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Adaptation of some Gladiolus Cultivars to Al-Qassim Environmental Conditions

أقلمة بعض أصناف الجلاديولس للزراعة تحت الظروف البيئية لمنطقة القصيم، المملكة العربية السعودية

عبدالرحمن ابراهيم الحميد

A.I. Al-Humaid

College of Agricultural and Veterinary Medicine,
Al-Qassim University, Saudi Arabia.

قسم إنتاج النبات ووقايته - كلية الزراعة والطب البيطري

جامعة الملك سعود فرع القصيم - المملكة العربية السعودية

Abstract: Two field experiments were conducted during two successive seasons to study the effect of the environmental conditions prevailing in Al-Qassim region on the behavior of reproduction and flowering characteristics of Eurovision, Rose Supreme, Prosperity and Nova Lux Gladiolus cultivars. The cultivars were planted on three different dates (October, November, and December), in order to examine their possibile adaptation. The results showed that the second planting date (Nov.) substantially improved the length, thickness and dry weight of the flowering-stem for all cultivars. The highest production of corms and cormels was also recorded for the second planting date. Nevertheless, the earliest flowering time was recorded for the first planting date (Oct.) for all cultivars. Prosperity was characterized by its better growth and flowering characteristics followed by Rose Supreme, and then Nova Lux. Chemical analysis showed that Nova Lux contained relatively higher N, P and K percentages, whereas the total carbohydrate of Prosperity was higher than that of the other cultivars. The study indicates that not only the genetic structure but also the environmental conditions are important factors determining the success of Gladioli cultivars to grow and flower under the existing field conditions in Al-Qassim.

Keywords: Saudi Arabia, Qassim, Gladiolus cultivars, Adaptation, Genetic structure, Environmental condition.

المستخلص : إجريت التجربة الحقلية على مدى موسمين متتاليين (1999/2000, 2000/2001) بهدف دراسة إمكانية أقلمة بعض أصناف الجلاديولس المستوردة للزراعة تحت ظروف الحقل المفتوح في منطقة القصيم بالسعودية، وبإستخدام أربعة أصناف منها، هي يوروفيشن، روزسبريم، بروسبرتي، ونوفالوكس. تمت زراعتها في ثلاث دورات تبدأ الخامس من أكتوبر، نوفمبر وديسمبر على التوالي مدى الموسمين. تتلخص أهم نتائج التجربة الحقلية في نجاح أقلمة صنف (بروسبرني)، (روزسبريم) و(نوفالوكس) حيث أن نمو النصف الأول (بوروفيتن) كان ضعيفاً في الدورتين الأولى والثانية، ولم يتأقلم أو ينمو في الدورة الأخيرة (5/ ديسمبر). إضافة إلى الزراعة في الدورة الأولى (5/ أكتوبر) أدى إلى تقليص الفترة من الزراعة إلى الإزهار، في جميع الأصناف، وقد تميز الصنف (روزسبريم) بالإزهار المبكر، يليه (بروسيرتي) ثم (نوفالوكس). من نتائج التجربة أيضاً أفضلية الزراعة في الدورة الثانية (5/ ،وفمبر) للحصول على المشاريخ الزهرية الأطول قياساً، الأكثر سمكاً وأثقل وزناً من كل الأصناف مع أفضلية الصنف (بروسبرتي)، (روزسبريم) ثم (نوفاكوس) على التوالي. كما تميز الصنف (روزسبريم) بإنتاج أكبر، وأثقل الكورمات الجديدة، يليه (بروسبرتي) و(نوفاكوس)، وتميز (رورسبريم) أيضاً بإنتاج أكبر من الكوريمات للنبات، يليه (نوفالوكس) ثم (بروسبرتي). برهنت نتائج الدراسة كذلك علي إرتفاع محتوي الأجزاء الهوائية من النيتروجين والفوسفور والبوتاسيوم في الصنف (نوفالوكس)،مقارنة بالصنفين الآخرين. حين تميز الصنف (بروسبرتي) بإرتفاع محتوى الإجزاء الهوائية من الكربوهيدرات الكلية، مقارنة مع الصنفين الآخرين. بهذه النتائج تبرهن الدراسة على نجاح وإمكانية أقلمة بعض أصناف الجلاديوبس وجدواها في إنتاج أزهار جيده، إعتماداً على التركيب الوراثي للصنف المعنى والبيئية السائدة خلال فترة النمو.

