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Freezing effect on developing growth of two *Cynanchum acutum* L. populations

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Abstract

Greenhouse study was conducted in 2013-2014, in order to investigation of freezing effect on roots developing reproduction capability in two *Cynanchum acutum* L. populations. The freezing temperature of two *C. acutum* populations (Karaj and Kerman) determined at -1, -2, -4 and -8° C; for durations of 0 (Evidence), 6, 12, 24, 48 and 96 hours. Results showed that the increasing of the duration and decreasing the freezing temperatures, the number stalk and leaves obtained from each root were declined. But Karaj population showed rather resistance to freezing. The results of study showed that, freezing can be used as appropriate management solution with the aim of weed control and management. Freezing efficiency was effective for weed management of Karaj and Kerman population.

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Introduction

In the recent year's Iranian fields and gardens pollution to *Cynanchum acutum* have increased conspicuously and already causes problematic situation in several province in Iran (Pahlevani *et al.,* 2008; Pahlevani *et al*., 2007). *C. acutum* is perennial and reproduced by productive and developing methods (Seed and root fragmentation). Morphologically**,** it′s pleomorphic characteristic is so high. According to several reports the flexibility of *C. acutum* phenotypes is the major reason of its extent distribution in different continental situations. *C. acutum* wrapping around the adjacent plant and surrounding the host plant up to 3 meter heights or over, even it can completely dry the young trees. Otherwise, aggregately shrubs develop and extent on the ground (Pahlevani *et al.,* 2008; Lawlor and Raynal, 2002).

The high potential of developing reproduction and the high germination ability of its reproduction fragments like root, bulb and rhizome is the major problem or challenge in perennial weeds management like *C. acutum* (Kigel and Koller, 1985; Mc Intyre, 1990). In associated with nomination of *C. acutum* subterranean organs there are inconsistencies. Most of the researchers named *C. acutum* subterranean organs as a root instead of rhizome. Generally, developing reproduction of *Ascelipiadaceae* family accomplished with non-relevant buds on roots (Coble and Slife, 1980). The effective parameters on developing reproduction of perennial weeds, can be prevented their gamogenesis production with utilizing of different management methods and plays a major role to achieve to the appropriate solution for it management in cropping systems (Holt and Orcutt, 1996; Soteres and Murray, 1982).

There are varieties of report, which presented about the environment factors on developing reproduction of perennial weeds (Guglielmini and Satorre, 2004; Orykot and Swanton, 1997; Singh and Achhireddy, 1984). Different research investigated the effect of temperature on ability of developing reproduction. For instance; the effect of temperature on rhizome and stalk of *Arundo donax* L (Boose and Holt, 1999), rhizomes of *Cynodon dctylon* L (Booth *et al*., 2003) and rhizomes of *Imperata cylindrical* L and *Panicum repens* L (Wilcut *et al*., 1988).

Utilizing winter chilling water is the major appropriate management solution in the term of perennial weeds control in moderate and cold regions (Dunham *et al.,* 1986; Dexter, 1987). Stoller (1983) to evaluate the effect of freezing on ability of developing reproduction in *C. esculentus* L and *C. rotundus* L reported; when glands of these two species settled at 0 to -10° C for 4, 8, 16 and 48 periods, there was no freezing effect on *C. esculentus* glands germination. However this freezing stress had a severe damage for *C. rotundus* glands and had no re-growth ability. According to the other studies, at -8° C *Convolvulus arvensis* roots wasted completely. However, at -6° C, about half of its roots kept their germination ability (Dexter, 1987). The effect of chilling stress on vitality of *Cirsium arvense* (L.) roots showed at -6 to -8° C for 8 hours leads entire damage for them and at -2° C the roots germination of *C. arvense* intensively damaged (Dexter, 1987). It is founded that the rhizomes of *Agropyron repens* Beauv completely lose their reproduction ability at -7° C (Dunham *et al*., 1986). The similar result is observed about the freezing effect on *Cynanchum leave* roots (Soteres and Murray, 1982).

Researches indicated that when a special species of plants settle and grow in a different places with varied environmental circumstances, then it tends to produce productive and vegetative organs with different traits. The new plants are able to show different responses in extend territorial condition. So recognizing these special traits not only could plays a major role in weeds masses to know the adapting models or behaviors of weeds that it uses to compatible itself with environment circumstances, it also helps to select appropriate management in cropping system (Roach and Wulff, 1987).

