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Research and Full Length Article:

Assessing the Effects of Different Incision Techniques on *Ferula assafoetida* Properties

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Abstract. The extinction of some of medical plants is not only due to the overuse of them and the grazing pressure but also their incorrect exploitation methods. *Ferula assafoetida* is one of the most important medical plants in Iranian rangelands, which is gradually disappeared from its habitats due to destructive traditional exploitations. Therefore, in order to determine how different incision techniques (exploitation methods) affect *F. assafoetida* properties, a study was carried out in the research field of Agricultural and Natural Resources Research Center in Mashad, Iran from 2009 to 2010. *F. assafoetida* plants were five years olds. The plants were cultivated in four densities in the field (25×50, 40×50, 55×50, and 70×50 cm) and four incision treatments as horizontal cutting (traditional), 45-degree cutting, concave cutting and non-incision (control) using a split plot design based on the completely randomized block design with three replications. In each plot, three plants were selected and leaf area, number of leaves, basal diameter, dry matter of post-harvest leaves and survival rate were measured. Analysis of variance of data was conducted and means comparisons were made using Duncan methods. The results showed the significant effects of incision on all the *F. assafoetida* traits ($P<0.05$). The effects of density and interactions of density by incision were not significant for all the traits. Results showed that the plants with a traditional incision had the lowest properties. It was concluded that the traditional incision method is fatal for plants and it is suggested to be replaced with 45-degree cutting method in plant density of 70×50 cm.

Key words: Asafetida, *Ferula assafoetida*, Incision methods, Survival rate.

Introduction

More than 50 percent of areas in Iran comprise the rangelands totaling about 85 million ha (Anonymous, 2016). Although livestock production is the main output of rangelands, they produce a diverse array of goods and services that are economically much more important than forage production for grazing and browsing animals and some of them are critical for human survival (Shahraki *et al.,* 2015). Iran is home to as many as 8000 plant species and 1810 of them are autochthonous (endemic) (Ghahreman and Attar, 1999); on the other hand, more than 2300 of them are used as sources of industrial chemicals, pharmaceuticals, etc. (Anonymous, 2013). Some productions of rangeland plant species like galbanum, tragacanth and asafetida are considered as export commodities (Mesdaghi, 2003). *Ferula* is a genus of about 170 species of flowering plants in the Apiaceae family, distributed throughout the Mediterranean region, eastern to central Asia while mostly growing in arid climates (Mozaffarian, 1983; Heywood, 1985). More than 30 species of the genus *Ferula* (Apiaceae) are native to Iran (Mozaffarian, 1983, 1996). The gum resin produced by many *Ferula* species has phytochemical properties that are used for medical or culinary purposes.

Ferula assafoetida is one of the native medicinal plants of Iranian rangelands with such usages as industrial chemicals. *F. assafoetida* is an herbaceous, monoecious, monocarpic, perennial plant of the Apeaceae family. *F. assafoetida* is native to the steppes in Iran and some parts of Afghanistan. The plant root is 30-40 cm in length and 10-20 cm in diameter (Zargari, 1996). Asafoetida is extracted from the *Ferula* plants which have massive taproots or carrot-shaped roots with the diameter of 12.5-15 cm at the crown when they are 4-5 years old (Mahendra and Bisht, 2012). Non-scientific and non-systematic harvests of *F. assafoetida* have destroyed many habitats of this valuable species; therefore, the areas of species habitats are declining (Beygzade *et al.,* 2015; Aghajanlou and Ghorbani, 2014; Sefidkan, 2008; Adnani *et al.,* 2005). Traditional harvest method damages the plant reproduction and reestablishment. If the traditional harvest methods are replaced with the scientific and systematic ones, regarding the economic values of the species, the sustainable exploitation can be attained while earning a good income by local people.

Asafoetida is a gum (gum resin) exuded from the top root of *F. assafoetida* by cutting plant or crashing top root with a blade. In the traditional extraction, the plants are cut off from the root crown and the cut-off surface of the root is protected from the sun. The cut will gradually exude the gum resin on the surface in the form of tears or masses of tears in various colors. Suitable utilization of *Ferula* habitats and its biodiversity preservation could introduce this plant as one of the most important items of medicinal plant export commodities of Iran that can stop the rate of rural people's immigration to cities (Khosravi and Mehrabi, 2006).