كلمات مدخلية: السعودية، القصيم، زراعة الجلاديولس، تأقلم، تركيب وراثي، ظروف بيئية.

Introduction

Under both natural and agricultural conditions, plants are frequently exposed to stress and unfavorable conditions. Environmental factors that limit the growth, reproduction and/or behavior of a plant or any other organism are called limiting factors, e.g. temperature, nutrients and water availability. Thus, plants are indicators of their environment. If a plant is introduced to a new habitat, its fitness depends on its ability to acclimate to the newly introduced situation. In this regard, gene expression was found to play an important role in the acclimation to certain environmental conditions (Guy 1990). Moreover, it has been found that natural conditions prevailing in the open field may influence the appearance of genetic characteristics that may not have the chance to appear under controlled conditions (Salisbury and Ross 1992).

Planting dates may determine the proper conditions of the environmental elements for growth and flowering of a certain cultivar. In this connection, Singh (1996) reported that successful cultivation of Gladiolus cultivarvs depends not only on the environmental conditions existing during the growth period, but also on the genetic factors of the cultivars. An earlier study by Hong and Kim (1988), showed that planting gladioli plants in a greenhouse in November under short day and cool conditions resulted in earlier sprouting and more production of GA3 - like substances. In addition, Ben-Hod, *et al.* (1989), found that day length and temperature, had a great effect on the growth and flowering processes in Anemone plants. Also, Ko *et al.* (1994) reported that earlier planting times often improve flowering characteristics and corm production of gladioli cultivars.

Genetic factors and gene expression associated with gladioli cultivars may also determine the possibility for a cultivar to tolerate certain harsh environmental conditions and to be successfully vigorous and healthy. In this respect, several studies on different Gladiolus cultivars concluded that the genotypic and phenotypic configurations of the cultivars had a great effect on the growth, flowering characteristics and other quantitative and qualitative parameters of the investigated species (Misra and Saini 1988, Gowda 1989, and Al-Humid and Mazrou, 1998). While Gladiolus needs temperate conditions of moderate temperature and relative humidity as well as an adequate water supply, the arid conditions of Al-Qassim with lack of water, hot climate, low relative humidity and high evapotranspiration states, may affect the normal growth and productivity of Gladiolus cultivars.

Since the reviewed results obtained from the different studies mentioned above reflected the importance of both the planting time and the genetic factors for growth and flowering characteristics of gladioli plants, it is necessary to carry out a comparative study between different planting times for some other gladioli cultivars, that were recently introduced, under open field conditions. This study aimed to examine the best cultivar that can survive, grow, and flower and the best planting time under the conditions prevailing in the arid region of Al-Qassim, Saudi Arabia. A parallel goal was to catalog and understand some biochemical and physiological changes that might occur during the acclimation of the selected cultivars.

Table 1. Chemical and Physical Analyses of the Soil.

Chemical properties		Physical properties	
pH:	8.20	Fractions (%):	
ECe (mS/cm):	2.06	Sand:	95.30
		Silt:	3.60
		Clay:	1.10
Soluble cations (meq.L-1):			
Na+	11.00		
Ca2+	4.35		
Mg2+	2.50		
Soluble anions (meq.L-1):			
CO32- + HCO3-	2.99	Texture:	Sandy Soil
SO42-	11.70		
Cl-	7.60		
CaCO3	4.00%		
O.M.*	0.23%		

Materials and Methods

The present study was carried out during the two successive seasons of 1999/2000 and 2000/2001 at the Research Farm of the Faculty of Agricultural and Veterinary Medicine, King Saud University in Al-Qassim to study the effect of planting time on the growth, flowering and flower characteristics of some recently introduced gladioli cultivars.

Corms (10-12 cm in circumference) of four gladioli cultivars: Eurovision (cv1) Rose Supreme (cv2), Prosperity (cv3) and Nova Lux (cv4) were obtained from Orman Botanical Garden in Cairo, Egypt. In both seasons, the corms of each cultivar were planted at three different times, the 5th of October, November and December at a distance of 20x50cm inter and intra row spacing in sandy structure soil with the physical and chemical properties shown in Table 1.

