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THE PERFORMANCE OF SEVERAL LOCAL FEMALE CUCUMBER HYBRIDS UNDER DIFFERENT LEVELS OF WATER STRESS

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Abstract

This experiment was conducted in an unheated plastic house in Al-Bu Shaaban on the outskirts of Ramadi during the 2024 season. It evaluated five locally produced hybrids, namely 2014, 2025, 2036, 2116, and 2000 designated B_1, B_2, B_3, B_4, and B_5, respectively and compared them to the Kenz hybrid (B_0) which is approved by the Horticulture Department of the Iraqi Ministry of Agriculture. The experiments were based on irrigation intervals of 3, 4, and 5 days (G_1, G_2, and G_3, respectively) using the randomized complete block design (RCBD). The 8 traits measured were plant height, number of nodes per plant, leaf area per plant, plant yield, fruits per plant, early plant yield, dry weight of shoots, and leaf proline content. The B_2 hybrid excelled at 43.911 nodes per plant^{-1}, while the B_3 excelled in leaf area and number of fruits, reaching 143.46 dm^2 and 53.45 fruits per plant^{-1}, respectively. The B_4 and B_5 hybrids excelled in plant yield at 4.66 and 4.65 kg plant^{-1}, respectively, while the B_0 excelled by giving the highest early yield of 1.91 kg plant^{-1}. The dry weight of the shoot and plant height did not show any significant difference between the hybrid and the hybrid superiority (B_5). The B_5 recorded a leaf proline concentration of 235.00 mg L^{-1}, while the comparison hybrid (B_0) had the lowest at 206.55 mg L^{-1}. As for irrigation level, it significantly exceeded the first level (G_1) in the number of cuttings, leaf area, plant yield, number of fruits, dry weight of the

shoot, and plant height, amounting to 45.47 plant nodes, 152.95 dm^2, 4.99 kg of $plant^{-1}$, 59.01 fruits per $plant^{-1}$, 82.39 g of $plant^{-1}$, 286.77 cm, respectively with the G_3 significantly superior in early yield at 1.93 kg per $plant^{-1}$.

Keywords: Female cucumber hybrids, Protected cultivation, Water stress, Irrigation intervals.

الأداء الحقلي لعدة هجن من الخيار الانثوي المحلي تحت مستويات مختلفة من الشد المائي

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الخلاصة

نفذت التجربة في احد البيوت البلاستيكية غير المدفئة في منطقة البو شعبان وموقعها الجغرافي هو 33.2828 شمالاً و43.1737 شرقاً ضمن أطراف مدينة الرمادي سنة 2024 لتقييم خمسة هجن محلية الإنتاج (2014,2025,2036,2116,2000) رمز لها (B_1,B_2,B_3,B_4,B_5) قورنت بالهجين كنز الذي رمز له (B_0) وهو هجين معتمد من قبل دائرة البستنة التابعة لوزارة الزراعة العراقية وفق ثلاث فواصل ارواء (3,4,5) يوم رمز لها (G_1,G_2,G_3) واستخدم ترتيب القطع المنشقة ضمن تصميم القطاعات العشوائية الكاملة (R.C.B.D) اذ اعتبرت فواصل ارواء الواح رئيسية والهجن ثانوية وتم قياس ثمان صفات هي عدد العقد عقدة نبات$^{-1}$، المساحة الورقية دسم^2، حاصل النبات كغم نبات$^{-1}$، عدد الثمار ثمرة نبات$^{-1}$، حاصل النبات المبكر كغم نبات$^{-1}$، الوزن الجاف للمجموع الخضري غرام نبات$^{-1}$، ارتفاع النبات سم، تقدير محتوى الأوراق من البرولين ملغم لتر$^{-1}$ ويمكن تلخيص النتائج بالأتي. تفوق الهجين الثاني(B_2) في صفات عدد العقد حيث سجل اعلى قيمة بلغت 43.911 عقدة نبات$^{-1}$، وتفوق الهجين الثالث (B_3) في المساحة الورقية وعدد العقد بلغ 143.467عقدة نبات$^{-1}$ و53.459 ثمرة نبات$^{-1}$ بالتتابع، فيما تفوق الهجين (B_4 وB_5) في صفة حاصل النبات بلغ 4.663، 4.450 كغم نبات$^{-1}$ بالتتابع وتفوق الهجين B_0 باعطائه أعلى حاصل مبكر بلغ 1.915 كغم نبات$^{-1}$ بينما لم تعطي صفة الوزن الجاف للمجموع الخضري وارتفاع النبات أي فرق معنوي وبين الهجن وتفوق الهجين (B_5) بتقدير نسبة البرولين في الأوراق حيث سجل اعلى نسبة بلغ 235.000 ملغم لتر$^{-1}$ في حين سجل هجين المقارنة (B_0) اقل نسبة من البرولين في الأوراق بلغت 206.556 ملغم لتر$^{-1}$ اما عن مستويات الري فقد تفوق المستوى الأول (G_1) معنويا في عدد العقل و والمساحة الورقية وحاصل النبات وعدد الثمار والوزن الجاف للمجموع الخضري وارتفاع النبات،