The amount of exuded gum resin from *F. assafoetida* is significantly related to the frequency of incision. Omidbaigi and Pirmoradi (2006) reported that the amount of exuded gum resin will increase till the ninth incision and then will significantly decrease till the fourteenth incision. The amount of exuded gum resin is also related to the incision methods. Omidbaigi *et al.* (2004) reported that the amounts of exuded gum resin in five methods including horizontal cutting (traditional), two-sided cutting, one-sided cutting, and vertical and mix cuttings were 9.62, 6.59, 0.39, 6.19 and 4.43 g/plant, respectively. Some studies deal with the plant survival after extraction.

Dini *et al.* (2003) examined the effect of extraction on *F. assafoetida* survival in the farm conditions. They focused their study on the effect of incision frequency on plant survival and found that there were no significance differences between incision frequencies in terms of gum resin production and plant survival. Nevertheless, three incision times had the highest gum resin production and survival rate. Shad *et al.* (1996) assessed the effects of three cutting methods as two-sided cutting, biased cutting and traditional cutting (horizontal cutting) on plant survival rate and reported that from 20 scarified plants with the first and second methods, 12 plants were survived and foliated next year but no plant survived with the traditional method. It appears that the irrigation can improve vegetative properties of *F. assafoetida* and its survival after incision but it decreases the amount of exuded gum resin form the plants (Pirmoradi *et al.*, 2014).

Horizontal incision is traditionally used to extract gum resin from plants in Iran. This means that a notch is made in the top section of the plant root and cutting the terminal bud leads to the plant death. Over time, plant species may be disappeared from the country. However, most of the rangelands are being destroyed and medicinal plants and plants with such uses as industrial chemicals are being deteriorated rapidly not only because of overharvesting, unethical and anachronistic harvests but also due to the unprincipled harvest methods. Therefore, current study was conducted to assess the effects of different incision methods on plant survival of *F. assafoetida* and to find the most proper incision method with respect to the plant survival while maximizing the gum resin production.

Materials and Methods

This research was conducted in Agricultural and Natural Resources Research Center of Khorasan Razavi, Mashad, Iran from 2009 to 2010. *F. assafoetida* plants were five years old. The plants were cultivated in four densities in the field (25×50, 40×50, 55×50, and 70×50 cm) and four incision treatments involving horizontal cutting (traditional), 45-degree cutting, concave cutting and non-incision (control) using a split plot design based on the completely randomized block design with three replications. In each plot, three plants were selected and the following traits were measured. Plant leaf area was calculated in cm^2. The number of leaves for each plant was counted too. In June when the plant leaves turned yellow, leaves were cut from the plant stem and moved to the laboratory. Each leaf was dried in an oven and its dry matter weight was determined in gram. Basal diameter of each plant was determined by measuring the diameter of root crown using calipers. The survival rate of regrown plants in the next growing season was determined by counting the number of emerged plants. Data were analyzed as the split plot design using SAS software. Means comparisons were made using the Duncan method.

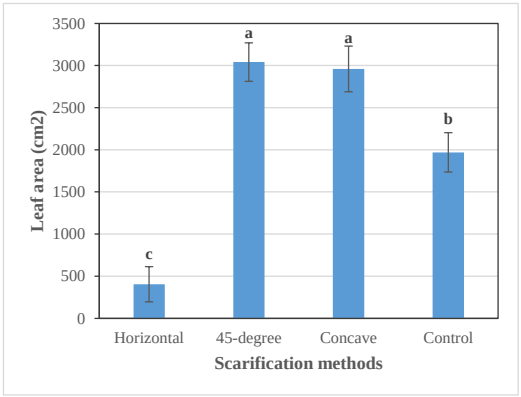
Results

Incision Effects

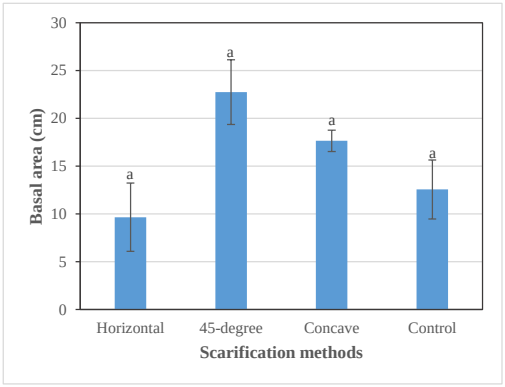
The results of analysis of variance showed significant effects of incision methods on the leaf area, basal diameter, number of leaves, plant survival rate and dry matter weight of leaf ($P<0.05$).

