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EFFECT OF TEMPERATURE AND RED LIGHT ON *Potamogeton crispus* L. BUDS OF TURION TYPES

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ABSTRACT

The pond weed *Potamogeton crispus* L. produces turions. In Egypt, turions are classified into 3 types according to their position of formation (apical, lateral-apical and lateral).The effect of temperature on turion types was studied under laboratory conditions. The best sprouting occurred under 15 °C, but sprouting was inhibited under 5 and 30 °C for all turion types in both light and dark. Lateral turions gave the highest percentage of sprouting at all tested temperatures. Turions lost their viability when submerged at 60 °C for 30 minutes. The seedlings which were formed from lateral turions decayed faster than those formed from apical and lateral-apical. Seedlings under 30 and 50 °C decayed after 20 and 6 days, respectively.

Under field conditions, temperature ranged from 34 to 38°C during July, August and September,1999 and 2000.The effect of red light on turions was studied. Red light induced the dormant buds to sprout and the high temperature killed the sprouts. The living sprouts percentage for both seasons studied was 5.1,12.2 and 18.4%,meanwhile, the decayed ones were 16.8, 28 and 43.3% during July, August and September, respectively.

Key words: *Potamogeton crispus, red light, sprouting, temperature, turion types.*

1. INTRODUCTION

Aquatic weeds are becoming a serious hydrological problem in many rivers, lakes and canals throughout the world especially submerged weeds (Holm *et al.*, 1969; Mitchell 1977, Murphy *et al.*, 1982 and Ross and Lembi 1985).Curly leaved pond weed *Potamogeton crispus* L. is a submerged perennial aquatic weed of temperate and tropical regions. It is one of 5 species of *Potamogeton* commonly found in Egypt. It is a dangerous weed widespread throughout the Nile region,always checking small canals that feed the fields and has been reported as an indicator species of eutrophication (Sculthorpe 1971 and Tackholm 1974). The problem of excessive growth reduces the rate of water flow and prevents water from reaching the end of canals (Khattab and El-Gharably 1986).

Gluck (1906) defined turions as a peculiar vegetative bud, which functions as a propagule and as an over wintering device in some aquatic plants to grow and survive. In Egypt, turions of *Potamogeton crispus* L. are classified into 3 types according to their position formation [Fig. (1) Attalla (1985)].

a-Apical turions,they carry 7-13 buds of about 35-75 mm in length.

b-Lateral-Apical turions, they carry 7-8 buds of about 26-28 mm in length.

c-Lateral turions, they carry 3-6 buds of about 14-22 mm in length.

Red light promotes organ buds of terrestrial species to germinate (Hendricks and Borthwick 1963,Kasperbaure *et al.*, 1963 & 1964). Red light with high temperature promotes turion buds of *Potamogeton crispus* L. to sprout (Attalla 1985).The penetration of red light into the water depends on the depth of water, the season, and the difference in length of day and dissolved colouring matter (Blackburn *et al.*, 1968).

The aim of this work was to study the effect of temperature on the viability of turion buds, on bud sprouting as well as on the formed seedlings.The work is an approach to control *Potamogeton crispus* L. by stimulating the sprouting of turions by red light in order to control the sprouts.

