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RESEARCH ARTICLE

Effect of cutting irrigation at different stages of growth and spraying with bitter melon extract on some vegetative qualities of two varieties of *Zea mays L.*

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Abstract

The experiment was conducted during the autumn season 2022 at the Soil Science and Water Resources Research Station of the Faculty of Agriculture at the University of Diyala, with the design of (R.C.B.D.) with the Split-Split plots Design system with three repeaters, The experiment included three stages of cutting irrigation: non-cutting irrigation, cutting irrigation in the tasseling stage, cutting irrigation in the milk stage, and three concentrations of bitter melon extract as an anti-transpiration (spraying with water, 50 ml L^{-1}, 100 ml L^{-1}), two cultivars of maize were used, AGN720 and JAMESON, In order to study the effect of different concentrations of bitter melon extract as an antitranspiration on some vegetative characteristics of the two varieties growing under water stress conditions, the most important results were summarized as follows: The AGN720 variety surpassed the JAMESON cultivar in most of the vegetative growth characteristics. Spraying with a concentration of 100 ml L^{-1} has given the highest mean number of days from sowing to the tasseling, plant height, and number of leaves, leaf area and index, dry weight of shoots, with an increase of 3.32%, 13.37%, and 10. 91%, 18.72%, 18.63%, 16.70% respectively, compared to the treatment of not spraying the plant extract (spraying with water).

Keywords: Irrigation cuttings, Bitter melon extract, Cultivar Agn720, Maize, Anti-transpiration, Number of days from planting to tasseling, Leaf area and index

Introduction

Maize (*Zea mays L.*) is the highest yielding crop in the world and is very sensitive to drought stress during critical stages, which significantly hamper cereal production (Halli et al., 2021). Maintaining an ideal balance between maize productivity and water use efficiency is critical to irrigated maize production in arid and semi-arid regions, including Iraq, which suffers from low rainfall, scarcity of water resources and high temperatures, by spraying antitranspiration and finding varieties that are more drought-tolerant. Spraying anti-transpirations on plant leaves reduces the transpiration rates, and saves irrigation water, and limits the spread of diseases and insect pests, increasing food production by achieving more potential yield during drought (Morsy and Mehanna, 2022). Spraying anti-transpirations on maize reduces water stress and drought, traps more water in leaves improving water use efficiency, improves photosynthesis, and chlorophyll pigments (Guleria and Shweta, 2020).

Nowadays, farmers and researchers pay great attention to plant extracts as a natural anti-transpiration for being environmentally friendly and effective in plant growth, to improve agricultural sustainability especially crop quality and quantity. *Citrullus colocynthis* produces many active plant secondary metabolic compounds, including alkaloids, flavonoids (Salama et al., 2017), saponins, tannins, glycosides and essential oils (Gordon and David, 2001), as secondary metabolites perform essential physiological and biochemical functions that ensure plant vitality and survival, especially with regard to their interactions with the environment and dealing with various biotic and abiotic stresses. Flavonoids are among the non-enzymatic antioxidants that enhance plant tolerance to water stress, and have another role is to improve the adaptation of plants to drought by regulating stomata movements, and also have a role in signal transmission, regulate gene expression, retain photosynthetic system functions, and ultimately improve plant performance under water stress conditions (Shomali et al., 2022).

Based on this point, the current research highlights the replacement of synthetic anti-transpirations used with natural anti-transpirations to improve crop production under water stress conditions. Therefore, the study aims to use the method of cutting irrigation at different stages of growth to reduce the amount of water required for the growth of the crop without causing significant effects on the yield, and to study the effect of spraying with natural extract (bitter melon extract) on some vegetative qualities of maize plants, and also aims to identify the best varieties of maize tolerant to cut irrigation at different stages of growth, and the effects of overlapping cut irrigation and spraying. With bitter melon extract and varieties in some vegetative qualities.

Materials and Methods

The field trials were conducted at the research station of the Department of Soil Science and Water Resources, Faculty of Agriculture, University of Diyala, which is 66 km from the city of Baghdad in the east, located at latitude 10.679'' 33° 41' North, and longitude 36.569'' 35' 43° East, It is 43 m above sea level. The physical and chemical properties of the field soil were estimated before planting, taking representative samples of soil at a depth of 0.00 m-0.30 m. Tab. 1 displays the most important physicochemical properties of soils.