The results of means comparison showed that the highest leaf area with the average value of 3000 cm^2 was related to the 45-degree cutting method. The traditional method with the average value of 490 cm^2 had the lowest leaf area (Fig. 1). Results showed that the plants with traditional incision (Horizontal) and 45 degree cutting methods with the average values of 10 and 25 cm had the lowest and highest basal diameters, respectively (Fig. 1). For number of leaves, the plants with

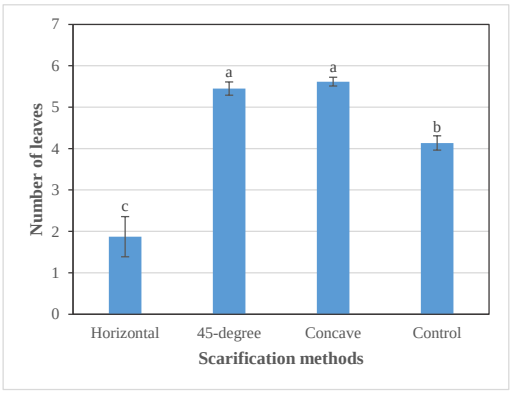
concave cutting and 45 degree cutting methods had the highest number of leaves. However, the number of leaves in plants with traditional cutting method was substantially decreased. The results showed that traditional incision method with the average value of 16.5% had the lowest survival rate (in next year after incision). As Fig. 1 shows, the less damage to terminal buds, higher survival rate. In this regard, there was no significant difference between control and plants with 45 degree cutting and concave cutting incisions in terms of survival rate. For leaf dry matter, the traditional method had the lowest leaf dry matter weight (Fig. 1).



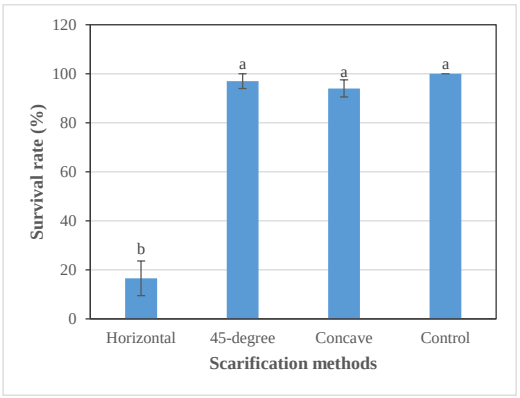
A: Leaf areas



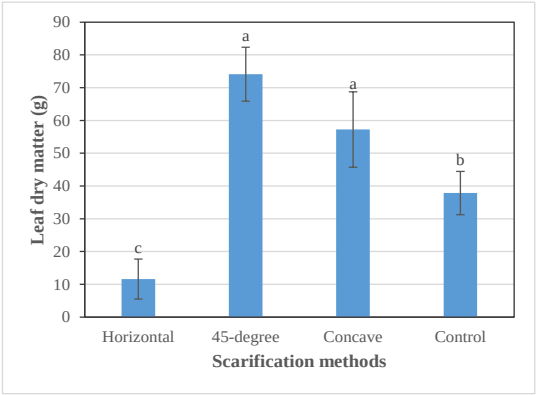
B: Basal diameters (cm)