بلغ 45.472 عقدة نبات$^{-1}$، 152.956 دسم^{2}، 4.993 كغم نبات$^{-1}$، 59.013 ثمرة نبات$^{-1}$ 82.397 غم نبات$^{-1}$، 286.773 سم بالتتابع وتفوقت الفاصلة G3 معنويا في صفة الحاصل المبكر حيث بلغت 1.938 كغم نبات$^{-1}$.

كلمات مفتاحية: هجن خيار انثوية، زراعة محمية، اجهاد مائي، فواصل ارواء.

Introduction

The cucumber C*ucumis Sativus* L. is considered an important crop within the widespread cucurbita family. Its original home is believed to be north India, it is a summer crop with a high economic return. The demand for its cultivation increased after the spread of protected cultivation to provide the crop outside its natural growing season. What encourages its cultivation even more is the short growing season and the possibility of growing it in two autumn and spring seasons (8). According to official reports, Iraq produced 196,000 tons of cucumbers in 2022, a 5.6% increase over the previous year (24). A study showed significant differences in traits between the local and exported hybrids (23).

Abiotic environmental stress is considered a determining factor for the growth of crops in all soils around the world. This does not mean underestimating the importance of biotic stress. However, the greatest impact, in general, is due to abiotic stress, the most critical being high levels of salts, in addition to the lack of moisture, or water stress, as it is considered one of the most important environmental influences that negatively affect the growth and production of plants (21). Iraq is currently facing many challenges and issues, the most important being the increase in the population and the decline in water resources, which constitute an important obstacle to increasing agricultural production. Organizing and managing water resources and increasing water use efficiency are among the most important goals for increasing vegetable yields. Growing vegetable crops requires more water and increased irrigation frequency than most other crops; so water management in its simplest form can reduce the water requirements of any crop (5). Such hybrids can be used in several breeding programs to select new strains resistant to unfavorable conditions (3).

Irrigation is one of the most important factors influencing the quantitative and qualitative characteristics of crop yield through its effect on the various stages of growth and formation of plant organs. Water plays an important role in promoting nutrients, cell growth, division and elongation, and in the regularity of the process of photosynthesis, in addition to being a solvent and a medium. Transporting these materials to different parts of the plant (11).

This study aims to identify the most water stress-tolerant local cucumber hybrids suitable for cultivation under drip irrigation in unheated greenhouses in the Anbar governorate.

Materials and Methods

This research began in autumn on 15/9/2024. Five locally grown gynoecious hybrids intended for greenhouse cultivation were produced in the Iraqi Ministry of Agriculture in Baghdad. Their codes were 2014, 2025, 2036, 2116, and 2000 represented by B_1,

B_2, B_3, B_4, and B_5, respectively. They were compared to the Kanz hybrid (B_0) approved by the Iraqi Ministry of Agriculture. Three irrigation intervals of 3, 4, and 5 days (G_1, G_2, and G_3) were applied, according to (18). The greenhouse was divided into six terraces, the seeds of each hybrid were planted on a terrace, and a drip irrigation system was used. After the season, the average of the following characteristics was calculated for 10 plants within each experimental unit and measurements taken.