Table 1. Some physico-chemical properties of the soil in the field before planting

Property	Value	Unit of measurement
Sand	24	g kg^{-1}
Silt	624	g kg^{-1}
clay	352	g kg^{-1}
Soil texture	Silty clay loam	
Bulk density	1.47	Megagram M^{-3}
Particle density	2.65	Megagram M^{-3}
Total porosity	0.445	%
Volumetric moisture content at 33 kPa	0.291	cm^{3}cm^{-3}
Volumetric moisture content at 1500 kPa	0.184	cm^{3}cm^{-3}
Available water	0.107	cm^{3}cm^{-3}
Soil salinity EC1:1	6.2	(Decisimens M^{-1})
Degree of reaction pH	7.59	-
Organic matter	1.22	%
Available phosphorus	7.34	mg kg^{-1}
Total nitrogen	1.79	%
Exchange capacity of positive ionsCEC	17.74	cmol (+) kg^{-1}

The experiment was carried out on a 252 m^2 plot of land., divided into three sectors, and the distance between each sector is one meter, and the number of experimental units within the sector was 18 units, for a total of 54 experimental units, the area of the experimental unit was 2×6 m, it contained 9 lines 6 m long, 70 cm between the lines and 20 cm between the holes, plant density was 71428 plants ha^{-1}, 1m breaks were left between the main treatments and the same between the repeaters to prevent irrigation water leakage. The experiment was carried out by designing the Randomized Complete Block Design (R.C.B.D.) with a Split-Split plots Design with three replications. The experiment included three stages of cutting irrigation: not cutting irrigation, cutting irrigation in the stage of tasseling, and cutting irrigation in the stage of milky, and three concentrations of bitter melon extract as an antitranspiration, which included spraying the extract with concentrations (50 ml. L^{-1}, 100 ml. L^{-1}), in addition to the comparison treatment (spraying with water), and two varieties of maize, AGN720 and JAMESON, were used. Varieties filled the main plots and antitranspiration concentrations filled the sub plots, the irrigation cutting stages also filled the sub-sub plots. Irrigation was carried out when 50% of the available water was drained, and the drip irrigation system was used and three irrigation treatments were used. Full irrigation throughout the experiment period after depleting 50% of the available water, and the amount of water added during one irrigation was 600 liters, and during the season 2550 m^3 hectares^{-1}, As for cutting irrigation in the tasseling stage: 4 consecutive irrigations were cut in the tasseling stage on 3/5, 6/5, 9/5 and 12/5, and the irrigation cut in the milky stage: 4 consecutive irrigations were cut in the milk phase stage on 8/ 6, 11/6, 14/6 and 17/6.

The amount of irrigation was estimated according to (Kovda et al. 1973)

$$W = a.As\left(\frac{\%Pw^{F\,c} - \%Pw^{w}}{100}\right)\times\frac{D}{100}$$

Whereas:

W = The volume of water per irrigation (m^3).

a = The area to be irrigated (m^2).

AS= bulk density (Megagram M^{-3}).

Pw^w Pw^{Fc} = % soil moisture before and after irrigation

D = irrigation depth at the required root (cm).

- Studied qualities: All qualities were taken in the tasseling stage and the milky phase and for all the studied treatment that began at the tasseling stage and ended at the harvest stage.

- Number of days from planting to 100% tasseling.
- Plant height (cm): Distance from the soil surface to the node below the tassel was measured for five plants randomly taken per experimental unit, and then their averages were taken (Al-Sahoki, 1990).
- Number of leaves per plant (leaf plant-1): It is the result of the average number of leaves of five plants from each experimental unit. (Al-Sahoki, 1990).
- Leaf area of the plant (cm^2): the total number of leaves a plant has by its average leaf area, and the area of one leaf was calculated according to the method given in the (Al-Sahoki and Jiyad 2013):
- Area of leaf = (Leaf length under the leaf of the ear) 2× 0.75.
- Leaf area index: the leaf area of maize divided by the area covered by the plant (Radford, 1967).
- The dry weight of the shoots (g plant-1): It is the average dry weight of five plants after cutting and air drying until their weight is stable.