C: Number of leaves



D: Survival rate

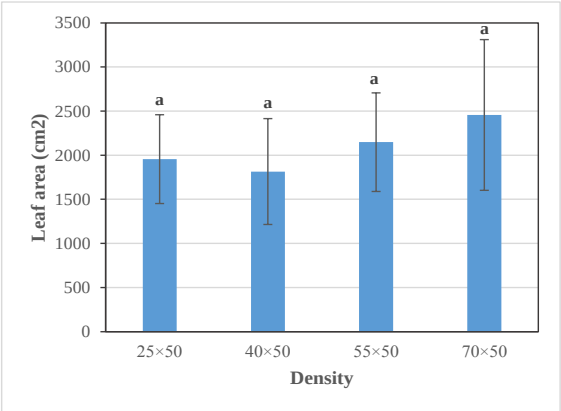


E: Leaf dry matter

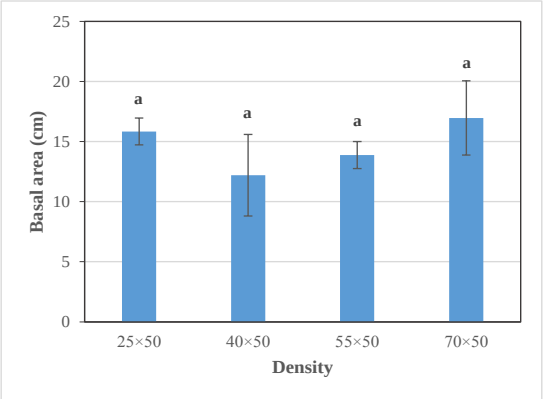
Fig. 1. Comparison of studied traits with different incision methods. Variables with different letters are significantly different (α=0.05).

Density Effects

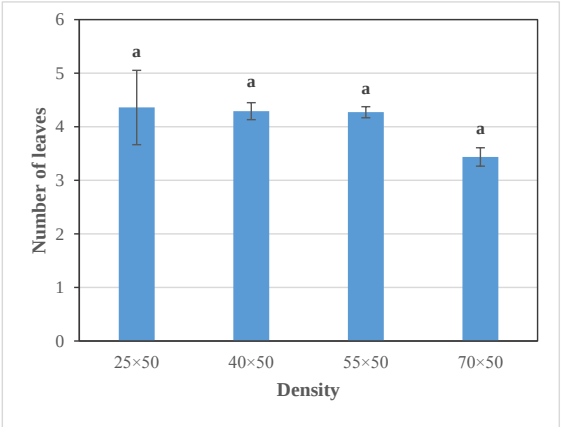
The results of analysis of variance showed no significant differences between the densities for the *F. assafoetida* traits. It seems that density had no significant effect on all the traits until the fifth year. Nevertheless, the highest survival rate belonged to the density of 50×25. The densities of 50×50 and 70×50 with 38.76 and 58.90 g/plant had the lowest and highest leaf dry matter weights, respectively (Fig. 2).



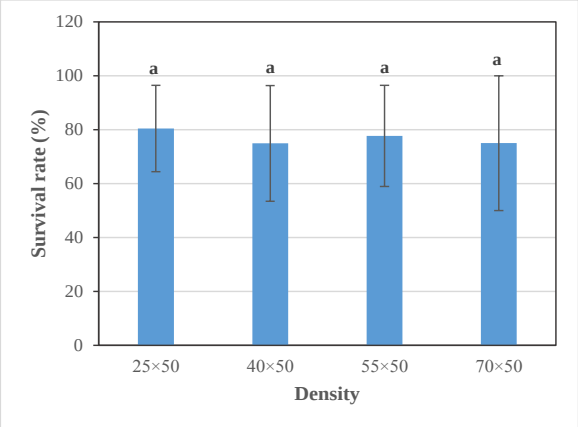
A: Leaf areas



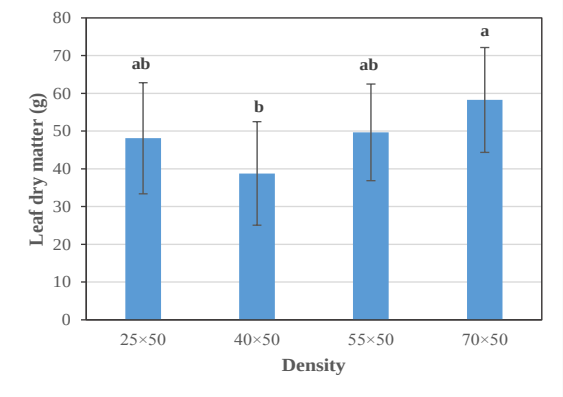
B: Basal diameters (cm)



