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Research Article

The Effect of Stopping Irrigation, Potassium and low Consumption Elements on Growth Indicators of Fodder Corn

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Abstract:

In order to investigate the effect of irrigation, potassium and low-use elements on the growth indicators of fodder corn 704, a study in 2022 in the form of split-split plots in the form of a basic randomized complete block design in three replications at the city of urmia was implemented. Irrigation treatment as the main factor in two levels (full irrigation and interruption of irrigation), potassium consumption as a secondary factor in two levels (no consumption and consumption of 200 kg/ha of potassium) and low-consumption elements as a secondary factor in three levels. (non-use, soil use and foliar spraying were low-use elements). Plant height, fresh fodder yield, stem and leaf dry weight, biological yield, flag leaf area, ear length and diameter, proline and leaf relative water content were studied. According to the results, the main effects of irrigation interruption were significant in reducing plant height, flag leaf area, ear length, fresh fodder yield, stem and leaf dry weight, and increasing proline. Potassium consumption had a significant effect in increasing plant height, biological yield, ear length and diameter, proline, and also reducing stem dry weight. The three-way interaction effect of irrigation interruption, potassium consumption and soil consumption of low consumption elements significantly increased leaf dry weight by 20% and proline by 0.34%. But in the condition of stopping irrigation and using potassium, the non-use of low-use elements increased the relative water content of the cell by 8% compared to the foliar application of low-use elements. Therefore, in the conditions of drought stress, the use of potassium together with low-use elements has improved the mentioned traits, under such conditions, the use of these elements is recommended for the cultivation of fodder corn in the region.

Key words: potassium; drought stress; fodder corn and low consumption elements

Introduction

Corn is a fodder plant with high dry matter yield, which can be used as silage for feeding livestock. The nutritional and fodder properties of this plant are at an optimal level, and the high protein content of corn in Increasing the importance of this forage plant is effective Imanzadeh et al., (2014). Drought is one of the most important abiotic stresses that reduces the production of agricultural products and the efficiency of using arid and semi-arid lands (Fattahi et al, 2020). The role of nutrients in plant nutrition is well demonstrated when other elements needed by the plant are provided to the plant in a balanced manner. On the other hand, insufficient nutrients increase plant resistance to some pests and diseases and environmental stresses (Kholdbrin and Eslamzadeh, 2006). Vazin., (2012) showed that the biological performance significantly decreased compared to the non-stressed condition by applying drought stress on corn. According to the report of Khalili Mahalle et al., (2004), the corn leaf surface decreases with the application of moisture stress during the reproductive stage. Hassanzadeh Moghadam and Afshar (2006) reported a significant effect of moisture stress on the reduction of cob length and cob diameter in research on hybrid corns 704 and 700. Atteya (2003) during an experiment by creating stress conditions in different stages of vegetative and reproductive growth of corn showed that stress had a significant effect on the relative water content of the cell and the stage of tassle emergence is more sensitive to water scarcity than other reproductive stages. Mohammad-Khani and Haidari (2008) showed that the amount of proline in the root and shoot of two corn cultivars 704 and 301 increased significantly after stress caused by polyethylene glycol. Ghahfarohki et al., (2004) found that the characteristics of seed yield, biological yield, ear diameter and ear length were affected by drought stress in vegetative growth and flowering stages. Khalili et al., (2004) during an experiment by investigating the effects of spraying low-use elements on the yield and yield components of corn 704, came to the conclusion that the combined use of manganese, zinc and iron fertilizers caused more grain production in the corn., plant height, diameter corn., the height of the corn. from the ground and the length of the corn. Rahimi and Mazaheri (2008) in Yasuj Azad University, during an experiment, investigated the morphological response and performance of corn to the chemical compounds of iron and copper and stated that the effect of spraying the above elements on plant height, leaf area index, cob length, cob diameter and seed protein was significant. Leblanc et al., (1997) stated that the application of zinc as foliar application or soil application had a significant effect on increasing corn yield. The purpose of this experiment was to investigate the effect of potassium consumption and low consumption elements of iron, zinc and manganese under drought stress conditions on the growth and yield indicators of fodder corn 704.