1. Plant height (cm): measured at the end of the season from the plant contact area in the soil to the highest peak of the plant.
2. Number of nodes per plant (plant node^{-1}): based on the length of the main plant stem at the end of the plant's growth
3. Leaf area (dm^2): the sheet area was calculated using the digimizer program on Windows 10 (1).
4. Dry weight of shoots (gm plant^{-1}): measured according to the method used by (9).
5. Number of fruits (fruit per plant^{-1}): the number of fruits in the experimental unit divided by the number of plants.
6. Yield per plant (kg plant^{-1}): obtained by dividing the quotient of each experimental unit by the number of its plants.
7. Early plant yield (kg plant^{-1}): calculated by measuring the first five pounds.
8. Proline content of leaves (mg L^{-1}): determined according to the method of (12).

The experiment data were analyzed statistically using the Genstat program. For the arithmetic mean of each trait, the comparison was made using LSD test at the 0.05 significance level (6).

Results and Discussion

Plant height (cm): Table 1 shows the significant differences between the hybrids in plant height. At the same time, the irrigation intervals recorded a significant difference for the G1 interval over the rest of the intervals at 286.77 cm, while the G3 interval recorded the lowest plant height at 265.05 cm. The interaction between hybrids and irrigation intervals recorded a significant difference in plant height for the B_2G_1 treatment at 301.97 cm, while B_5G_3 recorded the lowest at 248.00 cm.

Table 1: The effect of irrigation intervals on the heights of the cucumber hybrids.

Hybrid	Irrigation intervals (days)			B Average
	G1 (3)	G2 (4)	G3 (5)	
B0	296.90	271.57	265.56	278.01
B1	287.78	281.70	266.60	278.69
B2	301.97	257.38	274.86	278.07
B3	286.77	281.70	268.66	279.04
B4	276.64	265.49	266.60	269.57
B5	270.56	251.30	248.00	256.62
G Average	286.77	268.19	265.05	
LSD G	**9.80**			0.05
LSD B	**1.15**			
LSD G*H 1.99				

Number of nodes per plant (plant node^{-1}): The results in Table 2 show the significant differences between the hybrids in the number of nodes on the plant. The B_2 excelled at 43.91 plant nodes^{-1}, while the B_5 record the lowest at 38.23 nodes^{-1}. The irrigation level G_1 had an average of 45.47 plant nodes^{-1}, while G_3 recorded the lowest at 38.23 plant nodes^{-1}. The hybrid and irrigation level interactions showed significant differences in the number of nodes, with B_2G_1 recording the highest at 50.00 plant nodes^{-1} compared to 32.96 for the B_5G_3 which had the least numbers.

Table 2: The effect of irrigation intervals on the number of nodes on the cucumber hybrids.

Hybrid	Irrigation intervals (days)			B Average
	G1 (3)	G2 (4)	G3 (5)	
B0	46.56	43.76	35.56	41.96
B1	48.36	38.39	38.76	41.83
B2	50.00	39.36	42.36	43.91
B3	41.96	42.36	43.76	42.70
B4	42.16	44.36	35.96	40.83
B5	43.76	37.96	32.96	38.23
G Average	45.47	41.03	38.23	
LSD G		**1.15**		0.05
LSD B		**0.47**		
LSD G*H		**0.82**		

Leaf area (dm^2): The results in Table 3 indicate significant differences in leaf area, with the B_3 hybrid recording the largest area at 143.46 dm^2 and the B_5 the lowest at 119.60 dm^2. As for irrigation levels, G_1 had the highest average leaf area at 152.95 dm^2, while G_3 registered the lowest. For the intervention effect on plant leaf area, the table shows the B_2G_1 treatment being significantly superior to the others at 172.56 dm^2 while B_5G_3 recorded the lowest (105.76 dm^2).

Table 3: The effect of irrigation intervals on the hybrid cucumber leaf areas.

Hybrid	Irrigation intervals (days)			B Average
	G1 (3)	G2 (4)	G3 (5)	
B0	155.200	142.36	117.66	138.41
B1	152.43	143.90	129.50	141.94
B2	172.56	115.20	139.20	142.32
B3	151.93	145.86	132.60	143.46
B4	143.60	136.50	130.36	136.82
B5	142.00	111.03	105.76	119.60
G Average	152.95	132.47	125.85	
LSD G		**5.86**		0.05
LSD B		**8.58**		
LSD G*H		**14.86**		

Dry weight of shoots (gm plant^{-1}): Table 4 shows the significant differences in dry weight of the shoots between the hybrids. Also, irrigation intervals produced significant differences with the G_1 interval recording the highest value of 82.39 grams of plant^{-1} for dry weight, while the lowest was for G_3 at 78.70. The interactions between hybrids and irrigation intervals showed significant difference with the B_0G_1 treatment

recording 84.07 gm plant^{-1} and the B_5G_2 registering the lowest value of 75.03 gm plant^{-1}.