C: Number of leaves



D: Survival rate



E: Leaf dry matter

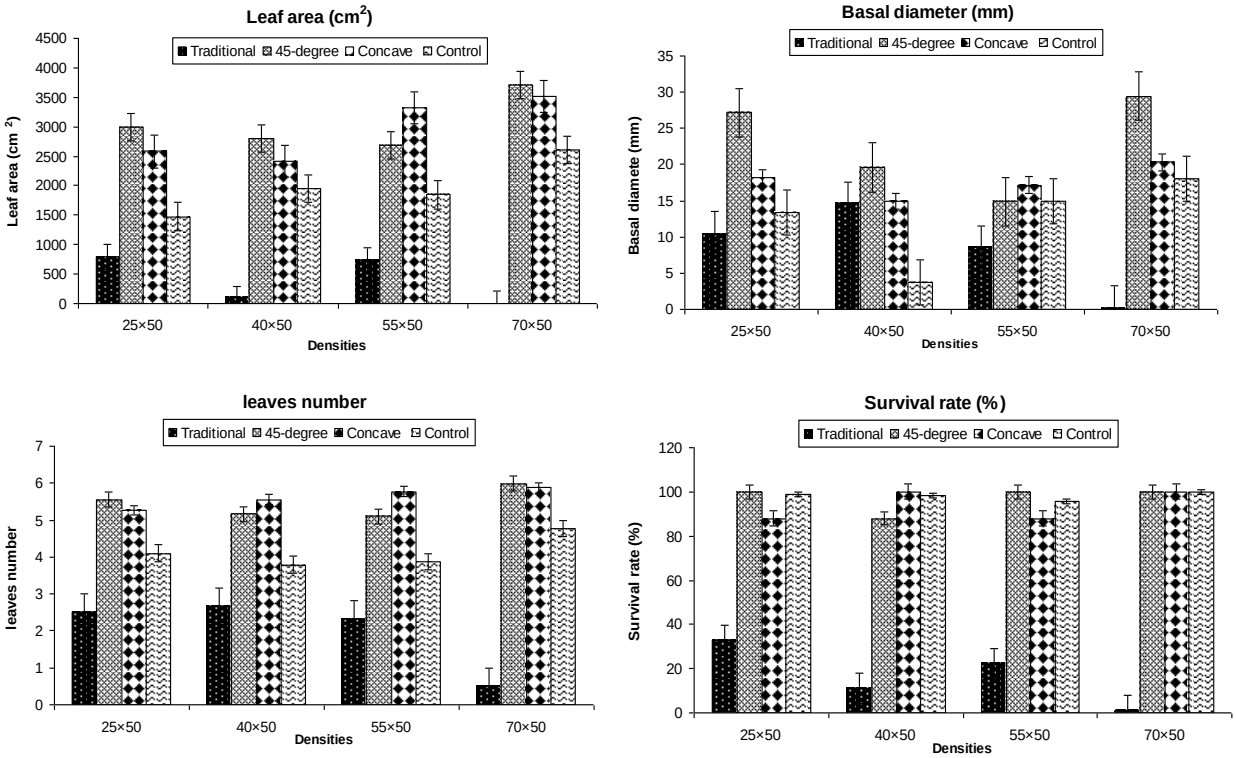
Fig. 2. Comparison of studied traits with different densities. Variables with different letters are significantly different (α=0.05).

Density and Incision Interaction Effects

The results of analysis of variance showed that there was no significant interaction between incision methods and densities regarding the *F. assafoetida* properties and their effects were additive.

The means comparison showed that the highest leaf area was related to 45-degree cutting method at 50×70 cm density. In contract, the lowest leaf area belonged to the traditional cutting method at all the densities (Fig. 3). The highest basal diameter was related to 45-degree cutting method at 50×70 cm density. In contract, the lowest basal diameter belonged to the traditional cutting method at the same density (Fig. 3). The highest and lowest numbers of leaves were related to 45-degree and traditional cutting methods at 50×70 cm density, respectively (Fig 3). The maximum plant survival rate was related to 45-degree and concave cutting methods at 50×70 cm density. In contract, the minimum plant survival rate belonged to the traditional cutting method at all the densities (Fig. 3). Leaf dry matter weight was ranked as the maximum one in 45-degree cutting method at 50×70 cm density. In contract, the minimum leaf dry matter content belonged to the traditional cutting method at all the densities (Fig. 3).