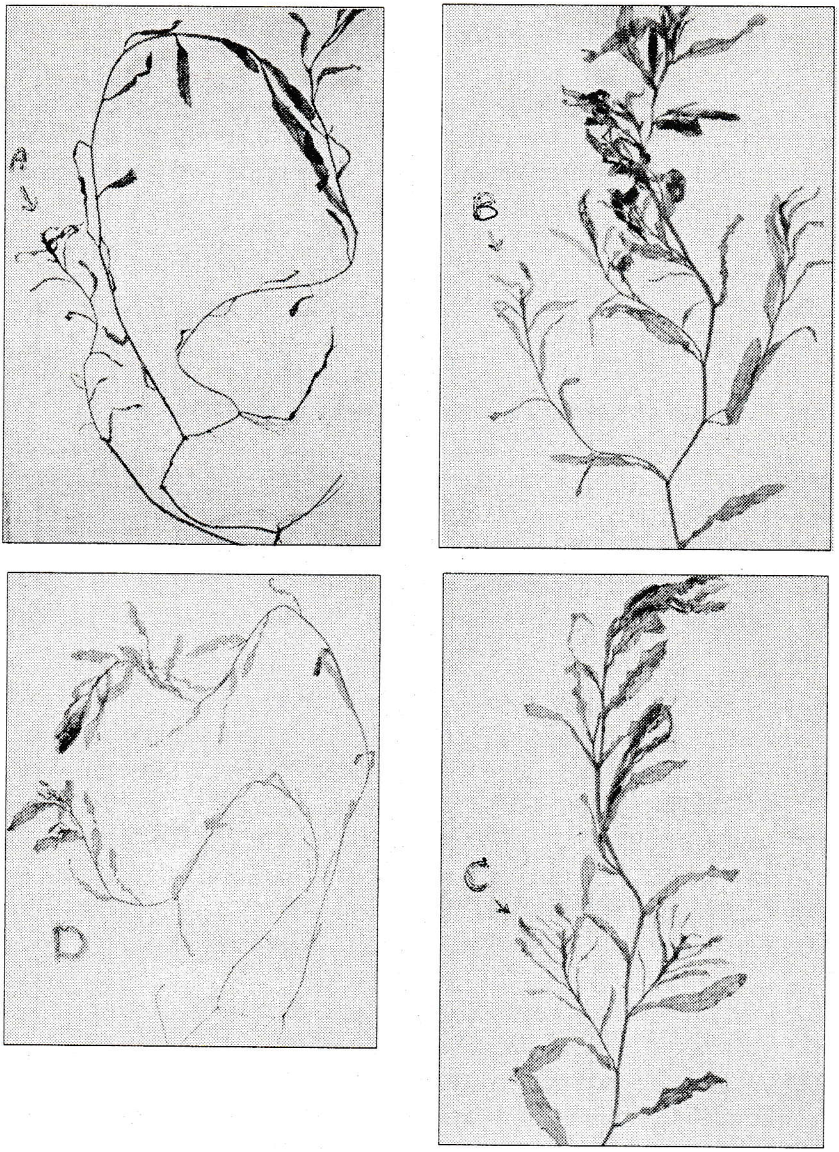

Fig. (1): The formation of turion

(A) Apical
(B) Lateral-apical

(C) Lateral
(D) Normal weed

2. MATERIALS AND METHODS

Turions of *Potamogeton crispus* L. were collected from a dense stand in the irrigation canal of Bahteem Agricultural Research Station, Kalubia Governorate. Two experiments were carried out, one in the laboratory and the other in the field.

2.1. Laboratory

The experimental work took place in August and September, 1999 as follows:

2.1.1. Effect of temperature on turion type sprouting

Apical, lateral-apical and lateral turions were placed seperately in either light or dark at constant temperatures of 5,10,15,20,25 and 30 °C in an environmental chamber. Each treatment contained 5 plastic bottles (replicates), and each bottle (8 cm in diameter and 6.8 cm tall in length) containing 5 turions under(8/16 h)light/dark cycle by fluorescent lamps. The numbers of sprouts were recorded after 4 weeks.

2.1.2. Effect of temperature on turion buds viability

The objective was to study the effect of temperature on turion bud viability. Seven temperatures were selected *i.e.*, 30,35,40,45,50,55 and 60 °C, fixed number of turions *i.e.*, 25 turions for each treatment, for different times *i.e.*, 0.25,0.5,1,3,6,12 and 24 hr. Practically,5 turions were placed in a bottle as a replicate. The viability of turion buds was tested with Benzyl Adenine (BA) after initial treatment with temperatures according to Imam *et al.*, (1983).

2.1.3. Effect of temperature on seedlings

Sprouted turions which were formed from apical, lateral-apical and lateral buds were used when sprout length was 2-3 cm and had 2-4 leaves. Each treatment contained 5 bottles (replicates) and each bottle contained 5 turions with a total number of 25 turions. The bottles were placed in an aquarium at constant temperatures *i.e.*, 30,35,40,45 and 50°C. The number of decayed sprouts was daily recorded.