The plants were fertilized with the commercial fertilizer, "Sangral", containing both macro and micro nutrients (20% N, 20% P, 20% K, 0.40% S, 0.02% Mg, 70 ppm Fe, 14 ppm Zn, 16 ppm Cu, 42 ppm Mn, 22ppm B and 14ppm Mo.) at a rate of 600 kg/ha. The fertilizer was applied in three equal side-dressing parts at monthly intervals during each growing season. The other required agricultural practices were done. The experimental layout was a factorial in a complete randomized block design with three replications (2.0x2.0m/replicate). In each growing season, the three planting times were arranged in combinations with the four gladioli cultivars.

At the end of each growing season, the following parameters were determined:

1-Flowering characteristics; the time taken from planting to flowering; length, base thickness and fresh weight of the flowering-stem; inflorescence length, number and fresh weight of florets/spike; diameter and fresh weight of the new corms; and number of cormels/plant.

2-Chemical analysis:

a) Methods of soil analysis: mechanical analysis of the soil was performed according to the pipette method as described by Dewis and Feritas (1970). Organic matter by oxidation with dichromate according to Walkley and Black method (Dewis and Feritas, 1970). Total carbonate content was determined gasometrically using a Collins calcimeter and calculated as $CaCO_3$ (Dewis and Feritas, 1970). Soil pH was measured in (1:1) soil: water suspension using a single probe combination pH electrode (744 pH meter, Metrohm). Electrical conductivity (EC) was measured in (1:1) soil : water extract using 3100 Conductivity Instrument. Ca^{2+} and Mg^{2+} concentrations were determined using Atomic Absorption Spectrometry (AAS, Shimazu, AA6200, Kyoto, Japan). Cl^- and SO_4^{2-} concentrations were determined using Ion Chromatography (761 compact IC, Metrohm). Na^+ concentration was determined photometrically using Flame Photometer, model Corning 410. CO_3^{2-} and HCO_3^- were determined volumetrically using HCl.

b) Methods of plant analysis: samples of the aerial parts of each treatment were oven dried (70°C) to constant weight, finely powdered and the following chemical constituents were measured: total N% using Micro-Kjeldahl method as described by Chapman and Pratt (1978), P% measured colorimetrically using stannus chloride method described by Frie *et al.* (1964), K% (using Flame Photometry method described by Jones and Steyn 1973), and total carbohydrate percent estimated by the phenol-sulfuric acid method described by Dubois *et al.* (1956).

All collected data were statistically analyzed according to Snedecor and Cochran (1973) with the aid of the COSTAT computer program for statistics. Differences among treatments were tested using LSD at a 5% level of significance.

Results and Discussion

1. Flowering Time

The first planting date (5th Oct.) induced a significantly earlier flowering for the different cultivars than the other dates, while the third planting date (5th Dec.) lengthened the period from planting to flowering significantly for Rose Supreme, Prosperity and Nova Lux cvs (Table 2). Similar findings were also obtained in the second experimental season. Eurovision, on the other side, failed to grow in the third planting date in both seasons.

Regardless of the differences between cultivars, data in the same table shows that the period required from planting to flowering, in the first season, was 95.9, 107.0 and 134.7 days when planting was done in Oct., Nov. and Dec., respectively. These results imply that the earlier the planting date, the ealier the flowering time of the cultivars despite the phenotypic and genetic differences between them.

Table 2. Effect of the planting date on the period from planting to flowering and flowring stem measurements of some gladioli cultivars during two seasons.