Although there was no significant difference for main effects of plant density, the results of interaction effects indicated that 45-degree method followed by concave cutting one at 50×70 cm density had higher values for most of traits than those for other densities



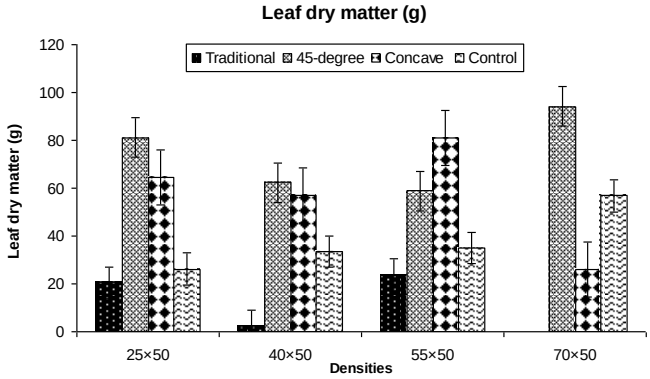


Fig. 3. Interaction between incision methods and different densities on some properties of *F. assa-foetida*

Discussion and Conclusion

Exploitation of non-forage products such as gums, manna, fruits and galls in the Iranian rangelands has been more or less common in the past but undoubtedly, these strategic ecosystems have never faced to such vulnerability and fragility. Long-term droughts, climate changes, overgrazing, pests, diseases and floods are threatening Iranian rangelands. Asafetida is one of the non-forage products of Iranian rangelands and its traditional exploitation is accompanied with making a notch on plant root crown. This kind of exploitation is fatal for plants and most of plants do not survive. Due to the incorrect exploitation of plants, i.e. wrong incision methods, and the incision of young roots in order to extract the maximum amount of asafetida, and high frequency of incision, this valuable plant species is endangered and abundance of *F. assafoetida* has sharply declined in Iranian rangelands (Omidbaigi and Pirmoradi, 2006). In order to minimize fatality rate and damages to the plants, the exploitation methods must be used to sustain the exploitation of plants and maximize the gum resin extraction while considering the plant vigor and reproduction and maximizing the plant survival rate.

As the results have shown, the incision methods had significant effects on *F. assafoetida* leaf area. So, plants with traditional cutting had the lowest leaf area. In contrast, plants with 45-degree cut had the highest leaf area (Fig. 2). It can be related to higher leaf production in the plants with 45-degree and concave cutting methods. These incision methods partially damage the root crown. It appears that this partial damage stimulates the production of vegetative buds in the next growing season. Higher number of leaves leads to higher leaf area. Therefore, the plants with 45-degree and concave cutting methods had the highest number of leaves but the plants with traditional cutting method had the least number of leaves. That is why plants with traditional cutting method had the lowest leaf dry matter content too. In addition, many plants with traditional cutting method had not survived from incision. As the extent of damage to the plant root is higher, the plant leaf dry matter content is Leaves lower. Therefore, in order to conserve the plant leaf area, partial cutting methods such as 45-degree and concave cutting methods must be used by which at least 50% of vegetative buds remain and the likelihood of plant regrowth is maximized in next growing season.

Plants with traditional cut also had the lowest basal diameter. Plants with 45-degree cut and concave cut had the highest basal diameter and had no significant differences with control plants. It can be related to the

production of more terminal buds in 45-degree and concave cutting methods. Higher amount of vegetative buds leads to higher number of leaves and consequently, higher amount of photosynthesis. Finally, higher photosynthesis leads to higher growth of roots.

Incision methods had significant effects on *F. assafoetida* survival rate. This is in accordance with other researches (Omidbaigi *et al.*, 2005; Shad, 1996). The results showed that none-scarified plants (control), and 45-degree and concave cutting methods had the highest survival rate (100%) but traditional cutting method (horizontal cutting method) had the lowest survival rate (5%). As the extent of damage to the terminal duds is lower, the plant survival rate is higher (Omidbaigi *et al.*, 2005; Dini *et al.*, 2003; Shad, 1996).

