect of humic acid foliar application and limited irrigation on growth and quantitative characteristics of corn reported irrigation withholding conditions in different growth stages significantly decreased plant height, yield components, seed yield, biological yield and harvest index. But humic acid in irrigation with holding at different growth stages had positive effect on all attributes traits. Generally usage of humic acid reduces the harmful effects of water deficit stress and increases resistance to drought stress in corn plant. Gomaa *et al*. (2014) concluded that application humic acid at 14.4 $kg.ha^{-1}$, was effective to avoid a significant increase in growth analysis and grain yield when the irrigation analysis interval was 10 and15 days with T.W.C 352 and S.C 168 hybrids understudy. Bakry *et al*. (2009) reported that significant increase in maize vegetative growth characters (plant height and leaf contents of chlorophyll a and b, ear characters and grain yield/ear length, ear diameter, rows number/ear, grains number/row and grain yield/plot and grain quality parameters (weight of 1000 seed) due to humic acid application. Also, Daur and Bakhashwain (2013) stated that significant differences were observed for all the studied parameters across the humic acid levels. Application of 25 kg humic $acid.ha^{-1}$, may be recommended to improve growth and quality of maize fodder in similar environmental conditions. Aisha *et al*. (2014) reported that increasing rate of humic acid increased growth characters, yield characters and increase the percentage of protein. Sharifi (2017) by evaluate the impact of drought stress and humic acid on physiological indices of maize growth reported drought stress is a limiting factor in LAI and receiving radiant energy, and these two factors limit production of dry matter, CGR, RGR, and NAR. Moreover, humic acid consumption due to its nutritional properties improved all indicators. On the other hand, in non-stress treatments (100% irrigation), using humic acid, compared to non-use, increased RGR, CGR, NAR and LAI, respectively, 1.3%, 21%, 8% and 12.5 %. This is while in water stress (50% irrigation) and humic acid consumption, these indices increased 7%, 25%, 14% and 30% respectively representing a reduction in drought stress in humic acid use. In general, it could be argued that the use of humic acid, due to adjusting the drought, could have a positive role in water stress to reduce the use of chemical fertilizers, reducing environmental pollution, and to mitigate drought stress, and as is suggested a stable source of supplying nutrients in drought conditions for maize. This research was conducted to investigate the effect of different irrigation regime and humic acid foliar application on the seed yield, yield components, harvest index and morphological traits of corn crop under warm and dry climate condition in southwest of Iran.

MATERIALS AND METHODS

Field and Treatment Information

This research was carried out to assessment seed yield, its components and morphological traits of corn hybrid (S.C.704) affected drought stress and different humic acid in Shush region, Khuzestan province at southwest of Iran via split plot experiment based on randomized complete blocks design with three replications along 2015 year. The main factor consists of four irrigation regimes (90mm, 110mm, 130mm and 150mm evaporation from pan class A). The evaporation rate is obtained from the daily meteorological center, which is applied at the four-leaf stage. Four level of humic acid belonged to subfactor (non-application or control, 20, 30, 40 and 40 $L.ha^{-1}$, once sprayed at a six to eight leaf stage). Geographical information of research place included

48^0 32' E as longitude, 32^0 22' N as latitude and altitude was 82 m. The average annual rainfall, temperature, and evaporation in studied region are 245 mm, 20 C and 3100 mm, respectively. Climate properties of studied field was mentioned in table 1.

Farm Management

Soils were fertilized according to recommendation based on soil tests (Table 2) and the level of treatments. The field was plowed, fertilized, and leveled before the field maize planted. The size of each plot was 6×5 m² and each block has 12 treatments. For the experiment, the distance between rows to rows was 75 cm with six rows per treatment, and irrigation was applied when the plants required it. The size of each plot was 6×5 m² and each block has 12 treatments. For the experiment, the distance between rows to rows was 75 cm with six rows per treatment, and irrigation was applied when the plants required it. Phosphorus and potassium fertilizers were provided from 150 $kg.ha^{-1}$ triple superphosphate and 150 $kg.ha^{-1}$ potassium sulfate. Biological fertilizer of nitroxin was used as much as two $L.ha^{-1}$ as combined with seeds. Nitrogen chemical fertilizer was provided from the urea source, 50% during planting and 50% during 8-leaf stage. Irrigation was done every three or four days and after the plant establishment it was done every seven to ten days if necessary. Weeds were controlled via Cruise herbicide by two $L.ha^{-1}$ at 4 to 5 leaf stage and Krakrown pesticide by one $L.ha^{-1}$ against leaf and stem borer larvae.