Treatments		Days to flowering		Flowering-stem measurements							
				Length (cm)		Base thickness (cm)		Fresh weight (g)		Dry weight (g)	
D*	CV**	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Effect of the cultivars (CVs)											
-	CV1	107.22	108.25	77.57	84.50	1.07	1.15	63.05	65.01	8.95	9.97
-	CV2	105.96	98.50	86.38	95.36	1.23	1.40	85.44	114.78	12.56	16.6
-	CV3	111.85	112.56	93.57	107.88	1.12	1.38	91.52	114.12	13.65	17.5
-	CV4	115.89	117.81	78.43	85.92	1.09	1.24	71.83	23.99	11..00	12.9
L.S.D. (5%)		3.11	2.26	4.69	4.77	0.08	0.09	3.32	8.71	0.56	1.3
Effect of planting date (D)											
D1	-	95.86	105.13	83.99	91.71	1.12	1.24	73.58	85.13	10.99	13.45
D2	-	107.01	108.16	89.17	102.51	1.23	1.39	85.40	110.27	12.58	16.90
D3	-	134.69	116.63	79.19	86.53	1.02	1.28	78.84	95.70	11.84	13.20
L.S.D. (5%)		2.09	2.04	4.20	4.32	0.07	0.08	3.00	7.88	0.51	1.18
Effecet of (CVs x D) interaction											
D1	CV1	101.14	106.67	72.10	75.28	1.01	1.02	51.20	56.47	7.42	8.47
	CV2	90.00	90.67	90.17	93.70	1.26	1.36	79.58	101.16	11.94	15.68
	CV3	94.96	109.33	93.82	112.27	1.11	1.33	91.16	107.35	13.49	17.17
	CV4	97.33	113.87	79.89	85.60	1.11	1.24	72.39	75.56	10.82	12.47
D2	CV1	113.30	109.83	83.03	93.72	1.14	1.29	74.90	73.56	10.48	11.47
	CV2	96.36	93.98	95.56	103.53	1.42	1.50	93.80	128.26	13.60	19.23
	CV3	106.71	111.87	96.21	114.44	1.12	1.43	96.98	124.27	14.48	19.8
	CV4	111.67	116.97	81.89	98.33	1.24	1.35	75.93	115.00	11.71	17.2
D3	CV1	-	-	-	-	-	-	-	-	-	-
	CV2	131.52	110.87	73.42	88.83	1.01	1.34	82.93	114.92	12.15	14.94
	CV3	133.87	116.63	90.67	96.92	1.14	1.38	86.43	110.74	12.97	15.50
	CV4	138.67	122.60	73.50	73.83	0.92	1.13	67.17	61.42	10.41	9.21
L.S.D. (5%)		5.40	3.91	8.12	8.27	0.14	0.16	5.75	15.09	0.97	2.25

*D: planting date; D1, D2 and D3 are the first (October), the second (November) and the third (December) planting date, respectively.

**CV: gladioli cultivar; CV1, CV2, CV3 and CV4 are Eurovision, Rose Supreme, Prosperity and Nova Lux cultivar, respectively.

The same trend of results was also obtained in the second growing season.

It seems, from the recorded data, that gladioli plants should be exposed to a cold temperature for a certain period of time before flowering. That was what happened when plants were planted in Oct. and exposed to the cold temperature of Dec. and Jan. before flowering; while for those planted in Dec., the produced plants were not exposed to a period of sufficient cold, and they therefore took a longer time to flower. In this respect, Hong and Kim (1988) reported that the short days and cool conditions resulted in earlier flowering and more GA3-like substances within cv. True Love gladioli plant tissues.

Rose Supreme was characterized by its considerably earlier flowering, followed by Prosperity and Nova Lux, respectively. These results were true in both seasons. Eurovision failed to grow when planted at the third date. It showed poor growth and late flowering for all the rest of the planting dates. It is suggested that the differences between cultivars that appeared under the same planting date might be attributed to the variation in their genetic structure or to the differences in the gene expression between the different gladioli

cultivars. These results may confirm the conclusion of Misra and Saini (1988), Gowda (1989) and Al-Humid and Mazrou (1998), all working on gladioli, that genotypic and phenotypic make-up of the gladioli plants had a great effect on their quantitative and qualitative characteristics.

2. Flowering-Stem Characteristics

Data in Table 2 shows clearly that the best flowering-stem measurements (stem length, thickness and fresh and dry weights) were recorded at the second planting time (5 Nov.) However, at the third planting date (5 Dec.), there were reductions in the values of flowering-stem parameters in Rose Suprem, Prosperity and Nova Lux cultivars. Moreover, cv. Eurovision failed to grow successfully at this planting date. The suitable day length and the optimum temperature under which plants were grown for the 2nd planting date might be important reasons for improving the flowering-stem characteristics in all gladioli cultivars. Similar results were obtained by Hong and Kim (1988) on True love gladioli and Ko, *et al.* (1994) on Gladiolus gandavensis.

Prosperity gave the tallest and heaviest flowering stems (Table 2). Furthermore, cv. Rose Supreme showed higher values of flowering-stem parameters than cv. Nova Lux and cv. Eurovision.