The factors like territorial situation and even the existence of different weed ecotype varieties is effective in the term of chilling resistance. It is seemed that plants of cold regions presented the higher resistance to chilling due to the different factors especially physiological adaptations (Hettwer and Gerowitt, 2004). Factors like solvable glucoses, lipids and amino acids aggregation occurred in chilling to prevent ice crystal establishment in the cell and cell damage (Schimming and Messersmith, 1988; Rao and Nagarajan, 1962).

According to conspicuous damages of *C. acutum* through the Iranian field and gardens, yet there are no appropriate managing recommendations to control weeds. The recent study aimed to investigate the different temperatures effect, freezing periods on developing reproduction ability of two *C. acutum* populations in order to gain effective and non-chemical solutions to control weeds. Since *C. acutum* known because of its great productive growth and its vast ability to response to different environment situation and to overcome the competition between other plants and also concerning to the limitation to manage *C. acutum*, this study aimed to determine the appropriate temperature and the adequate time needs to freeze and eliminate the roots of *C. acutum* to prevent its vegetative growth. The result of this study, greatly, can help how to manage cropping system in sustainable agriculture term and how to integrate non-chemical management just like freezing method to control unwilling elements like weeds.

Materials and methods

Collection and preparation of C. acutum roots

The roots of *C. acutum* randomly accumulated from 5 square kilometers at several fields and gardens in Karaj (Latitude: 35° 50' 24'' N, Longitude: 50° 56' 20'' E) and Kerman (Latitude: 30° 17' 02'' N, Longitude: 57° 05' 00'' E) during February 2013. Fragments prepared from roots with 15 cm length (with same diameter). Each three roots of either population placed at packet as an experimental foliage and two beneath experiments is done over them:

Experimental design and measurements

To this purpose, the experiment was conducted during the spring season of 2014 and the experimental treatments were arranged in factorial encompassed based on a randomized complete block design with four replications. The experimental factors roots of *C. acutum* populations at two levels (Karaj and Kerman), roots freezing period at six levels (0, 6, 12, 24, 48 and 96 hours) and freezing temperatures at four levels (-1, -2, -4 and -8° C). The three available roots in each packet after passing the determined freezing temperature periods, planted into plastic vases (content of field's soil plus sand plus livestock′s fertilizer at proportion of 2:1:1) and kept at greenhouse for 21 days with 30/20° C (day/night) temperature in natural lightning. As an evidence treatment (without freezing); roots which had no treatment planted at the same proceeding in four replications. After passing the 21 days period, the number of stalks and leaves in developed plants recorded for each vase.

Data analysis

Ultimately after initial data analyzing and evaluation of their distribution process, the hypothesis of normal data distribution is investigated. The abnormal data (the number of stalk and leaf) was regulated by logarithmic formula. At least data analysis was done with utilizing the SAS ver. 9.1 Software. The comparison means assessed with LSD test at 99% probability level and graphs were draw with Excel Software.

Results

Freezing effect on appeared stalks number of C. acutum roots

By increasing the duration and declining the freezing temperature of *C. acutum* root, the appeared stalks number of each root is decreased (Fig. 1). Treatments at -2, -4 and -8° C temperatures for durations of 48, 24 and 6 hours respectively could reduce the appeared stalks number of each roots to the zero point, whereas in -1° C for 96 hours duration could reduce the appeared stalks number from 2.8 (in evidence treatment) to 0.2 unite (Fig. 1). Thus at -1° C the shoot emersion is observed even after passing 96 hours of freezing which explained the high resistance of *C. acutum* root to this temperature. The 6 hours period freezing at -1 and -2° C had no effect to decrease the number of appeared stalks, but temperatures of -4 and -8° C for 6 hours reduced the appeared stalks number (Fig. 1).

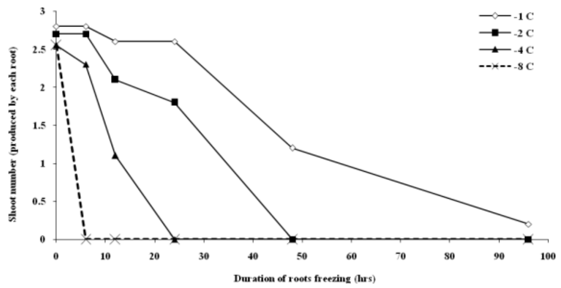

Fig. 1. The effect of root freezing temperature and duration on appeared. stalks number of *C. acutum*.