Table 1. Climate properties of studied field during 2015

Month	Relative Humidity (%)		Evaporation	Precipitation	Temperature (^{0}C)		
	min	max	(mm)	(mm)	Min	Max	Mean
July	8	79	373.4	0	25	48.4	36.7
August	8	99	372.2	0	22	47	34.5
September	11	85	232.1	0.51	16	41.8	28.9
October	23	60	75.5	71.4	9	34.6	21.8
November	13	55	58.1	66.1	1	27.4	14.2

Table 2. Soil characteristics of studied field

Depth (cm)	EC ($ds.m^{-1}$)	pH	O.C (%)	Soil texture	P (ppm)	K (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)	Zn (ppm)
0-30	1.25	7.1	0.85	Clay loam	9.4	114	9.6	1.3	8.5	0.6

Traits Measure

Total dry matter, relative seed yield and its components were estimated after the physiological maturity by harvesting interior rows (the outer rows excluding at least 0.5 m from either end of the rows. The samples were for 48 hours in the oven at 72-75 centigrade and dry weight was measured. To calculate the number of seeds per row and number of row per ear, of each plot, 10 ears was selected randomly and number of seeds per row , number of rows per ear were counted, and average 10 ear were considered as the number of seeds per ear and number of rows per ear for that plots. Harvest index is calculated as the ratio of the seed yield dry matter yield. Ear diameter and Ear length were measured by caliper with 10 sample of every plot. Leaf area index by using Li-3100 Lincoln device were measured.

Statistical analysis

The analysis of variance was done by SAS software (Ver.8) and the means were compared with using Duncan's multi range test at 5% probability level.

RESULTS AND DISCUSSION

Plant height

According result of analysis of variance effect of different irrigation regime and humic acid on plant height was significant at 1% and 5% level probability, respectively but interaction effect of treatments was not significant (Table 3). Mean comparison result of different irrigation regime indicated that maximum plant height (191 cm) was noted for 90mm evaporation and minimum of that (152 cm) belonged to 150 mm evaporation treatment (Table 4). Tohidi Moghadam *et al*. (2014) reported the highest plant height was obtained from complete irrigation. Irrigation with holding at 8 leaf stage decreased plant height. Irrigation withholding at staminate inflorescence appearance less decreased plant height compared to irrigation withholding at 8 leaf stage. Water stress induction after flowering stage does not decrease plant growth and elongation. The decrease in plant height, under drought conditions, may be due to suppression of cell expansion and cell growth that is in response to low turgor pressure (Jaleel *et al*., 2008; Ogbonnaya *et al*., 2003). As for Duncan classification made with respect to different level of humic acid maximum and minimum amount of plant height belonged to 40 $L.ha^{-1}$ (189 cm) and control (172 cm) (Table 5).

Table 3. Result of analysis of variance of morphological traits

S.O.V	df	Plant height	Leaf area index	Ear diameter	Ear length	Ear loses length
Replication	2	2.1^{*}	0.01^{*}	0.01^{*}	2.4^{*}	0.02^{*}
Irrigation regime	3	2314^{**}	3.4^{**}	11.2^{*}	171^{*}	9.1^{**}
Error I	6	11.5	0.02	0.1	1.9	0.03
Humic acid	3	1124^{*}	1.7^{**}	12.1^{**}	92^{*}	8.1^{*}
Irrigation regime * Humic acid	9	101.5^{ns}	1.2^{ns}	0.03^{ns}	2.3^{ns}	5.9^{ns}
Error II	24	5.2	0.04	0.04	3.5	0.1
CV (%)	-	9.7	8.6	7.9	8.1	7.5

^{ns,*} and **: non-significant, significant at 5% and 1% probability levels, respectively.