The interaction between cultivars and planting dates indicates that the best flowering-stem measurements were those of cv. Prosperity followed by Rose Supereme, Nova Lux and Eurovision, particularly in the second planting time (5 Nov.) of both seasons.

The different flowering-stem measurements recorded for the cultivars may explain the variation in the genetic configuration and/or the gene expression between cultivars even when they were grown under the same conditions of day length and temperature values. These results are in accordance with those obtained by Misra and Saini (1988), Gowda (1989) and Al-Humid and Mazrou (1998) working with different cultivars of gladiolus.

Table 3. Inflorescence measureements of four gladioli cultivars during two seasons. See Table 2 for abbreviations.

Treatments		Inflorescence measurements					
D*	CV**	No. of florets/inflor.		Length (cm)		Fresh weight (g)	
Effect of the cultivars (CVs)							
		1st season	2nd season	1st season	2nd season	1st season	2nd season
-	CV1	11.85	14.00	56.55	60.83	36.82	38.37
-	CV2	12.27	15.88	53.16	66.31	36.83	60.74
-	CV3	11.83	15.53	52.11	70.82	41.21	66.93
-	CV4	10.25	13.46	46.56	56.38	32.52	48.59
L.S.D (5%)		0.96	0.87	5.26	5.25	3.20	3.92
Effect of planting date (D)							
D1	-	10.61	14.26	52.19	58.81	34.57	44.73
D2	-	12.56	15.63	59.87	69.27	41.90	66.10
D3	-	11.37	14.33	40.13	63.31	33.14	54.07
L.S.D (5%)		0.87	0.79	4.76	3.84	2.89	3.55
Effect of (CVs x D) interaction							
D1	CV1	9.71	12.72	51.70	50.61	27.32	29.52
	CV2	11.50	15.90	52.17	63.14	29.75	49.26
	CV3	10.85	15.27	53.39	67.93	53.39	60.22
	CV4	10.36	13.13	51.49	53.53	27.80	39.93
D2	CV1	13.98	15.28	61.40	71.06	46.31	47.22
	CV2	13.63	16.17	62.42	70.13	47.90	75.50
	CV3	11.91	16.00	61.14	74.28	35.61	77.00
	CV4	10.72	15.07	54.50	61.60	37.78	64.67
D3	CV1	-	-	-	-	-	-
	CV2	11.68	15.58	44.90	65.67	32.83	57.46
	CV3	12.74	15.33	41.79	70.25	34.63	63.58
	CV4	9.68	12.07	33.69	54.02	31.97	41.18
L.S.D (5%)		1.67	1.51	9.11	7.36	5.54	6.79

Table 4. Effect of the planting date on the new corm and cormel production of four gladioli cultivars during two seasons. See Table 2 for abbreviations.

Treatments		New corm and cormel measurements					
D*	CV**	Corm diam (cm)		Fresh weight/corm (g)		No. of cormels/plant	
Effect of the cultivars (CVs)							
		1st season	2nd season	1st season	2nd season	1st season	2nd season
-	CV1	4.85	4.132	28.83	28.61	66.25	40.48
-	CV2	6.28	5.65	84.05	79.85	85.57	58.47
-	CV3	4.69	4.96	79.86	75.19	62.33	44.91
-	CV4	4.88	4.49	68.18	62.90	62.97	45.60
L.S.D (5%)		0.42	0.37	6.36	4.64	6.83	5.60
Effect of planting date (D)							
D1	-	5.87	5.22	57.07	51.01	74.08	52.47
D2	-	5.68	5.71	74.87	74.58	76.45	50.60
D3	-	3.68	3.28	75.39	69.57	60.33	38.54
L.S.D (5%)		0.38	0.33	5.75	4.19	6.17	5.06
Effect of (CVs x D) interaction							
D1	CV1	4.43	3.50	22.08	19.48	65.83	40.63
	CV2	7.43	6.25	72.83	66.42	89.52	59.17
	Cv3	5.83	6.03	70.83	63.29	69.56	45.60
	CV4	5.77	5.10	62.50	54.83	71.33	64.50
D2	CV1	5.27	4.75	35.58	37.75	66.67	40.33
	CV2	6.90	6.88	97.16	96.67	102.54	67.07
	Cv3	5.23	5.70	90.82	88.78	62.17	52.30
	CV4	5.33	5.49	75.92	75.11	74.42	42.68
D3	CV1	-	-	-	-	-	-
	CV2	4.50	3.23	82.17	76.47	64.58	49.17
	Cv3	3.00	3.13	77.92	73.50	55.25	36.83
	CV4	3.53	2.89	66.08	58.75	61.17	29.61
L.S.D (5%)		0.72	0.64	11.01	8.03	11.82	9.07