As the results showed, different densities had no significant effects on the studied traits. So, it was obvious that its interaction with different incision methods had no significant effects on the traits. However, the results of interaction effects indicated that 45-degree followed by concave cutting methods in 50×70 cm density had higher values for most of traits than other densities (Fig. 3).

The disappearance of some rangeland plants is not only due to the overuse of them but also because of non-scientific exploitation methods. It is the case about *F. assafoetida*. Our results showed that 45-degree and concave cutting methods were the best incision methods for extracting the gum resin from *F. assafoetida*. These methods do not decrease the plant survival rate, but they maintain the vegetative growth of plants. As there were no significant differences between these two incision methods, both of them are recommended to be used instead of traditional cutting method. Nevertheless, 45-degree cutting method is preferred because of its simplicity. In addition, it can be suggested to cultivate this plant to satisfy the society demands and reduce the pressure on natural habitats. These methods can only be implemented if the local populations are familiarized with the methods and their advantages.

Literature Cited

Adnani, S.M., Bashari, H., Bagheri, H., 2005. Investigation of provenance properties and some chemical components of *Ferula gumosa* Boiss. In Qom province. *Iranian Journal of Medicinal and Aromatic Plants*, 21(2): 189-206. (In Persian)

Aghajanlou, F., and Ghorbani, A., 2014. Effects of some environmental factors on *Ferula gummosa* and *Ferula ovina* distribution in Shilander mountainous rangelands of Zanjan. *Journal of Rangeland*, 9(4): 407-418. (In Persian)

Anonymous, 2013. Medicinal Plants and Traditional Medicine. National document of Supreme Council for Cultural Revolution, Available at: http://sccr.ir/Pages/simpleView.aspx?provID=1869&langid=1.htm (last access: 18 April 2016). (In Persian)

Anonymous, 2016. Rangelands. Forests, Range and Watershed Management Organization. Available at: http://frw.org.ir/00/En/StaticPages/Page.aspx?tid=13240.htm (last access: 18 April 2016).

Beygzade, Z., Melati, F., Naseri, K., Rastgoo, M., 2015. Evaluation of Emergence Characteristics and Storage Root Production of *Ferula gummosa* Boiss. Under its habitats and pot conditions. *Iranian Journal of Field Crops Research*, 13(1): 184-192. (In Persian)

Dini, M., Babakhanlo, P., Aliha, M., Golipor, M., Jafari, F., 2003. The effect of gum extraction on the survival of *Ferula gumosa* Boiss. In field. *Iranian Journal Medicinal Aromatic Plants*, 20(1): 99-109. (In Persian)

Ghahreman, A., Attar, F., 1999. Biodiversity of plant species in Iran, Tehran University Press, Tehran, Iran. (In Persian)

Heywood, V.H., 1985. Flowering Plants of the World, Croom Helm, London, 219-221.

Khosravi, H., Mehrabi, A., 2006. Economic study of *Ferula* harvesting in Tabass region. *Iranian Jour. Natural Res.*, 58(4): 933-944. (In Persian)

Mahendra, P., Bisht, S., 2012. *Ferula asafoetida*: Traditional uses and pharmacological activity. Pharmacogn Rev., 6(12): 141-146.

Mesdaghi, M., 2003. Rangeland management in Iran. Astan Ghods Razavi Press. Mashhad. (In Persian)*.*

Mozaffarian, V. 1996. A Dictionary of Iranian Plants Names, Farhang-e Moaser, Tehran, 228-230. (In Persian)

Mozaffarian, V., 1983. The Family of Umbelliferae in Iran-Keys and Distribution, Research Institute of Forest and Rangelands Press, Tehran, 114-116. (In Persian)

Omidbaigi, M., Pirmoradi, M.R. and Karimzadeh, Q. 2004. Effects of different methods of root incision on the yield and survival of asafoetida (*Ferula assafoetida* L.*). Iranian Jour. Natural Res*., 4(57): 791- 798. (In Persian)

Omidbaigi, R., Pirmoradi, M.R., 2006. A Study of the Effect of Root Diameter and Incision Time on Gum Yield in Medicinal-Rangeland Asafoetida, (*Ferula assafoetida* L) Plant. *Iranian Jour. Natural Res*., 58(4): 261-269. (In Persian)