Data of the treatments were distributed according to a split plot design with 5 replicates of each temperature as a main plot and the type classes of turions as subplots (Steel and Torrie 1960).

2.2. Field experiment

The aim of this experiment was stimulating the sprouting of turions by red light in order to control the sprouts by high temperature (more than 30 °C).

2.2.1. Construction of the canals for field test

Four irrigation canals were constructed with a length of 10 m and width of 1.5 m at the upper surface and 1 m at the bottom as shown in Fig.(2). The depth of each canal was about 1m and the canals were fed from a large stream connected to the Nile. The draining canal was similar to the feeding stream, with a concrete base of 10 cm thickness and brick walls of 25 cm thickness for the lower part of 45 cm height and 12.5 cm thickness for the upper part with a total height of 1m.Each canal was provided with inlet and outlet water opening. The hydrosoil of the canals was about 10 cm thick of mud. The experiments were carried out during July, August and September 1999 and 2000.

Turions were regularly placed on hydrosoil in the 4 constructed canals by 2000 turions/canal then the water supplied height was about 50 cm.Two red transparent poly-ethylene sheets of wave length 670 nm were used for 2 canals. The sheets were supported horizontally across the whole width and length of the canal by thin wooden frames which were left above water for 2 and 28 days without sheets exposed to high temperatures of July,August and September on the same canals *i.e.*, (2 days red light- 28 days high temperature). The other 2 canals were left without sheets for the same period. Temperature of the surface and bottom of the water were recorded daily at 2 pm. Number of unsprouted buds,living and decayed sprouts were recorded at the end of July,August and September 1999 and 2000.