Materials and methods

This experiment was carried out in the crop year of 2022 as a second crop and with the aim of producing fodder in the village of Sari-Beglou, in the functions of Urmia city, at an altitude of 1323 meters above sea level, with a geographic longitude of 37 degrees, 41 minutes and 27 seconds north and a geographic latitude of 45 degrees, 8 It was performed at 1 minute and 33 seconds. Table 1 shows the geological characteristics of the project implementation area.

			ppm			texture				%					
Fe	Mn	Cu	Zn	K_{ava}	P_{ava}		Sand	Silt	Clay	T.N.V	S.P	O.C	T.N	pH	EC(ds/m)
4.5	3.7	2.9	1.7	434	28.4	Lome	17	26	57	16.1	54	1.19	0.12	8.04	0.68

Table 1: shows the physicochemical characteristics of soil

The experiment was carried out in the form of double-sliced plots in the form of a basic design of completely randomized blocks in three replications, and the factors of the experiment included the following in order:

A: drought stress in the form of interruption of irrigation as the main factor including : a_1: full irrigation, a_2: stop irrigation in two stages: before the appearance of the tassel in the vegetative stage and at the time of seed filling.

B: Use of potassium fertilizer as a sub-factor including: b_1: no use of potassium, b_2: use of 200 kg per hectare of potassium from the source of potassium sulfate.

C: A mixture of fertilizers with low consumption of iron, manganese and zinc as sub-sub-factor including: c_1: lack of use, c_2: soil use and c_3: solution spraying.

The seed used, Hybrid Single Cross 704, was obtained from Dasht Kabudan Company under the supervision of the Ministry of Jihad Agriculture and was cultivated by hand on July 12, 2022. The distance between plants was 25 cm and the distance between rows was 50 cm. Fertilizers used in this experiment were:

100 kilograms per hectare of nitrogen from the source of urea as a base fertilizer in two stages at the same time with vegetative growth (time of five to six leaves) and the time of tassel emergence. Potassium from the source of potassium sulfate in the amount of 200 kilograms per hectare in the form of soil application and at the time of planting, iron sulfate, manganese sulfate and zinc sulfate in the amount of 100, 100 and 60 kg/ha respectively in the form of soil application and with a concentration of five per thousand They were used as a solution spray. Soil application of low-use elements was done simultaneously with planting and spraying of these elements in two stages before the appearance of tassel and during seeding. According to the results of soil tests, there was no need to use phosphorus in this project. The traits measured in the experiment on five plants selected from each plot are as follows:

1- Stem height: It was reported in centimeters.

2- Fresh fodder yield: It was calculated by sampling and measuring the fresh weight of all plants in kilograms per hectare.

3- Dry weight of stems and leaves: The average dry weight of organs in the oven for 72 hours at 70 degrees Celsius for the organs was calculated separately in terms of kilograms per hectare.

4- Biological performance: It has been obtained by drying all the plants in an oven at a temperature of 70 degrees Celsius in 72 hours and in terms of kilograms per hectare.

5- The area of the flag leaf: The length of the broadest part of the leaf facing the spikes was measured and averaged, and the following formula was used to calculate the area of the leaf in square centimeters.

$$\text{leaf area} = 0.75 \times \text{length} \times \text{width}$$

6- Corn length: It was reported in centimeters.

7- Ear diameter: measured by calipers and their average was reported incentimeters.

8- Proline: It was measured using the method of Batts and colleagues (1973).

9- The relative water content of the cell (RWC): was calculated using the following equation.

$$RWC = (F.W-D.W) / (T.W-D.W) \times 100$$

In the mentioned relationship, TW, D.W, and F.W represent the fresh weight, dry weight, and whole leaf weight, respectively. The obtained data were analyzed using Mintab 14 software and the averages were compared using Duncan's multi-range test.

Results and Discussion

Plant height: The interaction effect of potassium × low-consumption elements and potassium × irrigation interruption on plant height was significant (Table 2). The height of the plant under the conditions of moisture stress has decreased by 11% compared to the conditions without stress (Table 3). The use of potassium in treatments under drought stress has caused a 10% increase in plant height. The effect of the combined use of low-use elements and potassium was effective in increasing the height of the plant, especially if the low-use elements were used in the form of soil (Table 4). Zinc deficiency causes shortening of the length between the nodes and as a result the height of the plant decreases (Foth et al., 1999). Sah and Zamoureh (2005) also stated in their research that the height of the plant decreases with the application of drought stress.

Yield of fresh fodder: Stopping irrigation had a significant effect on the yield of fresh fodder (Table 2). With the application of stress, the yield of fresh fodder decreased by 13% (Table 3). Campose et al., (2004) showed a decrease in the yield of fresh forage under drought stress conditions.