Pirmoradi, M.R., Moghaddam, M., Navid, Y., 2014. The Effect of Different Irrigation Treatments on Resin Yield, Essential Oil Content, Morphological Traits and Survival of Bitter Asafetida (*Ferula assafoetida* L.). *Journal of range and watershed management (Iranian J. Natural Res*), 68(1): 15-24. (In Persian)

Sefidkan, F. 2008. The strategic plan of medicinal plant research. Research Institute of Forest and Rangelands (RIFR). Tehran, Iran. (In Persian)

Shad, Q., 1996. Autecology of *Ferula assafoetida* and investigation of its harvesting methods in Mohammad Abad region of Chelpo, Kashmar. MSc thesis, Gorgan University of Agricultural Sciences and Natural Resources. Gorgan, Iran. (In Persian)

Shahraki, M.R., Gholami Baghi, N., Sharafatmandrad, M., Behmanesh, B., 2015. Rangelands Goods and Services Local People Views and Priorities (Case Study: Hezarjarib Rangelands, Mazandaran Province, Iran). *Journal Rangeland Science*, 5(3): 212-221.

Zargari, A., 1996. Medicinal Plants, Tehran University Press, Tehran, Iran. (In Persian).

مطالعه اثر روش‌های مختلف تیغزنی بر برخی خصوصیات گیاه آنغوزه (*Ferula assafoetida*)

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چکیده. انقراض برخی گیاهان دارویی مراتع تنها به دلیل استفاده مفرط و فشار چرایی نبوده بلکه به دلیل شیوه‌های غلط بهره‌برداری از آنها نیز می‌باشد. گیاه آنغوزه یکی از گیاهان مهم دارویی مراتع ایران است که به دلیل روش بهره‌برداری سنتی مخرب، در حال انقراض از رویشگاه‌های طبیعی آن در کشور است. از این رو، این تحقیق به منظور تعیین اثرات روشهای مختلف تیغزنی بر برخی خصوصیات گیاه آنغوزه در مرکز تحقیقات کشاورزی و منابع طبیعی استان خراسان رضوی در سال ۱۳۸۱ تا ۱۳۸۲ انجام گرفت. در این مرکز گیاهان آنغوزه ۵ ساله بوده و قبلا با استفاده از طرح کرت‌های خرد شده در قالب بلوک‌های کامل تصادفی در سه تکرار کشت شده بودند. فاکتور اصلی تراکم کاشت در چهار سطح ۵۰×۲۵، ۵۰×۴۰، ۵۰×۵۵ و ۵۰×۷۰ سانتی متر بود. فاکتور فرعی چهار تیمار تیغ زنی شامل روش سنتی (تیغ زنی افقی)، تیغ زنی ۴۵ درجه، روش مقعر و شاهد (بدون تیغزنی) بودند. از هر کرت سه بوته انتخاب گردید و پس از اعمال تیمارهای فوق صفات تاج پوشش، تعداد برگ و سطح یقه اندازه‌گیری شدند. سپس برگ‌های گیاه جهت تعیین ماده خشک برداشت شدند و در نهایت، تعداد بوته‌های سبز شده و یا خشک شده بعد از تیغزنی به منظور تعیین درصد زنده‌مانی شمارش شدند. از آنالیز واریانس برای مقایسه اثر روش‌های مختلف تیغزنی و تراکم کاشت بر خصوصیات گیاه آنغوزه استفاده گردید. نتایج تجزیه واریانس نشان داد که اثر روش‌های مختلف تیغزنی بر کلیه خصوصیات گیاه آنغوزه در سطح ۵ درصد معنی دار بود. اما از لحاظ آماری اثر تراکم کاشت و اثر متقابل تراکم در تیغ زنی معنی‌دار نبود. با توجه به نتایج، کمترین درصد زنده‌مانی در روش سنتی مشاهده گردید و از آنجایی که روش تیغزنی سنتی برای گیاه آنغوزه مهلک است، پیشنهاد گردید که با روش تیغ زنی با برش ۴۵ درجه در تراکم ۵۰×۷۰ سانتی متر جایگزین گردد.

کلمات کلیدی: شیره آنغوزه، *Ferula assafoetida*، روش‌های تیغزنی، ، زنده‌مانی.