Results and Discussion

The number of days from planting to 100% tasseling

The results in Tab. 2 show that the highest duration of reaching 100% tasseling was obtained from the AGN720 variety, with the highest average of 73.59 days, an increase of 1.42% compared to the JAMESON variety, which recorded the lowest average of 72.56 days. The different of performance between the two varieties is due to the genetically different varieties.

The analysis of variance shows the significant differences between the averages of this trait as a result of spraying maize with antitranspiration at concentrations 0 ml L^{-1}, 50 ml L^{-1} and 100 ml L^{-1}, and the results in Tab. 2 show that the highest duration of reaching 100% tasseling was obtained as a result of spraying plants with antitranspiration at a concentration of 100 ml L^{-1}, amounting to 74.33 days, with an increase of 3.32% and 1.91% compared to concentrations 0 ml L^{-1} and 50 ml L^{-1} respectively, and this may be attributed to the role of antitranspiration in reducing damage caused by water shortages and stimulation of physiological and metabolic processes, and encouraged maize to continue growth from early flowering and end their life cycle early (Morsy et al., 2022).

The analysis of variance. Tab. 2 show that there is a significant difference in the average number of days of planting to 100% tasseling as a result of cutting irrigation, as plants in the treatment of cutting irrigation in the stage of tasseling recorded the lowest period to reach this stage amounted to 71.28 days and differed significantly from the treatments of not cutting irrigation and cutting irrigation in the stage of milk, which recorded 74.17 days and 73.78 days respectively, and did not differ significantly between them, because the irrigation cut in the stage of the milky phase was after Stage 100% tasseling. The cutting of irrigation at the stage of tasseling, as well as high temperatures, increased wind speed and low relative humidity, led to a decrease in soil moisture and high plant temperature, and this is what pushed the plant towards early flowering and completing its life cycle to escape from water stress, and therefore the period between planting and 100% tasseling in this treatment decreased, and water stress may cause an increase in the effectiveness of aging hormones in maize while reducing the effectiveness of Growth hormones, leading to plant entry 100% early in tasseling (Abd et al., 2021), and this is consistent with (Abdelamir et al. (2018); Morsy et al. 2022) who reported a reduction in the duration of planting to 100% tasseling under water stress conditions.

Table 2. Effect of varieties, spraying with bitter melon extract and cutting irrigation at different stages of growth and overlapping between them in the average number of days of planting to 100% tasseling (day).

Varieties	Antitranspiration concentrations	Stages of cutting irrigation: Without cutting	the tasseling stage	Milk phase stage	Varieties × Antitranspiration concentrations
AGN720	Spraying with water	73.67	69.67	73.33	72.22
	50 ml L^{-1}	75	71.33	75	73.78
	100 ml L^{-1}	75.33	74	75	74.78
JAMESON	Spraying with water	73.33	69.33	72.33	71.67
	50 ml L^{-1}	73	70.33	73	72.11
	100 ml L^{-1}	74.67	73	74	73.89
L.S.D.0.05 for triple overlap			n.s.		n.s.
Variety × cutting irrigation	AGN720	74.67	71.67	74.44	73.59
	JAMESON	73.67	70.89	73.11	72.56
L.S.D0.05 for overlap between varieties and cutting irrigation			n.s.		0.139
Anti-transpiration× cutting irrigation	Spraying with water	73.5	69.5	72.83	71.94
	50 ml L^{-1}	74	70.83	74	72.94
	100 ml L^{-1}	75	73.5	74.5	74.33
L.S.D0.05 for overlap between antitranspiration concentrations and cutting irrigation		1.197			0.691

Average cutting irrigation	74.17	71.28	73.78
L.S.D0.05 for cutting irrigation		0.691	