Stem dry weight: The interaction effects of irrigation interruption × potassium, irrigation interruption × low consumption elements and potassium × low consumption elements on stem dry weight were significant (Table 2). Under the conditions of drought stress, the dry weight of the stem decreased by about 2000 kg per hectare, and with the use of potassium, this decrease decreased by 50% (Table 3). By spraying the solution of low consumption elements, the effect of stress was partially compensated and the amount of dry weight of the stem increased. Soil consumption of low-consumption elements along with potassium was effective in increasing this index (Table 4). Chimenti et al., (1997) reported that applying stress 20 days before flowering in corn was effective in reducing dry matter and corn yield. Lack of water by shortening the effective growth of the stem, reducing the synthesis of photosynthetic substances and as a result reducing the transport of these substances causes less accumulation of these substances in the stem.

Leaf dry weight: The interaction effect of three experimental factors on leaf dry weight was significant (Table 2). Applying stress caused a decrease of about 430 kg/ha in the dry weight of leaves, but with the use of potassium, this decrease was reduced by 50% (Table 3). Spraying the solution of low-consumption elements along with the interruption of irrigation partially compensated the effects of leaf dry weight reduction and increased the leaf dry weight (Table 4). Spraying the solution of low-consumption elements was more effective in the conditions of interruption of irrigation and no consumption of potassium and increased the dry weight of leaves (Table 5). Gupta et al., (1996) reported that zinc element increases the amount of dry matter of corn. Biological performance: All bilateral interactions had a significant effect on biological performance (Table 2). The use of potassium along with the interruption of irrigation and the soil application of low consumption elements along with the interruption of irrigation resulted in the increase of this index. Along with potassium fertilization and soil application of low-use elements, biological performance increased (Table 4). Sepehri et al. (2002) also reported a significant decrease in biological yield with the application of moisture stress during the vegetative growth period of corn. Flag leaf area: Irrigation interruption and also the interaction effect of irrigation interruption × low consumption elements on corn leaf area was significant (Table 2). The applied stress caused a 10% decrease in the area of the flag leaf (Table 3). The interaction effect of drought stress × spraying of low consumption elements had the greatest effect on increasing the leaf area (Table 4). The processes of leaf development are affected by any lack of water, therefore, although the effect of water has little effect on the development and appearance of leaves, it significantly reduces the total surface of the leaf by reducing development and increasing leaf senescence (Kaker, 2004). Moisture stress affects many plant processes such as photosynthesis, cell development and division, and the accumulation and transport of nutrients in plants (Boyer and McPherson, 1998). Sah and Zamoureh (2005) reported that all the treatments under stress showed a decrease in the surface of the corn leaves.

Corn length: All two-way interactions had a significant effect on cob length (Table 2). Using potassium in the condition of 6% irrigation interruption compared to the condition of not using potassium caused an increase in ear length (Table 3). Spraying the solution of low consumption elements caused the maximum length of cobs in the condition of interruption of irrigation. Also, the soil application of low consumption elements combined with the use of potassium was effective in increasing the ear length (Table 4). Istanbuloglu et al., (2002) stated based on their research that moisture stress during vegetative and reproductive stages is effective in reducing the length of corn cobs. Khalili et al., (2004) also stated that the combined use of iron, manganese and zinc is effective in increasing the ear length.

Corn diameter: Potassium use, the interaction of potassium × irrigation interruption, the use of low consumption elements and the interaction effect of low consumption elements × irrigation interruption had a significant effect on ear diameter (Table 2). Application of potassium and soil application of low-use elements caused an increase in ear diameter (Table 3). The use of potassium in conditions under moisture stress caused an increase in the diameter of the cob, and the use of soil elements in the conditions of stress increased the diameter of the cob (Table 4). Sajdi and Ardakani (2008) reported the increase in ear diameter using iron, zinc and nitrogen elements.

Proline: The interaction effect of all three experimental factors on the amount of corn proline was significant (Table 2). The application of drought stress and the use of potassium show a significant increase, but the lack of use of low-use elements shows a significant increase in the amount of proline in the leaves (Table 3). An increase in the amount of proline with the use of potassium along with the interruption of irrigation was obtained in the results (Table 4). The increase of this index was observed with soil consumption of low-consumption elements at the same time as stopping irrigation and potassium consumption (Table 5). Mohammad Khani and Haidari (2008) reported an increase in the amount of proline after applying stress.