3. RESULTS AND DISCUSSION

3.1. Laboratory experiments

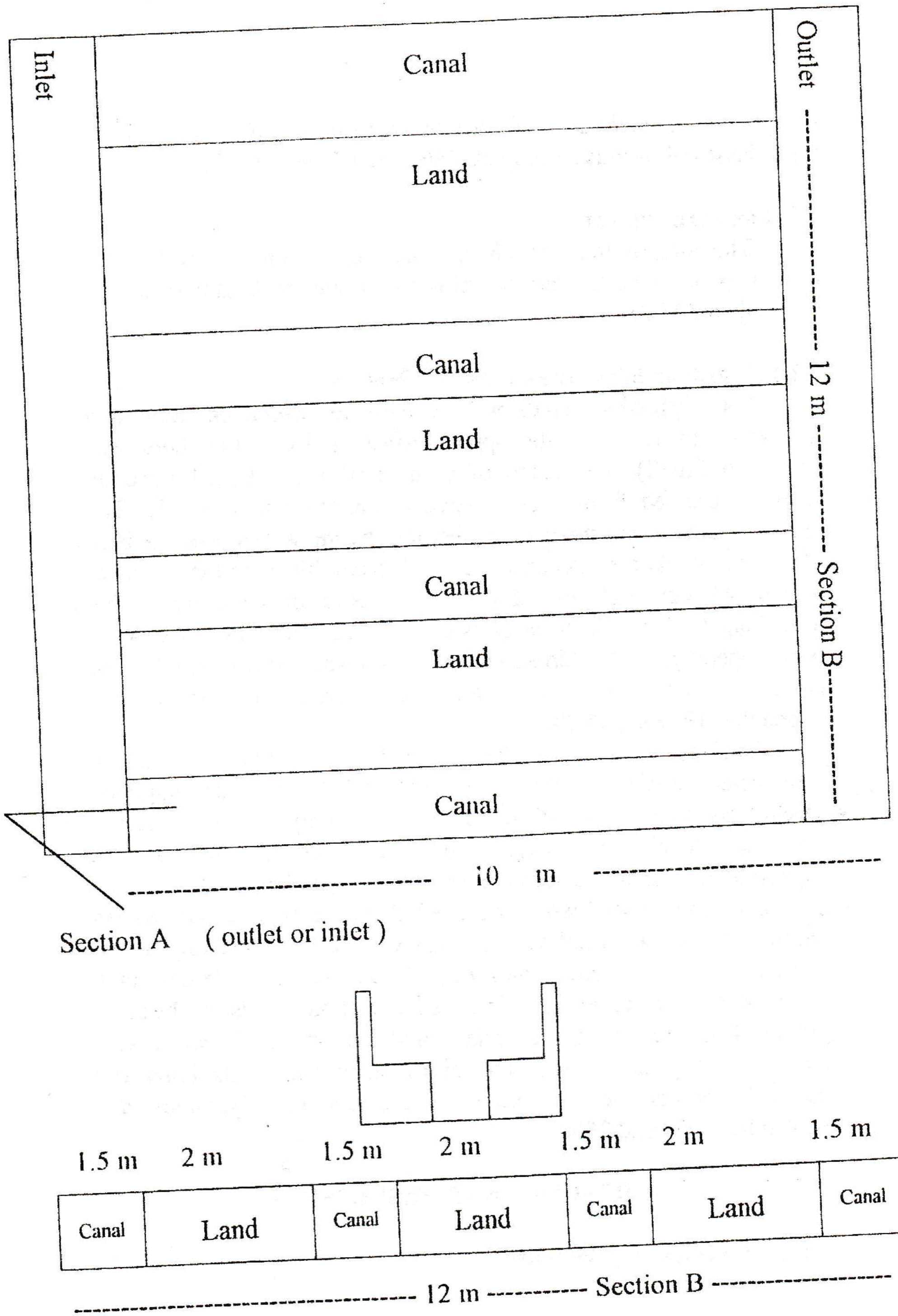

Fig. (2):The construction of the canals for field canal experiment.

3.1.1.Effect of temperature on turion type sprouting

Tables(1&2) and Fig. (3) show the effect of temperature on sprouting percentage of *Potamogeton crispus* L. turions in both light and dark after 4 weeks. Sprouting of turion type (apical, lateral-apical and lateral) had a significant effect for all tested temperatures.Lateral turions gave the highest value of sprouting in both light and dark and its value was 2.3 and 2.7, respectively (Table 1&Fig. 3). The best sprouting occurred at 15°C in both light and dark for the different turion types.Sprouting reduced when turions were exposed to 10,20 and 25 °C and were inhibited at 5 and 30 °C in both light and dark (Table 2 & Fig. 3).In general, sprouting of turions as affected by light and dark can be considered as neutral. But, temperature appears to be a major factor affecting and controlling the sprouting of turion. The findings of Waisel (1971),Rogers and Breen (1980),Sastroutomo (1981),Catlings and Dobson (1985) and Spencer and Ksander(1992) are in the same trend.

Table (1): Effect of turion types on the number of sprouting/ turion in both light and dark. Each treatment contained 100 turions. (average of 2 experiments) .

Turion types	Apical	Lateral-apical	Lateral	L. S. D.
Light	0.85	1.7	2.3	0.6
Dark	1.2	2.1	2.7	0.5

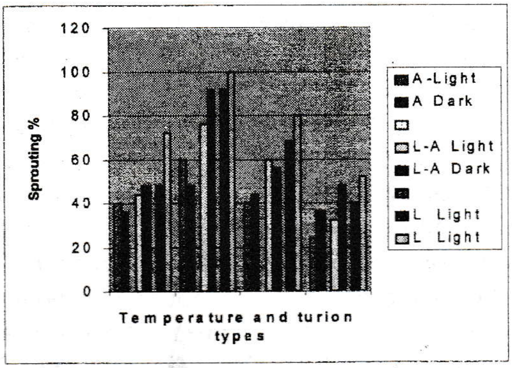

Fig. (3): Interaction effect between turion type and temperature on sprouting % under light and dark.

Table (2):Effect of temperature on the number of sprouts/turion of both light and dark. Each treatment contained 75 turions. (average of 2 experiments).

Temperature °C	10	15	20	25	LSD
Light	1.2	2.8	1.8	0.7	0.6
Dark	1.6	3.0	2.0	1.4	0.5

3.1.2. Effect of temperature on turion bud viability

Table (3) shows the effect of temperature at different times exposure on viability of turion buds. The viability of turion buds decreased by increasing the temperature and its time exposure. Turions which were submerged in water for ¼, ½, 1,3, 6,12 and 24 hr at 60,55,50 and 45°C lost their bud viability. But, turions did not lose their viability at 30°C for 24 hr. Similar results were obtained by Waisel (1971) who mentioned that the turions lost their viability when submerged at 48°C for 30 minutes.