This result, were accordance with results of Jing-min *et al*. (2010). The increase in the plant height in the humic acid amended treatments most probably was due to the improvement of growth of the root zone. Increasing drought stress, the plant height decreased due to lack of plant access to the amount of water suitable for growth, also with increase in humic acid level, plant height increased. The amount of this decline is influenced by the genetic factors and varies depending on the cultivar. Drought stress decreases leaf area, stomata obstruction, protoplasmic activity and carbon fixation and decreasing photosynthesis, which ultimately reduces plant height (Qurbani *et al*., 2010).

Leaf area index

Result of analysis of variance revealed effect of different irrigation regime and humic acid on leaf area index was significant at 1% probability level, but interaction effect of treatments was not significant (Table 3). According result of mean comparison maximum of leaf area index (4.1) was obtained for 90mm evaporation and minimum of that (3.0) was for 150 mm evaporation treatment (Table 4). Evaluation mean comparison result indicated in different level of humic acid the maximum leaf area index (4.3) was noted for 40 $L.ha^{-1}$ and minimum of that (3.5) belonged to control treatment (Table 5). Drought stress during the vegetative period led to leaf loses and decreased the leaf area index during the period of ripening and the amount of light absorption by the plant, but the use of humic acid could decrease this negative effect, so, in all humic acid treatments, a relative increase compared to the control was observed. Mao *et al*. (2011) have pointed similar results in this regard.

Table 4. Mean comparison of different level of irrigation regime on morphological traits

Treatments	Plant height (cm)	Leaf area index	Ear diameter (cm)	Ear length (cm)	Ear loses length (cm)
90 mm	191[a*]	4.1[a]	8.1[a]	21.4[a]	0.34[d]
110 mm	175[b]	3.7[b]	7.5[ab]	18.5[b]	1.1[c]
130 mm	165[bc]	3.3[c]	7.0[b]	15.7[bc]	1.87[b]
150 mm	152[c]	3.0[d]	6.1[c]	13.1[c]	2.28[a]

[*]Means followed by similar letters have not significantly different ($p<0.05$) via Duncan test.

Table 5. Mean comparison of different level of humic acid on morphological traits

Treatments	Plant height (cm)	Leaf area index	Ear diameter (cm)	Ear length (cm)	Ear loses length (cm)
Control	172[c*]	3.5[c]	6.4[d]	15.0[c]	1.9[a]
20 $L.ha^{-1}$	179[b]	3.8[b]	7.1[c]	16.7[b]	1.1[b]
30 $L.ha^{-1}$	185[ab]	4.0[ab]	7.7[b]	18.9[ab]	0.84[c]
40 $L.ha^{-1}$	189[a]	4.3[a]	8.0[a]	20.1[a]	0.71[c]

[*]Means followed by similar letters have not significantly different ($p<0.05$) via Duncan test.

Ear diameter

According result of analysis of variance effect of different irrigation regime and humic acid on ear diameter was significant at 5% and 1% probability level, respectively but interaction effect of treatments was not significant (Table 3). Assessment mean comparison result indicated in different irrigation regime the maximum ear diameter (8.1 cm) was noted for 90mm evaporation and minimum of that (6.1) belonged to 150mm treatment (Table 4). Compare different level of humic acid showed that the maximum and the minimum amount of ear diameter belonged to 40 $L.ha^{-1}$ (8.0 cm) and control (6.4 cm) treatments (Table 5). According to the results, ear diameter were decreased with increasing stress, which can be due to the reduction in the number of seeds per row and the lack of ear growth due to stress. It is evident same another traits increase of humic acid causes an increase in the ear diameter, which also indicates the positive effect of humic acid on the seed yield of corn. Khadem *et al*. (2011) by investigated the effect of humic acid on corn growth in calcareous soils reported that different doses of humic acid had a different and significant effect on the ear diameter. Decrease in the ear diameter in corn under drought stress conditions during the growth period was related by reducing the number of seeds per ear. Another researcher such as Puglisi *et al*. (2009); Celik *et al*. (2010) reported same result.