Table 4: The effect of irrigation intervals on shoot dry weight of the cucumber hybrids.

Hybrid	Irrigation intervals (days)			B Average
	G1 (3)	G2 (4)	G3 (5)	
B0	84.07	81.35	76.72	80.71
B1	82.84	81.84	77.42	80.70
B2	82.38	75.45	80.74	79.52
B3	82.69	82.08	79.72	81.50
B4	81.38	79.97	78.13	79.83
B5	81.00	75.03	79.46	78.50
G Average	82.39	79.29	78.70	
LSD G		**1.70**		0.05
LSD B		**1.89**		
LSD G*H		**3.28**		

Fruits per plant (fruits per plant^{-1}): Table 5 shows significant differences between the hybrids with the B3 being significantly superior to the others at an average of 53.45 fruits per plant^{-1} while B1 recorded the lowest at 49.38 fruit of plant^{-1}. The G1 irrigation level recorded the highest average number of fruits per plant, amounting to 59.01 fruit per plant^{-1}, while G3 recorded the lowest at 42.39. In contrast, the B_2G_1 interaction between hybrids and irrigation levels recorded the highest number of fruits (63.84 fruit of plant^{-1}) while B_5G_3, recorded the lowest average at 40.33 fruit per plant^{-1}.

Table 5: The effect of irrigation intervals on fruits per plant of the cucumber Hybrids.

Hybrid	Irrigation intervals (days)			B Average
	G1 (3)	G2 (4)	G3 (5)	
B0	56.31	53.81	40.57	50.23
B1	60.04	46.64	41.46	49.38
B2	63.84	46.39	45.02	51.75
B3	58.06	57.64	44.66	53.45
B4	57.79	51.59	42.33	50.57
B5	58.01	50.09	40.33	49.48
G Average	59.01	51.03	42.39	
LSD G		**8.38**		0.05
LSD B		**2.69**		
LSD G*H		**4.67**		

Plant yield (kg plant^{-1}): Significant differences were found in plant yields among the hybrids (Table 6) with the B_4 and B_5 being significantly superior to the others, though not between them at an average of 4.66 and 4.65 kg plant^{-1}, while the lowest was for B_3. Meanwhile, the G1 irrigation level recorded the highest quantity at 4.99 kg plant^{-1}, and the lowest was for G_3. The interaction between irrigation levels and local hybrids on yield showed the B_4G_1 treatment being superior at 5.55 kg plant^{-1}, while B_0G_3 treatment recorded the lowest average yield of 3.63 kg.

Table 6: The effect of irrigation intervals on the plant yield of the cucumber hybrids.

Hybrid	Irrigation intervals (days)			B Average
	G1 (3)	G2 (4)	G3 (5)	
B0	4.79	4.34	3.63	4.25
B1	4.74	4.57	4.00	4.43
B2	4.88	4.32	3.66	4.28
B3	4.83	4.01	3.91	4.25
B4	5.55	4.70	3.74	4.66
B5	5.17	4.66	4.12	4.65
G Average	4.99	4.43	3.84	
LSD G		**0.33**		0.05
LSD B		**0.25**		
LSD G*H		**N*S**		

Low humidity (high moisture tension) leads to negative effects of water stress on the vital processes of plants such as photosynthesis, transport of manufactured nutrients, and enzyme effectiveness in addition to hormonal activity and overall metabolic processes. This decreases the number of fruits and yields, as noted by (10, 15 and 19) for cucumbers, and (17 and 20).