3.1.3. Effect of temperature on seedlings

Figs. (4,5&6) show the effect of different temperatures on seedlings formed from turion types. The average mean number of seedling length was about 1.5-2 cm with 2-4 leaves. In general ,the decayed seedlings significantly increased by increasing the temperature as well as time exposure. Here,it is worth to indicate that seedlings resulted from lateral turions decayed faster than from both apical and lateral-apical turions. However, plants from all turion types significantly decayed by 50 °C after 6,8 and 8 days exposure, while the seedlings decayed due to 30 °C after 18,18 and 20 days exposure. The sign of decayed seedlings was changed from green to dark brown. Tobiessen and Snow (1984) mentioned that the severe tissue decomposition happened at 25 °C during 2 months growth period. The effect of high temperature seemed to be less on seedlings than on dormant buds (Vegis 1964). The seedlings formed from turion types are considered as a biological factor which plays a role in regulating this plant abundance under the effective environmental conditions.

Here, it is worth to mention that high temperatures caused plant death in several different ways:

1-Photosynthesis reaches an optimum at about 22°C and then declines, while respiration continues to increase with increasing temperature. Carbohydrate suplies will be depleted and injury will result.

2-High temperature causes irreversible protein destruction.

Similar results have been obtained by Waisel (1971), Rogers and Breen (1980),Kunii (1982),Tobiessen and Snow (1984) and Bolder *et al*., (1985).

Table (3): Effect of temperature and time exposure on turions viability.

Temp. °C	Number of living buds of time period(hr)						
	0.25	0.5	1.0	3.0	6.0	12.0	24.0
30	32.0	31.0	29.0	30.0	30.4	29.4	31.6
35	32.0	31.0	29.0	28.8	28.2	26.4	26.4
40	32.0	31.0	26.6	24.0	19.6	12.2	5.6
45	32.0	29.4	25.4	18.8	11.4	4.4	0.0
50	26.8	18.0	10.6	6.8	0.0		
55	17.6	8.6	3.8	0.0			
60	12.8	0.0					
L.S.D	2.7	3.6	3.7	2.5	5.0	3.7	4.3

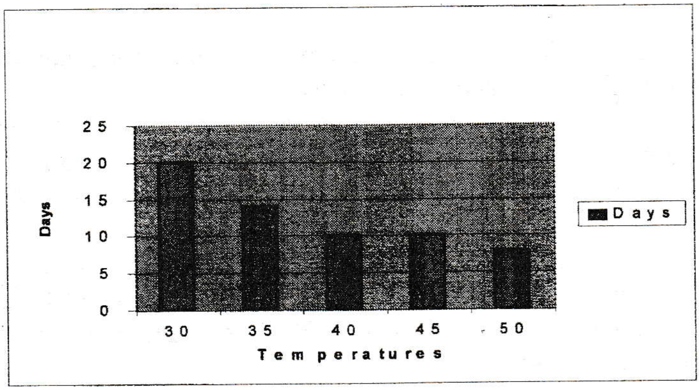

Fig. (4): Effect of temperature on seedling mortality % under time exposure.

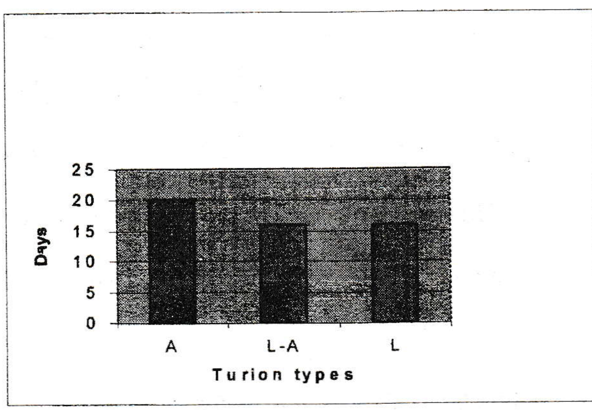

Fig. (5): Effect of turion types on seedling mortality % under time exposure (average of two experiments).