Ear length

Result of analysis of the variance indicated the effect of different irrigation regime and humic acid on ear length was significant at 5% probability level but interaction effect of treatments was not significant (Table 3). Evaluation mean comparison result revealed in different irrigation regime the maximum ear length (21.4 cm) was noted for 90mm evaporation and minimum of that (13.1 cm) belonged to 150mm evaporation treatment (Table 4). Between different levels of humic acid the maximum ear length (20.1 cm) was observed in 40 L.ha^{-1} and the lowest one (15.0 cm) was found in control treatment (Table 5). Gorbani *et al.* (2010) reported that the application of 3.500 g.ha^{-1} of humic acid significantly increased the number of seeds per row and ear length. This finding, were accordance with results of Eldardiry *et al.* (2012).

Ear loses length

According result of analysis of variance effect of different irrigation regime and humic acid on ear loses length was significant at 1% and 5% probability level, respectively but interaction effect of treatments was not significant (Table 3). Mean comparison result indicated the maximum and the minimum amount of ear loses length belonged to the 150 mm evaporation (2.28 cm) and 90 mm evaporation (0.34 cm) (Table 4). Among different level of humic acid maximum ear loses length (1.9 cm) was obtained for conrol and minimum of that (0.71 cm) was for 40 L.ha^{-1} treatment (Table 5). Some researchers such as Verlinden *et al.* (2009) confirmed mentioned result.

Number of row per ear

Result of analysis of variance revealed effect of different irrigation regime on number of row per ear was significant at 5% probability level but effect of humic acid and interaction effect of treatments on mentioned trait was not significant (Table 6). Assessment mean comparison result of different irrigation regime revealed the maximum number of row per ear (14) was noted for 90mm evaporation and minimum of that (9) belonged to 150mm evaporation treatment (Table 7). Due to the mentioned results, drought stress reduced the number of row per ear; it can be happen due to incomplete inoculation and the loss of pollen grain, although that trait in maize crop is more affected genetic. This result, were accordance with results of Gomaa *et al.* (2014).

Table 6. Result of analysis of variance of seed yield and its components

S.O.V	df	Number of row per ear	Number of seed per row	Seed weight	Seed yield	Biologic yield	Harvest index
Replication	2	56.8*	1.5*	9.9*	1297*	8181*	2.3*
Irrigation regime	3	108.2*	671.2**	19850**	8017**	2667**	591.3**
Error I	6	89.2	1.2	21.6	4082	27496	4.1
Humic acid	3	32.9^{ns}	426.8**	2439**	2153*	3042*	69.5*
Irrigation regime * Humic acid	9	24.7^{ns}	616.1^{ns}	5420.1^{ns}	5331^{ns}	3021^{ns}	81.1^{ns}
Error II	24	33.1	8.2	64.2	8679	3806	5.9
CV (%)	-	8.1	6.8	7.3	9.2	11.6	6.5

$^{ns, *}$ and **: non-significant, significant at 5% and 1% probability levels, respectively.

Number of seeds per row

According result of analysis of variance effect of different irrigation regime and humic acid on number of seeds per row was significant at 1% probability level, but interaction effect of treatments was not significant (Table 6). Mean comparison result of different level of irrigation regime indicated maximum number of seeds per row (40) was obtained for 90mm evaporation and minimum of that (20) was for 150 mm evaporation treatment (Table 7). Irrigation withholding during flowering and pollination effect on metabolism, physiology and morphology of plants. It seems that decrease in seed number is due to lack of fertilization. In addition, water stress leads to reduction in nutrient uptake and photosynthesis rate and thus reproductive organs will damage. Compare different level of humic acid showed that the maximum and the minimum amount of number of seeds per row belonged to 40 $L.ha^{-1}$ (39) and control (21) treatments (Table 8). Shuixiu and Ruizhen (2001) mentioned that HA used as a soil treatment at the seeding stage significantly increased the seeds per plant in soybean plants. Also Saruhan *et al*. (2011) have reported that the highest grain number per bunch was obtained from humic acid treatment. Some researchers such as Hirisch *et al*. (2007) confirmed mentioned result. The results showed that the number of seeds was affected by drought stress and humic acid, with the increase of the humic acid, the number of seeds increased which can be attributed to improving the better inoculation and increased seed numbers. Adani *et al*. (2006) reported that drought stress conditions during the growth period led to decrease corn yield by reducing the number of seeds per maize. Humic acid can have a direct positive effect on plant growth. The growth of the aerial and root portion of the plant is stimulated by humic acid. Humic acid increases nitrogen, potassium, calcium, magnesium and phosphorus uptakes by the crops (Khadem *et al*., 2011).