The interaction of roots freezing period and *C. acutum* on appeared stalks number of each root is showed at fig. 2. By increasing the root freezing period, the appeared stalks number of each root in both populations reduced intensively and had a nonlinear steep reduction. However, the intensity of this reduction was rather in Kerman population compared to Karaj ones due to the higher resistance of Karaj population to freezing period (Fig. 2).

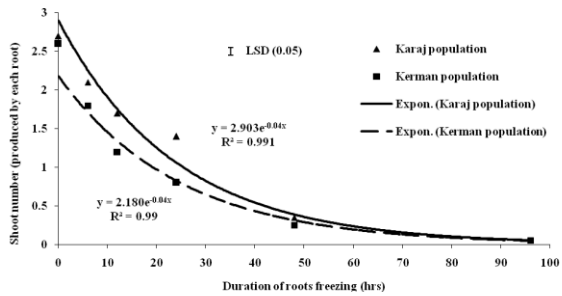

Fig. 2. The root freezing period effect on appeared stalks number of two *C. acutum* population.

Moreover, the difference between both populations was drastic in 24 hours of freezing period (then at 12 and 6 hours of freezing period this inconsistencies was observed). So that, the number of appeared root from each root after 24 hours of freezing in Karaj and Kerman population respectively achieved to 1.4 and 0.8 stalk. The difference of two populations in aspect of appeared stalks number was so trivial in evidence treatment, the mount of that was about 0.1 in 48 hours of freezing period and this factor approximately got to zero point in 96 hours of freezing period (Fig. 2).

The interaction of roots freezing temperature and *C. acutum* on appeared stalks number of each root is showed at Fig. 3. Generally, by decreasing the root freezing temperature, the appeared stalks number of each root in Karaj and Kerman population respectively showed a linear and nonlinear reduction. However, the intensity of this reduction was rather in Kerman population compared to Karaj ones due to the higher resistance of Karaj population to freezing temperature (Fig. 3). In aspect of appeared stalks number from each root, the most difference between two populations was observed at -4° C (then at -2 and -1° C); so that, at -4° C the number of appeared stalks from *C. acutum* roots in Kerman and Karaj population respectively reached to 0.87 and 1.33 stalk; and this factor at -8° C in both populations got to zero point (Fig. 3).

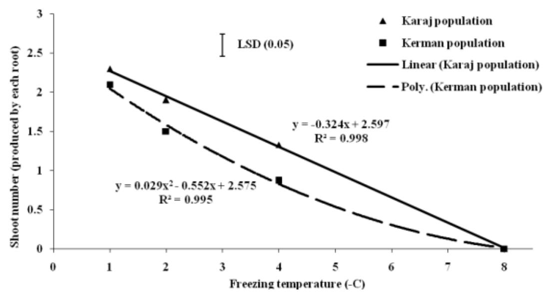

Fig. 3. The root freezing temperature effect on appeared stalks number of two *C. acutum* population.

The Freezing effect on appeared leaves number of C. acutum roots

Fig. 4 is showed by increasing the roots freezing period, the number of appeared leaves from each *C. acutum* root in two populations intensively decreased, which had a nonlinear reduction. But the intensity of leaves number reduction in Kerman population was rather than Karaj population due to high resistance of Karaj population to freezing period (Fig. 4). This inconsistency between two populations was intensified at 6 hours freezing period. Hence by increasing the freezing period, the difference between two populations reduced. The number of appeared leaves of each root after 6 hours freezing period in Karaj and Kerman population respectively achieved to 11 and 9 leaves. The difference of two populations in aspect of appeared leaves number in evidence treatment and at 48 hours freezing period was so trivial. The leaves number at 96 hours of freezing in both populations got to zero point (Fig. 4).

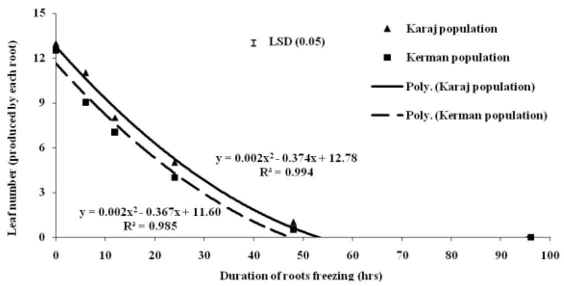

Fig. 4. The effect of root freezing period on appeared leaves number of two *C. acutum populations*.