3. Inflorescence Characteristics

The second planting date resulted in a conspicuous improvement in the inflorescence attributes of all cultivars as compared with other dates (Table 3). The number of florets per spike, spike length and spike fresh weight were significantly increased. Meanwhile, the delay in planting date to December either reduced the inflorescence characteristics in cvs. Prosperity, Rose Supreme and Nova Lux or completely inhibited the appearance of the reproductive organs (flowering-stems, flowers, florets, corms, cormels and inflorescences) in cv. Eurovision.

Genetic discrepancies between gladioli cultivars seem to play an important role in the acclimation to environmental conditions. The present study showed that Prosperity cultivar was superior to the others followed by cvs. Rose Supreme, Nova Lux and Eurovision, when grown under the same field conditions of Al-Qassim. The obtained results may confirm those reported by Hong and Kim (1988) on gladioli plants.

It should be mentioned that the environmental factors, particularly ambient temperature and day length, play a substantial role in the synthesis and accumulation of the flowering hormone "Floregen", which was found to be controlled by genetic factors (Salisbury and Ross 1992). Thus, as the present results indicate, times of planting as well as plant species and cultivars are significantly important factors determining the appearance and fertility of reproductive organs such as florets and inflorescences.

4. New Corms and Cormels

Among all gladioli cultivars used in the present study, cv. Rose Supreme was found to produce the largest corm diameter and the heaviest corm fresh-weight at any of the three planting times (Table 4). In addition, the width and weight of the new corms of Prosperity cv. was higher than those produced by Nova Lux and Eurovision. This was true in the two growing seasons.

Concerning time of planting, data in the same table showed that the second planting date (5 Nov.) produced larger and heavier new corms than those produced in the first and third planting dates.

The number of cormels/plant was also influenced by both the planting date and the gladioli cultivar. In the three planting dates, the highest number of cormels/plant was produced by cv. Rose Supreme. However, the width and weight of cormels were more pronounced in the second planting date than in the other dates. These results are in accordance with those obtained by Hong, *et al.* (1989) and Al-Humid and Mazrou (1998), working with different gladioli cultivars.

5. N, P and K (%)

It is obvious from collected data (Table 5) that there were no clear differences between the first (5.3%) and the third (5.0%) planting dates concerning the measurements of N, P and K percentages in the aerial parts of cv. Eurovision, while a slight reduction was observed in this respect for the second (4.5%) planting date of the first season. The reduction in the elemental percentages could be attributed either to the dilution effect in the mineral content as a result of producing heavier aerial parts in the second planting time, as a consequence of accumulating higher dry matter, compared to those obtained for the first and third planting dates. Alternatively the reduction may be due to the utilization of these elements in synthesizing some other materials such as proteins, nucleic acids, and phenolic compounds that can

Table 5. Effect of the planting date on N, P and K percentages in the dry matter of the aerial parts of four gladioli cultivars during two seasons. See Table 2 for abbreviations.

Treatments		The first season			The second season		
Palnting Dates (D*)	**Cultivar (CV**)**	**N%**	**P%**	**K%**	**N%**	**P%**	**K%**
Effect of the cultivars (CVs)							
-	CV1	1.85	0.32	2.60	1.75	0.30	3.00
-	CV2	1.88	0.33	2.67	1.89	0.34	2.62
-	CV3	1.72	0.26	2.44	1.74	0.26	2.45
-	CV4	2.04	0.38	3.06	2.47	0.35	2.79
L.S.D (5%)		0.14	0.11	0.45	0.25	0.08	0.50
Effect of planting date (D)							
D1	-	1.82	0.29	3.15	2.00	0.29	3.03
D2	-	1.90	0.34	2.29	1.95	0.31	2.64
D3	-	1.91	0.36	2.66	2.01	0.36	2.30
L.S.D (5%)		NS	NS	NS	NS	NS	NS
Effect of (CVs x D) interaction							
D1	CV1	1.84	0.28	2.87	1.95	0.34	3.10
	CV2	1.87	0.31	3.21	1.90	0.28	2.87
	CV3	1.66	0.25	2.86	1.84	0.22	2.65
	CV3	1.91	0.30	3.65	2.30	0.30	3.50
D2	CV1	1.86	0.35	2.32	1.54	0.26	2.89
	CV2	1.84	0.33	2.29	1.82	0.35	2.66
	CV3	1.77	0.28	1.76	1.94	0.25	2.45
	CV3	2.12	0.39	2.78	2.50	0.37	2.57
D3	CV1	-	-	-	-	-	-
	CV2	1.92	0.35	2.51	1.96	0.38	2.34
	CV3	1.72	0.26	2.71	1.45	0.30	2.26
	CV3	2.08	0.46	2.76	2.62	0.39	2.30
L.S.D (5%)		0.25	0.15	0.88	0.65	0.15	0.75