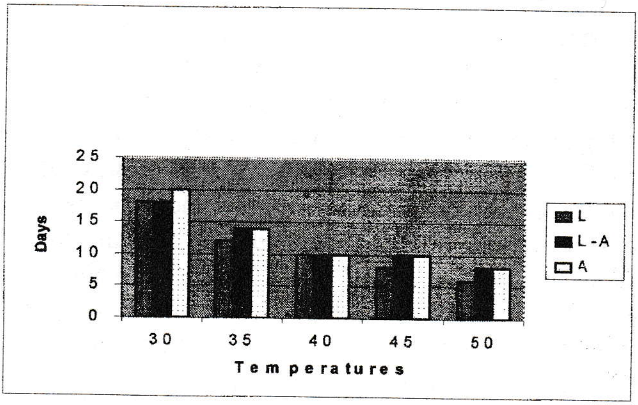

Fig. (6): Interaction effect between temperatures and turion types on seedling mortality % under time exposure.

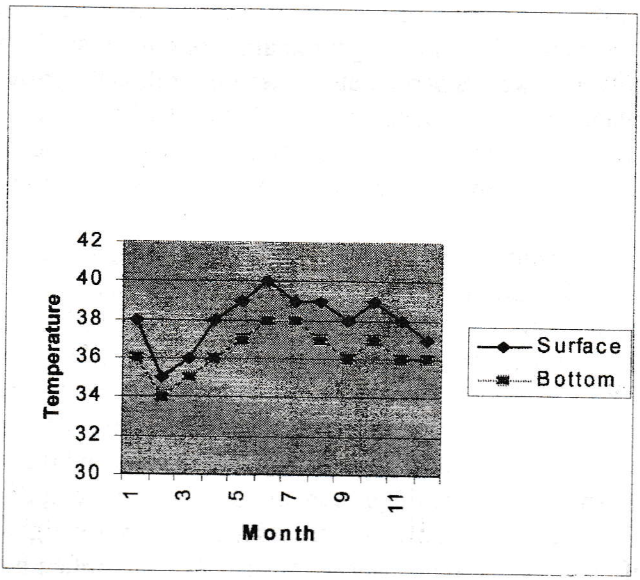

Fig. (7): Mean weekly temperature at mid-day (2 pm) of surface and bottom water during July, August, September (1999 and 2000).

3.2. Field experiment

The effect of red light for 2 days and high temperature for 28 days during July, August and September 1999 and 2000, when stimulating the sprouting of turions by red light then controlling the sprouts by high temperature is shown in Table (4). The treatment with 2 days red light induced the dormant buds to sprout, while without red light the sprouting disappeared during summer months. At the end of September 1999, the number and percentage of living sprouts,dead sprouts and unsprouted buds was 271(17.7),637(41.6) and 622 (40.7), respectively. At the end of September 2000, similartly , the number and percentage of living sprouts,dead sprouts and unsprouted buds was 242 (19.1),574 (45.2) and 454 (35.7), respectively.

From field observations,at the end of plant life,the plants lie down on the hydrosoil and by time the turions lie dormant free from the mother plant on it. Spence *et al*., (1971) mentioned that in still water at a depth of (1 m),the relative transmittance of incident values of red light (654 nm) was 75% with energy 13 J/cm^2/day and far red light (730) was 10% with energy 1.8 J/cm^2/day. Takimoto (1964) stated that the effect of red light remains constant at any temperature. In natural waters,particulate detritus,colloidal material and phytoplankton may reduce the irradiance to below the sprouting requirements. Therefore, red polyethylene sheets were used for 2 days in this experiment during July, August and September in both seasons.

The results showed that red light at a high temperature was effective in promoting the turion buds to sprout, while the temperature only had not effect in promoting the buds to sprout. The red light was the primary factor in breaking the turion dormancy and temperature was a secondary one. Kasperbaure (1971) and Bodkin *et al*., (1980) mentioned that red light increases the level of promotors in the buds till they could overcome the inhibitors and the buds could start to sprout. The seedlings were decayed by high temperature more than 30°C during summer months after 2 days of red light exposure. Therefore, *Potamogeton crispus* L. can be controlled by using red sheet in small canals without pollution.