Plant height

The analysis of variance Tab. 3 show the significant differences between the averages of this trait as a result of spraying maize with antitranspiration at concentrations 0 ml L^{-1}, 50 ml L^{-1} and 100 ml L^{-1}, and the results show that the highest plant height obtained was as a result of spraying maize with antitranspiration at a concentration of 100 ml L^{-1}, as this addition recorded the highest average of 182.872 cm with an increase of 13.37% and 4.45% compared to concentrations 0 ml L^{-1} and 50 ml L^{-1} respectively. This may be attributed to improving the water condition of the plant when spraying antitranspiration and reducing the water stress of cells during the division process, causing an increase in average stem height (Al-Obeidi, 2005), and bitter melon plant extracts contain antioxidants such as flavonoids (Ali et al., 2013), which prevent and stop the reactions of ROS, and improve the adaptation of plants to drought by regulating stomata movements (Shomali et al., 2022), The presence of phenols in bitter melon extracts has also improved the performance of maize (Cheema et al., 2009 and Jabran and Farooq, 2013) and This is consistent with those found by (Farooq et al. 2017) who acknowledged that the addition of plant extracts containing phenols leads to increased drought tolerance of the wheat plant.

Table 3. Effect of varieties, spraying with bitter melon extract, irrigation cuttings at different stages of growth and overlap between them in plant height (cm)

Varieties	Antitranspiration concentrations	Stages of cutting irrigation			Varieties×Antitranspiration concentrations
		Without cutting	The tasseling stage	Milk phase stage	
AGN720	Spraying with water	180.1	139.667	169.033	162.933
	50ml L^{-1}	190.933	154.033	188.567	177.844
	100 ml L^{-1}	195.8	160.833	189.033	181.889
JAMESON	Spraying with water	178.2	137.3	163.5	159.667
	50 ml L^{-1}	186.033	148.833	182.033	172.3
	100 ml L^{-1}	190.2	172.7	188.667	183.856
L.S.D.0.05 for triple overlap			n.s		n.s
Variety× cutting irrigation	AGN720	188.944	151.511	182.211	174.222
	JAMESON	184.811	152.944	178.067	171.941
L.S.D0.05 for overlap between varieties and cutting irrigation			n.s.		n.s.
Anti-transpiration× cutting irrigation	Spraying with water	179.15	138.483	166.267	161.3
	50 ml L^{-1}	188.483	151.433	185.3	175.072
	100 ml L^{-1}	193	166.767	188.85	182.872
L.S.D0.05 for overlap between antitranspiration concentrations and cutting irrigation			8.749		3.181
Average cutting irrigation		186.878	152.228	180.139	
L.S.D0.05 for cutting irrigation			5.051		

Table 4. Analysis of variance of the studied qualities

Dry weight	Leaf area index	Leaf area	Number of leaves	Plant height	tasseling	Df	Sources of difference
30481.703	0.18	227.056	0.401	19.34	0.13	2	repeaters
35862.047$^{n.s}$	6.291**	12403229.6**	7.943$^{n.s}$	70.270$^{n.s}$	14.519**	1	Varieties
30955.019	0.023	320.907	0.749	18.665	0.019	2	Error (a)
32912.029$^{n.s}$	2.125**	4205243.3**	8.920**	2147.625**	25.907**	2	Antitranspiration concentrations
30423.688$^{n.s}$	0.005$^{n.s}$	9536.4**	0.802$^{n.s}$	66.745$^{n.s}$	1.463$^{n.s}$	2	Varieties * Anti
30637.284	0.025	147.009	0.261	22.84	2.019	8	Error (B)
6133.470$^{n.s}$	8.462**	16516982.7**	32.495**	6075.196**	44.241**	2	Stages of cutting
19223.501$^{n.s}$	0.012$^{n.s}$	22867.796**	0.110$^{n.s}$	46.575$^{n.S}$	0.352$^{n.s}$	2	Varieties * Cutting stages
25850.128$^{n.s}$	0.064$^{n.s}$	125170.4**	1.866**	119.674**	3.435*	4	Anti * Cutting stages
36099.964$^{n.s}$	0.008$^{n.s}$	17584.2**	2.882**	40.476$^{n.s.}$	0.213$^{n.s}$	4	Varieties * Anti * Cutting
30679.824	0.03	125.333	0.317	26.953	1.009	24	Error (c)

n.s = non-significant ** = high at probability level 0.01 * = significant at probability level 0.05

Number of leaves per plant

Variance analysis (Tab. 4) shows significant differences between the averages of this trait as a result of spraying maize with antitranspiration at concentrations 0 ml L^{-1}, 50 ml L^{-1} and 100 ml L^{-1}, and the results of Tab. 4 show that the highest average of this trait was obtained as a result of spraying maize with antitranspiration at a concentration of 100 ml L^{-1}, and amounted to 14.032 leaf $plant^{-1}$ with an increase of 10.91% and 7.09% compared to concentrations 0 ml L^{-1} and 50 ml L^{-1} respectively, and the reason for this is due to the fact that bitter melon extracts contain flavonoids in their composition, which It has a role in regulating the movement of stomata and thus reducing the rate of transpiration (Shomali et al., 2022), thus reduce water loss from leaves and preventing leaf wilting and fall, as leaf fall is a defensive means that enables the plant to reduce transpiration (Saidah et al., 2018).