Early plant yield (kg plant^{-1}): Table 7 shows the significant differences in the early plant yield for the hybrids, with the B_0 achieving the highest average (1.91 kg plant^{-1}) and B_5 the lowest (1.55 kg plant^{-1}). For irrigation intervals, the G_3 interval was highest in plant yield at 1.93 kg plant^{-1}, while G_2 recorded the lowest (1.68 kg plant^{-1}). As for the hybrid and irrigation interval interactions, the B_4G_3 had the highest plant yield at 2.18 kg plant^{-1}, while the B_5G_2 recorded a lower amount at 1.42 kg per plant^{-1}.

Table 7: The effect of irrigation intervals on early plant yield of the cucumber hybrids.

Hybrid	Irrigation intervals (days)			B Average
	G1 (3)	G2 (4)	G3 (5)	
B0	1.70	1.87	2.15	1.91
B1	2.02	1.72	1.97	1.90
B2	2.03	1.46	1.68	1.72
B3	1.53	1.72	1.98	1.74
B4	1.53	1.89	2.18	1.87
B5	1.59	1.42	1.63	1.55
G Average	1.73	1.68	1.93	
LSD G		**0.032**		0.05
LSD B		**0.23**		
LSD G*H		**0.40**		

The bred hybrids were characterized by a higher number of nodes and, thus, in the number of flowers, fruits and, consequently yield. This could be due to some hybrids carrying genes that can express and produce abundantly even under low irrigation conditions. Such hybrids had superior yields and other characteristics despite their exposure to water stress conditions and the ability to adapt to various ambient conditions. This may indicate the presence of genes resistant to water stress, and may

be more effective than the approved hybrid. The results are similar to the findings of (7, 13 and 22) for cucumbers.

Proline content of leaves (mg L^{-1}): Table 8 illustrates the significant differences in average proline concentrations in the plant leaves of the hybrids with B_5 being significantly superior at 235.00 mg L^{-1}, compared to the lowest concentration in B_0 of 206.55 mg L^{-1}. The G_3 irrigation level showed significant superiority in proline production, reaching 241.22 mg L^{-1}, compared to the lowest for G_1, at 189.33 mg L^{-1}. The statistical analysis indicated no significant differences in the hybrid and irrigation level interactions for proline content in the plants.

Table 8: The effect of irrigation intervals on leaf proline content among the hybrid cucumbers.

Hybrid	Irrigation intervals (days)			B Average
	G1 (3)	G2 (4)	G3 (5)	
B0	184.66	216.66	218.33	206.55
B1	189.66	222.66	241.33	217.88
B2	178.66	233.66	247.66	220.00
B3	176.66	199.00	260.00	211.88
B4	210.33	211.00	221.66	214.33
B5	196.00	250.66	258.33	235.00
G Average	189.33	222.27	241.22	
LSD G		**3.93**		0.05
LSD B		**12.40**		
LSD G*H		**21.48**		

It can be concluded from the proline acid results that in water stress, especially severe ones, protein synthesis slows down, and its metabolic rates increase, that is, in the breaking down and release of amino acids. This process ultimately raises the plant's free amino acid content, especially proline, although the amount varies among plants. The slowdown in protein synthesis during stress may be due to a change in the cell's control system in activating its genes, whereby the stress tolerance genes are activated at the expense of the other genes. Most of the cell's energy, carbon, and nitrogen are allocated to synthesizing compounds in large quantities, such as sugars and nitrogenous compounds. In addition to the negative impact of stress on the efficiency of the protein synthesis system, proteins are exposed to damage due to excess salts or lack of water, leading to their rapid metabolism and conversion into amino acids by specialized mechanisms (2). The increase in the proline content of the leaves may be due to synthetic gene activity and a decline in activities by the proline dehydrogenase enzyme which oxidizes prolines in cucumbers, as noted by (14), in tomatoes (4), and in roses (16).

Conclusions

Locally produced hybrids excelled in their resistance to water stress conditions compared to their imported counterparts, and the third hybrid excelled over the others in tolerance to water stress. The short-interval treatment maintained high moisture levels in the absorption areas of the roots, while it decreased in the second interval, and with yield decreasing in the third interval. Adopting a schedule with short irrigation

intervals provides adequate moisture to the root zone and salt dilution thereby reducing stress on the plant and positively affecting yields.

Supplementary Materials:

No Supplementary Materials.

Author Contributions:

Hamad, A.H: methodology, writing—original draft preparation; Saeed. S.S. and Salih, S.M: writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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The authors declare no conflict of interest.

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