increase the degree of adaptation in the plant (Salisbury and Ross 1992). These results are in accordance with those obtained by Mazrou, *et al.* (1993), Al-Humid and Mazrou (1998) on gladioli plants and Desouky (1999) on Hibiscus rosa sinensis plants.

Apparent evidence of genetic roles can be clearly inferred from the present data (Table 5). In this regard, the variations between the different cultivars seem to regulate the mineral absorption and accumulation in the aerial parts. The highest values in this respect were found in the tissues of cv. Nova Lux, while, relatively lower values were recorded in cv. Prosperity tissues. The reduction in the concentration of mineral elements within certain cultivars may be explained through the dilution effect that resulted from the increment of the dry matter accumulation in this cultivar.

6. Total Carbohydrates

The total carbohydrate percentages in the aerial parts did not show significant differences between the various planting times (Table 6). On the contrary, remarkable differences were recorded between the cultivars. The aerial parts of cv. Prosperity contained higher percentages of total carbohydrates than those of other cultivars. In contrast, cv. Eurovision contained the lowest values of carbohydrate. One can reach the conclusion that there was a possible relationship between the content of total carbohydrates of the aerial parts and their dry weight (Table 2). This is clear in the case of Prosperity cv., which appeared superior to the other cultivars. Similar results were obtained by Mazrou, *et al.* (1993) on Gladiolus gandvensis L. and Al-Humaid (1998) on rose plants. Shinozaki and Yamaguchi (1997) proposed that, in certain plant species some genes can be activated, that synthesise certain materials such as carbohydrates and nitrogenous compounds useful for tolerating the unfavorable environmental conditions prevailing during plant growth and reproduction.

Conclusion

In the present study it is concluded that cvs. Rose Supreme, Prosperity and Nova Lux were successfully acclimated and adapted for cultivation in the arid region of Al-Qassim, since they can be planted on different dates, Oct., Nov. and Dec. However, the second planting time (5 Nov.) gave the best results of growth, flowering and corm production for all gladioli cultivars used in this investigation. The study showed also that some cultivars such as Eurovision could not grow well under Al-Qassim environmental conditions for all planting dates. It showed low growth for the first and second planting times, and completely failed to grow in the third planting date (5 Dec.). Two mechanisms might be involved in the acclimation of certain cultivars in order to survive and to do well under the new conditions. The first is that acclimation to the prviously mentioned harsh environmental conditions requires transcription and activation of a set of genes normally not expressed under non-acclimating conditions. The second is that the synthesis of new proteins and other compounds necessary for adjustment could generate the ability of plant species to withstand the unfavorable conditions that might exist in the new environment of the growth medium.

Table 6. Effect of the planting date on the total carbohydrate precentages in the dry matter of the aerial parts of four gladioli cultivars during two seasons. See Table 2 for abbreviations.

Season	The first season				The second season			
	D1*	D2	D3	Mean	D1	D2	D3	Mean
CV1**	12.50	10.21	-	11.36	13.42	11.80	-	12.61
CV2	11.76	13.20	12.46	12.47	14.60	13.92	12.78	13.77
CV3	14.59	13.72	11.68	13.33	15.25	15.80	14.70	15.25
CV4	12.15	13.80	12.75	12.9	15.26	14.98	13.65	14.61
Mean	12.75	12.73	12.30	-	14.63	14.11	13.71	-

L.S.D (5%): for (D1-D3) at first season = 0.56 (NS)
L.S.D (5%): for (D1-D3) at second season = 0.95 (NS)
L.S.D (5%): for (CV1-CV4) = 1.25

References

Al-Humid, A.I. (1998). The influence of foliar nutrition and gibberellic acid application on the growth and flowering of sntrix rose. The second conf. Of Ornamental Hort. Egypt Ismailia.