Relative water content (RWC): The mutual effect of all three experimental factors on the relative water content was significant (Table 2). Soil consumption of low-consumption elements caused a further decrease of this index (Table 3). The lack of consumption of low-consumption elements along with the consumption of potassium in the conditions of irrigation interruption caused an increase in the amount of relative water content (Table 5). Siddique et al. (2000) reported the reduction of the relative water content of cells by applying stress.

				Square	Mean							
S.OV	d.f	Plant height	Fresh forage	Stalk biomass	Leaf biomass	Biomass	Flag leaf area	Maize lenght	Maize Diameter	Prolin	RWC	
Replication	2	131.672^{ns}	282235291.4^{ns}	735558.8^{ns}	167046.1^{ns}	1794766.4	1810.8^{ns}	0.14^{ns}	0.03^{ns}	0.01^{ns}	5.9^{ns}	
Irrigation	1	5372.9**	1197321472.1*	29579095.1*	1669694.7*	8580993.7^{ns}	40434.5**	20.25**	0.26^{ns}	20.49**	97.3^{ns}	
Error 1	2	7.9	22350260.1	317735.5	40250.4	855670.8	230.7	0.09	0.07	0.01	24.7	
potassium	1	1456.7**	77833565.4^{ns}	2936653.5*	166600.1^{ns}	205119684**	943.6^{ns}	0.75**	0.90**	0.12**	68^{ns}	
Irrigation*potassium	1	463.7*	6320196^{ns}	1734489*	260270.1^{ns}	72431447.1**	1856.2^{ns}	7.84**	0.72**	0.018**	213.5*	
Error 2	4	4.9	14315968.1	15350.8	95112.7	953323.5	1372	0.02	0.01	0.01	15.1	
micronutrients	2	132.3*	3247202.1^{ns}	2934997.1**	11760.8^{ns}	39986626.8**	3005.9^{ns}	1.64*	0.27*	0.02**	81.5*	
Irrigation* micronutrients	2	4.3^{ns}	1308417.2^{ns}	1454602.1*	237300.2**	29785179.8**	14292.8**	1.44*	0.25*	0.03^{ns}	23.5^{ns}	
Potassium*micronutrients	2	169.9**	5282605.5^{ns}	2011439.4**	72728.9^{ns}	10866638.2**	296.6^{ns}	1.15*	0.51^{ns}	0.03^{ns}	295.3**	
Irrigation*potassium* micronutrients	2	62.6^{ns}	9867891.1^{ns}	793768.6^{ns}	72728.9**	2587313.1^{ns}	1417.4^{ns}	0.03^{ns}	0.04^{ns}	0.02**	216.1**	
Error 3	16	21.9	39733164.5	259214.1	27340.2	876566.4	1501.6	0.24	0.06	0.01	20.5	
%C.V	-	2.18	7.69	8.25	6.74	6.63	6.05	2.47	5.42	0.03	5.65	

*, ** and ns indicate significance at five and one percent probability levels and non-significance, respectively.

Table 2: Result of analysis variance on studid charactristics in corn Mean squre

factors	Plant height (cm)	Fresh firage (kg/ha)	Stalk biomass (kg/ha)	Leaf biomass (kg/ha	Biomass (kg/ha)	Flag leaf area (cm^2)	Maize lenght (cm)	Maize Diameter (cm)	Prolin (mg/F.W)	RWC (%)
drought stres										
T1	222.6	87874	7078	2669	13630	673.7	22.3	4.93	99.93	81.70
T2	202.2	76250	5265	2238	14606	606.7	20.8	4.76	100.46	78.41
potassium										
K1	208.1	80547	6457	2522	11731	635.1	21.4	4.69	100.14	78.68
K2	220.8	8349	5886	2386	16505	645.3	21.7	5.01	100.26	81.43
micronutrient										
M1	211.6b	82589	5665b	2480	12779c	639.3	21.1b	4.68b	100.24a	82.36a
M2	218.1a	81890	6197ab	2463	16197a	624.8	21.9a	4.97a	100.20b	77.23b
M3	213.6b	81572	6652a	2419	13377b	656.5	21.7a	4.90ab	100.16c	80.58ab