In the experiment noted, the surface water temperature was higher than the bottom water temperature by 1-2°C during summer months. The atmospheric temperature as well as the surface water temperature were equal and recorded for July, August and September (Fig. 7). Similar result was obtained by Rogers and Breen (1980) and Tobiessen and Snow (1984).

Table (4): Effect of red light and high temperature on sprouting of *Potamogeton crispus* L. turions during summer months (July,August and September). (Each treatment contained 200 turions).

Year		1999		2000	
Month	Treatments	Red light + High temperature (No.) (%)	High temperat ure	Red light + High temperature (No.) (%)	High Tempera ture
July	Total buds	1492	0.0	1450	0.0
	Living sprouts	79 (5.3)	0.0	71 (4.9)	0.0
	Dead sprouts	182 (12.2)	0.0	165 (11.4)	0.0
	Unsprouted buds	1231(82.5)	0.0	1214 (83.7)	0.0
August	Total buds	1476	0.0	1386	0.0
	Living sprouts	177 (12)	0.0	173 (12.5)	0.0
	Dead sprouts	404 (27.4)	0.0	398 (28.7)	0.0
	Unsprouted budsT	895 (60.6)	0.0	815 (58.8)	0.0
September	Total buds	1530	0.0	1270	0.0
	Living sprouts	271(17.7)	0.0	242 (19.1)	0.0
	Dead sprouts	637(41.6)	0.0	574 (45.2)	0.0
	Unsprouted buds	622(40.7)	0.0	454 (35.7)	0.0

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تأثير درجة الحرارة والضوء الأحمر على براعم(توريـــون) نبات الحريش(*Potamogeton crispus* L.)

صفوت ابراهيم عطاالله

قسم بحوث الحشائش – معهد المحاصيل الحقلية – مركز البحوث الزراعية

ملخص

أقيمت تجربتان إحداهما معملية والأخرى حقليـــة لدراســـة تـــأثير درجـــة الحرارة على براعم نبات الحريش(التوريون) ، وكذا النباتـــات النامية منـــها. أظهرت النتائج ان احسن درجة حرارة لانبات البراعم هي ١٥° م وان درجتي الحرارة(٥°، ٣٠°م) قد ثبطت إنبات البراعم بأنواعها الثلاثة سواء فى الضوء أو الظلام. وقد وجدان التوريون الجانبي أعطى أعلى نسبه إنبات لجميـــع درجـــات الحرارة المستعملة(١٠ ، ١٥، ٢٠، ٢٥ م).

وقد فقدت البراعم حيويتها عند غمرها فى الماء على درجة٦٠°م لمـــدة ٣٠ دقيقة وقد أظهرت النتائج أيضا ان النباتات النامية مـــن براعـــم التوريـــون الجانبي تحللت بسرعة عن باقي النباتـــات الناميـــة من براعم الأنواع الأخرى (القمى والقمى الجانبي).وقد ماتت النباتات المعرضة لدرجـــة حـــرارة (٥٠°م) خلال٦ أيام بينما ماتت النباتـــات المعرضة لدرجـــة حـــرارة (٣٠م) خـــلال ٢٠ يـــوما .

أقيمت التجربة الحقلية خلال شهور يوليو– أغســـطس – ســـــــبتمبر عامي ١٩٩٩ و ٢٠٠٠ لدراسة تأثير الضوء الأحمر علـــى إنبـــات براعـــم توريونات هـــذا النبات أثنـــاء درجات الحرارة غير المناسبة للنمـــو (درجـــات الحرارة العالية). وقد أظهرت النتائج إن النباتات النامية وصلـــت ٥,١، ١٢,٢، ١٨,٤ %و قد وصلت نسبة الإبادة ١٦,٨، ٤٣,٤،٢٨ % خلال اشهر يوليو– أغسطـــس – سبتمبر(متوسط موسمي التجربة) وهذه التجربة تعطـــى إمكانيـــة مقاومة هذا النبات بيئيا.

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد(٥٢) العدد الثالث (يوليو ٢٠٠١) :٣٦٧ – ٣٨٤.