Analysis of variance Tab. 4 and Tab. 5 show that cutting irrigation led to significant differences in the characteristic of the number of leaves, and the non-cutting treatment was superior to the highest average of 14.408 leaves Plant^{-1}. While cutting in the tasseling stage gave the lowest average of 11.783 leaves Plant^{-1}. The reason for this is due to the decrease in the height of the plant in the two treatments (Tab. 3), which results in a reduction number of leaves in the plant. In addition to the negative effect of water stress on the elongation of the internodes and thus reduce the rate of leaf emergence (Hakim et al., 2018). The study of (Shahrabian, Soleymani 2011; Chukwudi et al. 2021) was consistent with the results of the current study, as they observed a decrease in the number of leaves in the corn plant growing under water stress conditions.

Analysis of variance (Tab. 4) showed significant differences between the average number of leaves in the plant as a result of triple overlap between varieties, antitranspiration concentrations and stages of irrigation cuts, The results in Tab. 4 cleared that the best averages of 15.883 leaves Plant^{-1} were obtained as a result of the combination of non-cutting irrigation + AGN720 + antitranspiration at a concentration of 100 ml L^{-1}, while the lowest mean number of leaves per plant was 10.150 leaves Plant^{-1}, which resulted from the overlap of cutting irrigation in the tasseling stage with the non-spraying of antitranspiration with the variety JAMESON. This is due to the positive effect of anti-transpiration, the effective and important role of water, and the response of cultivar AGN720 to the average trait compared to cultivar JAMESON due to their genetic variation.

Table 5. Effect of varieties, spraying with bitter melon extract and irrigation cuttings at different stages of growth and overlapping them in the number of leaves in maize (leaves Plant^{-1})

Varieties	Antitranspiration concentrations	Stages of cutting irrigation			Varieties × Antitranspiration concentrations
		Without cutting	The tasseling stage	Milk phase stage	
AGN720	Spraying with water	13.713	11.6	13.063	12.792
	50 ml L^{-1}	14.57	12.627	13.66	13.619
	100 ml L^{-1}	15.883	12.53	15.17	14.528
JAMESON	Spraying with water	13.67	10.15	12.217	12.512
	50 ml L^{-1}	12.667	11.383	13.713	12.588
	100 ml L^{-1}	14.447	12.413	13.753	13.538
L.S.D.0.05 for triple overlap			0.948		n.s.
Variety× cutting irrigation	AGN720	14.722	12.252	13.964	13.646
	JAMESON	14.094	11.316	13.228	12.879
L.S.D0.05 for overlap between varieties and cutting irrigation			n.s.		n.s.
Anti-transpiration × cutting irrigation	Spraying with water	14.442	10.875	12.64	12.652
	50 ml L^{-1}	13.618	12.005	13.687	13.103
	100 ml L^{-1}	15.165	12.472	14.462	14.033
L.S.D0.05 for overlap between antitranspiration concentrations and cutting irrigation			0.671		0.387
Average cutting irrigation		14.408	11.784	13.596	
L.S.D0.05 for cutting irrigation			0.387		

The leaf area

It is clear from variance analysis (Tab. 4) the significant differences between the averages of this trait for the two cultivated varieties, and the results in Tab. 6 clear that the best leaf area was obtained in the AGN720 variety, as the highest average was recorded and reached 6120.04 cm^2, with an increase of 18.57% compared to the JAMESON variety. This may be due to the fact that the AGN720 variety has better growth efficiency under the influence of moisture deficiency due to its ability to extract quantities of groundwater to meet its needs of evaporation-transpiration and its ability to maintain sufficient water content for growth.