Table 3: Mean comparisons of main intractions on studid charactristics in corn

factors	Plant height (cm)	Fresh firage (kg/ha)	Stalk biomass (kg/ha)	Leaf biomass (kg/ha	Biomass (kg/ha)	Flag leaf area (cm^2)	Maize lenght (cm)	Maize Diamete (cm)	Prolin (mg/F.W)	RWC (%)
drought stress*potassium										
T1 * K1	223.9a	85895	7583a	2822	9825c	675.8	22.6a	4.92a	99.95c	82.76a
T1 * K2	229.4a	89673	6573b	2516	17435a	671.7	22b	4.95a	99.92c	80.64a
T2 * K1	192.3c	75198	5331c	2221	13637b	594.4	20.2d	4.46b	100.33b	74.60b
T2 * K2	212.2b	77301	5199c	2255	15575ab	619	21.4c	5.05a	100.59a	82.22a
drought stress*micronutrients										
T1 * M1	224.3	88289	6904b	2699ab	13356c	702.6a	21.7bc	4.93a	99.96	83084
T1 * M2	230.5	87365	6742b	2816a	16455a	666.5a	23a	4.95a	99.93	77.56
T1 * M3	225.2	87697	7586a	2492bc	11079e	652.1a	22.2b	4.93a	99.91	83.69
T2 * M1	198.9	76889	4424d	2260cd	12203d	576.1b	20.6d	4.43b	100.52	80.88
T2 * M2	205.7	76415	5652c	2108d	15940b	583.2b	20.7d	5a	100.46	76.89
T2 * M3	202.1	75446	5718c	2346cd	15675b	660.8a	21.1cd	4.86a	100.40	77.64
Potassium*micronutrients										
K1 * M1	208.6c	81668	6038bc	2506	9637e	663.8	20.6b	4.48	100.17	84a
K1 * M2	207.7c	79682	6036bc	2482	14879c	624.9	21.9a	4.78	100.13	70.13b
K1 * M3	208c	80289	7296a	2577	10677d	646.6	21.7a	4.81	100.11	81.91a
K2 * M1	214.6bc	83510	5290c	2453	15923b	644.9	21.6a	4.83	100.31	80.71a
K2* M2	228.5a	84098	6376b	2443	17516a	624.8	21.8a	5.16	100.26	84.33a
K2 * M3	219.3b	82854	6009bc	2261	16073b	666.3	21.7a	4.98	100.20	79.25a

Table 4: Mean comparisons of two factors intractions on studid charactristics in corn

factors	Plant height (cm)	Fresh firage (kg/ha)	Stalk biomass (kg/ha)	Leaf biomass (kg/ha	Biomass (kg/ha)	Flag leaf area (cm^2)	Maize lenght (cm)	Maize Diameter (cm)	Prolin (mg/F.W)	RWC (%)
drought stress *potassium*micronurients										
T1 * K1 * M1	222.7	86038	7220	2768ab	8431	696.5	21.7	4.93	99.92fg	92.09a
T1 * K1 *M2	226	85641	7031	3099a	14241	686.2	23.6	4.90	99.97ef	68058d
T1 * K1 * M3	223	86004	8497	2598bc	6803	644.7	22.6	4.93	99.95ef	87.61ab
T1 * K2 * M1	225.9	90540	6588	2629bc	18281	708.6	21.7	4.93	100.01e	75.59bcd
T1 * K2 * M2	235	89089	6454	2533bcd	1869	646.9	22.4	5	99.89fg	86.54ab
T1 * K2 * M3	227.4	89390	6675	2385bcd	15355	659.5	21.8	4.93	99.87g	79.78bcd
T2 * K1 * M1	194.5	77297	4856	2244cde	10843	571.1	19.6	4.03	100.43c	75.92bcd
T2 * K1 * M2	189.3	73723	5042	1865e	15517	563.6	20.3	4.66	100.28d	71.67cd
T2 * K1 * M3	193	74574	6094	2555bcd	14553	648.5	20.7	4.70	100.28d	76.21bcd
T2 * K2 * M1	203.3	76480	3992	2277cde	13564	581.1	21.6	4.83	100.61a	85.84ab
T2 * K2 * M2	222	79106	6262	2352bcd	16363	602.8	21.2	5.33	100.64a	82.11abc
T2 * K2 * M3	211.2	76318	5341	2137de	16797	673.2	21.5	5.03	100.53b	78.71bcd

T1: full irrigation conditions K1: conditions without potassium consumption M1: conditions without consumption Low consumption elements. T2: Irrigation interruption conditions K2: conditions of potassium consumption M2: soil consumption conditions Low consumption elements

Table 5: Mean comparisons of three factors intractions on studid charactristics in corn

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