Table 7. Mean comparison of different level of irrigation regime on seed yield and its components

Treatments	Number of row per ear	Number of seed per row	Seed weight (gr)	Seed yield ($kg.ha^{-1}$)	Biologic yield ($kg.ha^{-1}$)	Harvest index (%)
90 mm	14^{a*}	40^{a}	338^{a}	7120^{a}	14650^{a}	48.6^{a}
110 mm	12^{b}	34^{b}	317^{b}	5400^{b}	12900^{b}	41.8^{b}
130 mm	10^{bc}	27^{c}	261^{c}	3400^{c}	8600^{c}	39.5^{bc}
150 mm	9^{c}	20^{d}	240^{d}	2550^{d}	6850^{d}	37.2^{c}

[*]Means followed by similar letters have not significantly different ($p<0.05$) via Duncan test.

Seed weight

Result of analysis of variance revealed effect of different irrigation regime and humic acid on seed weight was significant at 1% probability level, but interaction effect of treatments was not significant (Table 6). According mean comparison result of different irrigation regime the maximum seed weight (338 gr) was observed in 90mm evaporation and the lowest one (240 gr) was found in 150 mm evaporation treatments (Table 7). Drought stress reduced the capacity of assimilate production due to a small green leaf area and leaf greenness. Thus, reduced current and reserve carbohydrates production during reproductive and/or vegetative water deficit may have limited the 1,000 seed weight in our study. Drought stress during the vegetative and reproductive stage reduces number of seed per ear and along grain filling period decreases seed weight and finally reduce seed yield (Karimi and Naderi, 2007). Between different level of humic acid highest value of seed weight content was belonged to the 40 $L.ha^{-1}$ treatment (312 gr) and the lowest one was found in the control treatment as 259 gr (Table 8). This finding, were accordance with results of Saruhan *et al*. (2011). As the drought stress increases, the amount of photosynthesis, assimilates and transfers to the seed decreases, and causes wrinkling and weight loss seeds. The seed weight is determined during pollination, and the inadequacy of photosynthetic materials for the growth of embryonic cells has a negative effect on seed weight. Also Drought stress reduced seed yield by reducing the number of seed per ear and 1000-seed weight (Karimi and Naderi, 2007).

Table 8. Mean comparison of different level of humic acid on seed yield and its components

Treatments	Number of seed per row	Seed weight (gr)	Seed yield ($kg.ha^{-1}$)	Biologic yield ($kg.ha^{-1}$)	Harvest index (%)
Control	21^{d*}	259^{d}	4970^{c}	12551^{c}	39.6^{b}
20 $L.ha^{-1}$	30^{c}	278^{c}	6280^{b}	14100^{b}	44.3^{ab}
30 $L.ha^{-1}$	37^{b}	305^{b}	6670^{ab}	14700^{ab}	44.5^{ab}
40 $L.ha^{-1}$	39^{a}	312^{a}	7010^{a}	15510^{a}	45.1^{a}

*Means followed by similar letters have not significantly different ($p<0.05$) via Duncan test.