The analysis of variance also shows significant differences between the mean leaf area as a result of spraying maize with antitranspiration, and that the highest average of this trait resulted from spraying at a concentration of 100 ml L^{-1}, amounting to 6090.17 cm^2, with an increase of 18.72% and 6.79% compared to concentrations 0 ml L^{-1} and 50 ml L^{-1} respectively (Tab. 6), due to the fact that spraying ant transpirations on plants significantly reduces the rate of water loss and increases their relative water content through Control the movement of stomata.

The same analysis of variance shows the significant differences between the mean leaf areas due to irrigation cuts. The results in Tab. 6 clear that the best leaf area was obtained as a result of not cutting irrigation, as this treatment recorded the highest average of 6288.28 cm^2 with an increase of 38.50% and 3.19% compared to the irrigation cutting treatments in the tasseling and milk stage respectively, and the reason for the decrease in the leaf area as a result of cutting irrigation may be due to the fact that water drought leads to loss of swelling pressure applied to the cell walls from the inside and outside, which affects The growth of leaf cells and their elongation stops, which negatively affects the increase in their leaf area (Boyer, 1970). Lack of irrigation also accelerates the aging of leaves and stiffness of their edges (Mohamed et al., 2015). These results agreed with (Abdelamir, 2018) who found a decrease in the leaf area of water-stressed maize.

The results of the analysis of variance and Tab. 6 cleared significant differences between averages this trait due to triple overlap between varieties, antitranspiration concentrations and stages of irrigation cutting, and combinations consisting of non-cutting + AGN720 + antitranspiration concentration 100 ml L^{-1} recorded the highest average of 7222.67 cm^2.

Table 6. **Effect of varieties, spraying with bitter melon extract and irrigation cuttings at different stages of growth and overlapping them in leaf area (cm²)**

Varieties	Antitranspiration concentrations	Stages of cutting irrigation: Without cutting	the tasseling stage	Milk phase stage	Varieties × Antitranspiration concentrations
AGN720	Spraying with water	6164	4625.67	6015.67	5601.78
	50ml L^{-1}	6867.67	5064	6691.33	6207.67
	100ml L^{-1}	7222.67	5295	7134.33	6550.67
JAMESON	Spraying with water	5204.67	3717	5049.67	4657.11
	50ml L^{-1}	5978	4157.67	5457.67	5197.78
	100ml L^{-1}	6292.67	4383	6213.33	5629.67
L.S.D.0.05 for triple overlap			18.866		10.892
Variety× cutting irrigation	AGN720	6751.44	4994.89	6613.78	6120.04
	JAMESON	5825.11	4085.89	5573.56	5161.52
L.S.D0.05 for overlap between varieties and cutting irrigation			11.414		18.168
Anti-transpiration× cutting irrigation	Spraying with water	5684.33	4171.33	5532.67	5129.44
	50 ml L^{-1}	6422.83	4610.83	6074.5	5702.72
	100 ml L^{-1}	6757.67	4839	6673.83	6090.17
L.S.D0.05 for overlap between antitranspiration concentrations and cutting irrigation			13.34		8.071
Average cutting irrigation		6288.28	4540.39	6093.67	
L.S.D0.05 for cutting irrigation			7.702		

Leaf area index

The analysis of variance shown in Tab. 4 shows the significant differences between the averages of this trait for the two cultivated varieties, and the results clear that the best leaf area index was obtained in the AGN720 variety, with the highest average of 4.371 with an increase of 18.52% compared to the JAMESON variety (Tab. 6), and this may be due to the fact that the AGN720 variety has better growth efficiency under the influence of lack of moisture.

From the analysis of variance Tab. 4 and Tab. 7, it is clear that the significant increase in averages of leaf area index as a result of spraying maize with antitranspiration, as the spraying treatments at concentrations of 50 ml L^{-1} and 100 ml L^{-1} recorded the highest averages for the leaf area index, which are 4.073 and 4.349 respectively, with an increase of 11.10 and 18.63% compared to non-spraying, as the treatment of non-spraying with antitranspiration gave the lowest average for the leaf area index of 3.666, as the increase in leaf area by the effect of antitranspirations was reflected in the increase in its index.