Al-Humid, A.I. and Mazrou, M.M. (1998). Physiological influences of different soil moisture levels on some Gladiolus gandavensis cultivars : Growth and flowering. Minufiya J. Agric. Res. **23**: 157-167.

Ben-Hod, G., Kigel J. and Steinitz, B. (1989). Photo thermal effects on corm and flower development in Anemone coronaria L. Scientia, Hort. **40**: 247-258.

Chapman, H.D. and Pratt, P.F. (1987). Method of Analysis for Soil, Plant and Water. Univ. California, Dept. Agric. Sci., USA, pp. 112-129.

Desouky, M.T. (1999). Effect of CCC on salt toleronce of Hibiscus rosa sinensis plants. Minufiya J. Agric. Res. **24**: 611-624.

Dewis, J. and Feritas, F. (1970). Physical and Chemical Methods of Soil and Water Analysis. FAO, Rome, Soil Bulletin, No. 10.

Dubios, A., Gilles, A., Hamelton, J.K., Robers, P.A. and Smith, P.A. (1956). A colorimetric methods for determination of sugars and related substances: Anal. Chem. **28**: 350.

Frie, E., Peyer, K. and Schutz, E. (1964). Phosphorus determination. Schw, Land Wirtschaft Forschung Heft. **3**: 318-328.

Gowda, J.V.N. (1989). Genetic and phenotypic variability and correlation in quantitative and qualitative characters in gladiolus. Crop. Res. **2**: 235-237.

Guy, C.L. (1990). Cold acclimationand freezing stress tolerance: role of protein metabolism. Annu. Rev. Plant Physiol. Mol. Biol. **41**: 187-223.

Hong, Y.P. and Kim Y.K. (1988). Studies on the corm formation in Gladiolus gandavensis :Effect of climatic conditions for corm formation on dormancy and flowering. Res. Reports, of Rural. Develop. Admin. Hort. **30**: 99-103.

Hong, Y.P., Goo, D.H. and Huh, K.Y. (1989). Studies on corm formation in Gladiolus gandavensis : The effect of planting date of cormels on corm production, dormancy and flowering of the corm in the next generation. Res. Reports. Of the Rural - Develop. Adminst. Hort. **31**: 54-59.

Jones, J.B. and Steyn, W.J.A. (1973). Sampling, handling and analyzing plant tissue samples. *In*: **L.M. Walish, and J.d Benton.**Soil Testing and Plant Analysis. Ed. L.M. Walsh and J.D. Benton. Soil Sci. Amer. ed. Inc., pp. 249-270.

Ko, J.Y., Kim, S.K., Um, N.Y., Han, J.S. and Lee, K.K. (1994). Planting times and corm grades of Gladiolus gandavensis for retarding culture in high land. RAD, J. of Agric. Sci. Hort. **36**: 430-434.

Mazrou, M.M., Afify, M.M. and Eraki, M.A. (1993). Growth, flowering and some chemical as well as anatomical structure of gladiolus plants as affected by : indole - butyric acid application. Minofiya J. Agric. Res. **18**: 2521-2535.

Misra, R.L. and Saini, H.C. (1988). Genotypic and phenotypic variability in gladiolus. Ind. J. of Agric. **45**: 148-152.

Salisbury, F.B. and Ross, C.W. (1992). Environmental stress. *In*: **Plant Physiology, 4th ed. Wadsworth Publishing Comp.** USA, pp. 214-232.

Shinozaki, K. and Yamaguchi, K. (1997). Gene expression and signal transduction in water-stress response. Plant Physiol. **115**: 327-334.

Singh, K.P. (1996). Studies on size of cormels and levels of nitrogen on corm multiplication in Gladiolus. "Pink Friendship". Adv. in Plant Sci. **9**: 241-243.

Snedecor, C. and Cochran W.G. (1973). Statistical Methods 6th ed; Iowa State Univ., Press, Ames, Iowa U.S.A.

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