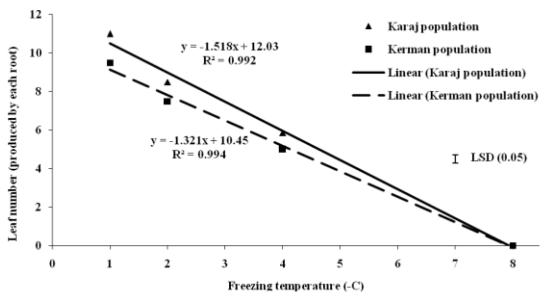

Fig. 5. The effect of root freezing temperature on appeared leaves number of two *C. acutum* populations.

By decreasing the roots freezing temperature, the number of appeared leaves from each root in two *C. acutum* populations has a linear reduction. However, the reduction rate of Karaj population was less than Kerman ones because of its rather sensitivity to freezing temperature (Fig. 5).The major difference between two populations was observed at -1° C in aspect of appeared leaves number of each root. So that, this difference at -1° C respectively reached to 9.5 and 11 leaves in Karaj and Kerman population (Fig. 3). By over decreasing of temperature, the difference between two population in aspect of appeared leaves declined and at -8° C the number of leaf in two population got to zero point.

Discussion

About *C. acutum* freezing effect on developing reproduction ability, it can be said by increasing the duration and decreasing the freezing temperature of *C. acutum*, the number of appeared stalks and leaves from each root decreased (Fig. 2 to 5); however the sensitivity of Kerman population was rather to freezing compared to Karaj ones (Fig. 3 to 5). Also the similar result is observed about the freezing effect on *Cynanchum leave* roots (Soteres and Murray, 1982). Stoller (1983) in order to investigate the freezing effect on developing reproduction ability of *Cyperus esculentus* and *Cyperus rotundus*, placed the glands of two species under the 0 to -10° C for 4, 8, 16 and 48 hours. The result of his study showed the freezing had no effect on glands germination of *C. esculentus*. Whereas, the glands of *C. rotundus* due to chilling stress were exterminated and lost their re-growth ability. The other study showed *Convolvulus arvensis* roots at -8° C experienced the entire damage, but at -6° C about half of it roots were able to germinate (Dexter, 1987). In study about the effect of chilling stress on *Cirsium arvensis* (L.) Scop roots vitality, it is proved that exposing the developing organs of this plant at -6 to -8° C for 8 hours duration make an entire extermination and also at -2° C their germination damaged intensively (Dexter, 1987). The study on *Agropyron repens* Beauv. Rhizomes showed at -7° C the reproduction ability of these organs completely devastated (Dunham *et al.*, 1986).

The physiological principle to chilling resistance in plants is utterly unknown. But the rate saturating in fatty acids can approximately justify the chilling resistance mechanism (Lyons, 1973; Schimming and Messersmith, 1988; Dexter, 1987). Unsaturated fatty acids compared to saturated ones become solid in the lower temperature. Thus; the tissues which involved the higher unsaturated fatty acid, have the lower freezing point and the higher chilling resistance. So, perceiving from status of saturated and unsaturated fatty acids in developing organs can justify its chilling resistance. The factors like territorial situation and even the existence of different weed ecotype varieties is effective in the term of chilling resistance. It is seemed that plants of cold regions presented the higher resistance to chilling due to the different factors especially physiological adaptations (Hettwer and Gerowitt, 2004). Factors like solvable glucoses, lipids and amino acids aggregation occurred in chilling to prevent ice crystal establishment in the cell and cell damage (Schimming and Messersmith, 1988; Rao and Nagarajan, 1962).

According to (Fig. 2 to 5) the highest sensitivity of *C. acutum* roots to freezing is proved especially in Kerman population. Hence, the winter's chilling water can be utilized as an appropriate solution in the term of weed management. This element is the main and effective factor to control perennial weeds in the moderate and cold regions (Dunham *et al.,* 1986; Dexter, 1987). Before the cold seasons the land can be ploughed and irrigated in order to eradicate the root fragments by freezing. Furthermore the roots can be cut to the smaller fragments to eradicate easier through the aforementioned process (Dexter, 1987).

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