The analysis of variance in Tab. 4 and Tab. 7 shows significant differences between the average leaf area index in maize as a result of cutting irrigation, and that the best index obtained as a result of not cutting irrigation, as this treatment recorded the highest average of 4.494 with an increase of 38.62% and 3.26% compared to the irrigation cutting treatmens in the tasseling and milk phase, which recorded the lowest average for the leaf area index with 3.242 and 4.352 respectively. The high index of leaf area in the treatment of non-cutting irrigation is attributed to the increase in the leaf area in this treatment, which positively affected its index, which positively affected its index, while the decrease in the leaf area of maize in the irrigation cutting treatment in the tasseling and milk phase stages led to a decrease in its index (Tab. 6). This corresponds to (Lubajo et al. 2021; Laskari et al. 2022) as the leaf area index decreases with decreasing water availability. It also agrees with the results of (Igbadun et al. 2008) that cutting irrigation in tasseling stage or in the grain filling stage leads to a reduction in leaf area index of maize compared to plants that have not been cut irrigation for the duration of their growth.

Table 7. **Effect of varieties, spraying with bitter melon extract and irrigation cuttings at different stages of growth and overlapping them in the leaf area index**

Varieties	Antitranspiration concentrations	Stages of cutting irrigation: Without cutting	the tasseling stage	Milk phase stage	Varieties×Antitranspiration concentrations
AGN720	Spraying with water	4.402	3.304	4.297	4.001
	50ml L^{-1}	4.907	3.618	4.778	4.434
	100ml L^{-1}	5.158	3.777	5.098	4.678
JAMESON	Spraying with water	3.734	2.655	3.606	3.332
	50ml L^{-1}	4.27	2.969	3.898	3.712
	100ml L^{-1}	4.494	3.13	4.438	4.021
L.S.D.0.05 for triple overlap		n.s.			n.s.
Variety× cutting irrigation	AGN720	4.823	3.566	4.724	4.371
	JAMESON	4.166	2.918	3.981	3.688
L.S.D0.05 for overlap between varieties and cutting irrigation		n.s.			0.153
Anti-transpiration× cutting irrigation	Spraying with water	4.068	2.979	3.952	3.666
	50ml L^{-1}	4.589	3.294	4.338	4.073
	100ml L^{-1}	4.826	3.454	4.768	4.349

L.S.D0.05 for overlap between antitranspiration concentrations and cutting irrigation	n.s.			0.105
Average cutting irrigation	4.494	3.242	4.352	
L.S.D0.05 for cutting irrigation	0.119			

Dry weight of shoots

The analysis of variance shown in Tab. 4 and Tab. 8 show the superiority of the AGN720 variety by giving it the highest average dry weight of 186.307 g plant^{-1} with an increase of 2.10% compared to the JAMESON variety, due to the ability of the AGN720 variety and its efficiency in converting growth inputs into dry matter.

Analysis of variance (Tab. 4) shows significant differences between averages this trait as a result of spraying maize plants with antitranspiration at concentrations 0 ml L^{-1}, 50 ml L^{-1} and 100 ml L^{-1}, and the results show that the highest average of this trait was obtained when spraying maize with antitranspiration at a concentration of 100 ml L^{-1}, as this addition recorded the highest average of 199.235 g plant^{-1}with an increase of 16.70 and 8.74% compared to concentrations 0 and 50 ml L^{-1} respectively (Tab. 8), The reason for this is due to the improvement in the water condition of the plants after spraying the bitter melon extract, which makes the cells water-swollen and This enables the plant to absorb a greater amount of nutrients and increase their concentration in dry matter (Delamor et al., 2010 and Ouerghi et al., 2014). The increase in the averages of this trait is due to the importance of bitter melon extract in enhance the vegetative growth qualities and increasing the components of dry matter, which positively affected the increase in dry weight of the shoots, This may be attributed to the importance of antitranspiration in decrease transpiration, increasing the water content in plant tissues, thus maintaining the metabolic rate in the plant and physiological processes, increasing the production of carbohydrates which leads to improved plant growth (Ibrahim and Selim, 2010), as components of bitter melon extract (phenol, flavonoids, ɑtocopherol……) can cause a significant effect in increasing water drought tolerance and decrease its physiological effects (Xu and Leskovar, 2015).