Seed yield

According result of analysis of variance effect of different irrigation regime and humic acid on seed yield was significant at 1% and 5% probability level, respectively but interaction effect of treatments was not significant (Table 6). Mean comparison result of different level of irrigation regime showed maximum seed yield (7120 $kg.ha^{-1}$) was obtained for 90mm evaporation and minimum of that (2550 $kg.ha^{-1}$) was for 150 mm evaporation treatment (Table 7). Among different level of humic acid the maximum and the minimum amount of seed yield belonged to 40 $L.ha^{-1}$ (7010 $kg.ha^{-1}$) and control (4970 $kg.ha^{-1}$) treatment (Table 8). Another researcher such as Sarir *et al*. (2005); Waqas *et al*. (2014) reported same result. Seed yield has positive correlation with harvest index while it has negative with plant growth. Under water deficit stress, economical yield and biological yield affect by different factors such as plant growth rate, leaf size, root hydrolytic resistance and evaporation and then harvest index changes. Small leaves decrease transpiration rate and conserve more water into the soil, this water will consume during seed setting and seed filling stage. One of the most important agrophysiological processes which affect by water deficit stress is assimilate transport (Seliim *et al*., 2009). Drought stress led to decrease leaf area index, assimilate production, low transfer to seed, loses seed weight and finally decrease seed yield. The undesirable moisture regime, while decreasing the leaf area, accelerates their aging and thereby reduces production much more than it reduces due to the effects of reducing the severity of pure photosynthesis, which ultimately leads to a decrease in seed yield. Dough stress had a negative effect on the growth and development of reproductive organs led to reduce the yield components such as number of ear per unit area, number of seed per row, 1000 seed weight and finally the seed yield. yield of corn in optimum irrigation, mild and severe drought stress conditions (irrigation after 30, 40 and 50% of field capacity point, respectively) and reported severe drought stress reduced seed yield by 40% in comparison with optimum conditions (Fazeli-Rostampor *et al*., 2012). Rajpar *et al* .(2011) stated that humic acid increased plant yields through positive physiological effects including affecting cells metabolism and increasing chlorophyll content of leaves.

Biologic yield

Result of analysis of variance revealed effect of different irrigation regime and humic acid on biologic yield was significant at 1% and 5% probability level, respectively but interaction effect of treatments was not significant (Table 6). According mean comparison result of different irrigation regime the maximum biologic yield (14650 $kg.ha^{-1}$) was observed in 90mm evaporation and the lowest one (6850 $kg.ha^{-1}$) was found in 150 mm evaporation treatments (Table 7). Compare different level of humic acid indicated highest value of biologic yield was belonged to the 40 $L.ha^{-1}$ (15510 $kg.ha^{-1}$) and the lowest one was found for control treatment as 12551 $kg.ha^{-1}$ (Table 8). Some researchers such as Tohidi Moghadam (2015); Fahramand *et al*. (2014) confirmed mentioned result. Anyia and Herzog (2004) indicated that water deficit caused between 11 and more than 40% reduction of biomass across the genotypes of cowpea due to decline in leaf gas exchange and leaf area. However humic acid foliar application with high concentration (300 and 450 ppm) could improve biological yield. Humic acid consumption increased fresh and dry weight of leaves and stems. Cordeiro *et al*. (2011) reported that humic acid through increases the nitrogen content led to increase the growth, plant height and consequently biological yield.

Harvest index

Harvest index is a function of grain yield and biological yield, therefore reduction of each component causes a change in harvest index Harvest index is a function of grain yield and biological yield, therefore reduction of each component causes a change in harvest index According result of analysis of variance effect of different irrigation regime and humic acid on harvest index was significant at 1% and 5% probability level, respectively but interaction effect of treatments was not significant (Table 6). Mean comparison result showed the maximum and the minimum amount of harvest index belonged to 90mm evaporation (48.6%) and 150 mm evaporation (37.2%) (Table 7). Among different level of humic acid maximum harvest index (45.1%) was obtained for 40 $L.ha^{-1}$ and minimum of that (39.6%) was for control treatment (Table 8). Yoon-Ha *et al*. (2012) have pointed similar results in this regard. According mentioned result drought stress reduces seed and biological yields, and the fact that both traits have decreased has led to a reduction in harvest index. Harvest index is the coefficient of transmission therefore, the higher the drought stress, due to its impact on the transport of the produced material, it can have an effect on the harvest index and decrease it.

CONCLUSION

Humic acid is an organically charged bio-stimulant that significantly affects plant growth and development and increases crop yield. According result of this research effect of different irrigation regime and humic acid on all measured traits (instead number of row per ear) was significant. Result of mean comparison revealed 90mm evaporation treatment had highest amount of morphological traits (instead ear length loses), seed yield, its components and harvest index. Also among different level of humic acid 40 $L.ha^{-1}$ treatment had same trend. It should be noted that the amount of organic matter in the soil, type and texture of the soil can be effective on grades of stress, and for each climate and region, the level of water stress and the optimum amount of humic acid can be different.

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