The analysis of variance for this trait shows that irrigation cutting led to significant differences on the average dry weight of shoots of maize, Tab. 7 shows that the highest average was 203.801 g plant^{-1} in the non-cutting treatment, while cutting in the tasseling stage led to the lowest average of 148.774 g plant^{-1}, This is due to the decrease in plant height, number of leaves and leaf area (Tab. 3, 5 and 6) in the two stages of irrigation cuts., as well as a decrease in radiation interception by maize and a change in some physiological processes, including a reduce in the rate of photosynthesis, metabolism of carbohydrates and proteins (Portala et al., 2004 and Westgate, 1997), as well as accelerating the aging of leaves and reducing processed materials, which negatively affects plant growth and accumulation of dry matter, On the other hand, its effect on plant cell division, growth and stomata closure, which affects photosynthesis and its output, and thus affects the plant's ability to produce and accumulate dry matter (Al-Awda and Khiti 2008), The results shown in the same table are consistent with those found by (Imanzadeh et al. 2014 and Zhang et al. 2018), who found a reduction in dry weight for maize exposed to water stress.. It also agrees with the results of (Igbadun et al. 2008) who found that cutting irrigation in tasseling stage or in the grain filling stage causes a reduction in accumulation of dry matter of maize compared with plants that have not been cut irrigation throughout their growth period.

The analysis of variance (Tab. 4) indicates significant differences between the average dry weight in the plant as a result of the triple overlap between the varieties, antitranspiration concentrations and stages of irrigation cuts, as Tab. 8 cleared that the best average of 224.177 g plant^{-1} was obtained from the combination of non-cutting irrigation + AGN720 variety + antitranspiration 100 ml L^{-1}, while the lowest average dry weight in maize was 133.933 g. Plant^{-1}, which resulted from the overlap of the cutting irrigation in the tasseling stage with the non-spraying of antitranspiration with the variety AGN720. This is due to the positive action of antitranspiration, the active and important role of water and the response of AGN720 variety to the average trait compared to the variety JAMESON due to their genetic variation.

Table 8. Effect of varieties, spraying with bitter melon extract and cutting irrigation at different stages of growth and overlapping them in the dry weight of the shoots (g plant^{-1})

Varieties	Antitranspiration concentrations	Stages of cutting irrigation: Without cutting	the tasseling stage	Milk phase stage	Varieties×Antitranspiration concentrations
AGN720	Spraying with water	187.553	133.933	194.147	171.878
	50ml L^{-1}	208.83	143.987	201.853	184.89
	100ml L^{-1}	224.177	167.91	214.377	202.154
JAMESON	Spraying with water	181.347	138.437	188.89	169.558
	50ml L^{-1}	203.093	147.357	194.257	181.569
	100ml L^{-1}	217.803	161.02	210.123	196.316
L.S.D.0.05 for triple overlap			1.457		0.416
Variety× cutting irrigation	AGN720	206.853	148.61	203.459	186.307
	JAMESON	200.748	148.938	197.757	182.481
L.S.D0.05 for overlap between varieties and cutting irrigation			0.841		1.498
Anti-transpiration× cutting irrigation	Spraying with water	184.45	136.185	191.518	170.718
	50ml L^{-1}	205.962	145.672	198.055	183.229
	100ml L^{-1}	220.99	164.465	212.25	199.235
L.S.D0.05 for overlap between antitranspiration concentrations and cutting irrigation			1.03		0.294

Average cutting irrigation	203.801	148.774	200.608
L.S.D0.05 for cutting irrigation		0.595	

Conclusions

We note from the previous results that the AGN20 variety surpassed the JAMESON cultivar in most of the vegetative growth characteristics, and the AGN720 cultivar recorded the best values for water use efficiency with an increase of 9004% compared to the JAMESON cultivar. Also, spraying the extract of bitter melon fruits as an anti-transpiration at two concentrations of 50 and 100 ml - reduced the effects resulting from water stress by increasing most of the vegetative growth characteristics. Therefore, it is recommended to grow the AGN 720 variety to achieve high averages in some vegetative traits, and spray the yellow corn plants with an extract of bitter melon fruits to reduce water loss through transpiration and improve their ability to withstand water stress, and the possibility of cutting irrigation during the milky phase of the yellow corn plants. This is to increase the efficiency of irrigation water use.

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