

EFFECTS OF DIFFERENT CUTTING METHODS AND TIMES OF
CUTTING ON GROWTH PERFORMANCE AND GUM RESIN
PRODUCTION OF *FERULA ASSA-FOETIDA*

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Abstract: *Ferula assa-foetida* L. is an important industrial and medicinal plant of Iran which is mainly distributed in arid and semi-arid areas of Khorasan province in north east of the country. Gum of this plant is widely used in pharmacological industry. This plant is endangered because of more harvesting and unsustainable harvesting methods. The objective of this study was to evaluate the effects of different cutting methods (conventional, cut of crown part, concave and surface) and times of cutting (5, 10 and 13 times) on gum yield of this species in its wild habitat in Mazar region in Bajistan. The treatments were studied under a factorial experiment which was arranged in a completely randomized design with three replications. Results showed significant differences among cutting methods and times of harvesting. Yield of gum was affected by times of harvesting and the highest yield was obtained in 10 cutting times. The highest and lowest gum yields were obtained in concave method with 10 cutting times (25.24 g/plant) and superficial method with 5 cutting times (2.02 g/plant), respectively. Results showed that conventional cutting method destroys crown buds, which causes death of the plant. The highest gum yields and the best plant regeneration rates were obtained by using of concave method with 10 cutting times.

Key words: cutting methods, asafetida, habitat, latex.

Introduction

Asafetida (*Ferula assa-foetida* L.) is the plant used for production of dried latex (gum oleoresin) exuded from the rhizome or tap root, a perennial fleshy tap root. It grows 1 to 1.5 m tall, has deeply dissected leaves, and inconspicuous yellow flowers borne in compound umbels. The bark is wrinkled

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and black and contains large amounts of thick alliaceous juice (Behpour et al., 2011; Golmohammadi, 2013).

As its name suggests, asafetida has a fetid smell but in cooked dishes it delivers a smooth flavor, reminiscent of leeks. The genus *Ferula* (*Apiaceae*) consists of about 170 species worldwide, with thirty species found in Iran, of which fifteen are endemic (Mozaffarian, 1996). Its root is erect, succulent, and nearly thick. Its leaves are gray with short hairs. It is a monocarp plant with schizocarp fruits, and it grows up to 1,000 m above sea level (Krebs, 1989). Phytochemical analyses of *Ferula* spp. confirmed the presence of 62% of resin, 25% of gum, 3-7% of essential oils, 1.28% of free acid sulfuric, and a little of vanilla. Also, some novel compounds such as sesquiterpene coumarin derivatives and sesquiterpene chromone derivatives have been isolated from the roots of *Ferula assa-foetida*. Their structures were established by comprehensive spectroscopic analysis (Bahrami et al., 2013; Meng et al., 2013).

The exudates from this plant are locally known as ‘anghuzeh’, ‘heng’ and ‘buganeh’, and have been traditionally used for treatment of a vast range of diseases: urinary, gastrointestinal, respiratory infections and epilepsy, as well as an aphrodisiac and as emmenagogues. It is used to treat snake and insect bites as well as worm infections (Hadidi et al., 2003; Shweta et al., 2011).

Ferula assa-foetida is one of the most important plants in arid regions of South Khorassan province. Local beneficiaries of the South Khorassan believe that they have a profit of 1,300 to 1,500 USD annually from gum harvesting for each family in habitats. South Khorassan province ranks third in gum production, in Iran (Golmohammadi, 2013). Unfortunately, habitats of asafetida decrease yearly, because of the conventional and non-scientific harvesting methods. Conventional harvesting of gum has some steps as identification regions, marking, twist, cutting and gum collection (Shinwari and Gilani, 2003; Golmohammadi, 2013).

A study of the effect of different methods of cutting on gum yield and *Ferula assa-foetida* survival showed that sap rate was changed from 19.6 to 62.9 g per plant by different cutting methods and times of cutting. Two-way cutting of the crown was recommended as the best cutting method (Omidbeygi and Pirmoradei, 2006). Shad (1995) reported that four cuts at harvesting period and a 6-day interval between cutting and collection is the best collection method with 5.28 g/plant gum yield. Salar et al. (2006) reported that the best harvesting age for this plant is when the plant is 5 years old or older. Askarzadeh (1999) observed a non-significant difference between different cutting methods in gum yield.

The aim of this study was to investigate the effect of cutting methods and times of cutting on yield and regeneration of this plant in wild habitat of Mazar in South Khorasan province in Iran.

Material and Methods

The main habitats of asafetida were identified according to the latest researches and field works in Razavi Khorasan province. The sample plants were selected and marked in Mazar village in Bajestan for the field studies (Figure 1).



Figure 1. The main habitats of *Ferula assa-foetida* in Mazar, Khorasan Razavi, Iran.

Plants were randomly selected and marked in the habitat. Treatments consisted of 4 harvesting methods: conventional cutting, cutting a part of crown, concave cutting, and superficial cutting and 3 different times of harvest including 5 times, 10 times and 13 times (Figure 2a-f).

The gum resin was harvested 5 days after cutting. Regeneration of the plants was checked and recorded in the following year. A factorial experiment based on a completely randomized design was used for the data analysis.

Results and Discussion

Results (Table 1) showed that both harvesting methods and cutting times have a significant effect ($p \leq 0.01$) on gum yield. The highest and the lowest yields of gum were observed in concave method and superficial method, respectively. Thirteen cutting times resulted to the highest yield of 20.93 g/plant (Figure 3). The lowest resin yield was found in the superficial cutting method (Figure 4).



a) Stoning after cutting



b) Conventional cutting method



c) Sunshade making after cutting



d) Superficial cutting method



e) Part of crown cutting method



f) Concave cutting method

Figure 2. Different cutting methods for harvesting the gum resin of asafetida.

Table 1. Analysis of variance for the gum resin yields of asafetida in different harvesting methods and cut-off frequency.

Source of variation	df	MS	Cut-off frequency
Methods of cutting	3	349.711 ^{**}	2.49 [*]
Cut-off frequency	2	2155.936 ^{**}	7.96 ^{**}
Cut-off frequency × Methods of cutting	6	32.297 ^{ns}	1.19 ^{ns}
Error	108	36.58	0.70

^{*} and ^{**}: significant at p<5% and p<1% respectively; ^{ns}: non-significant.

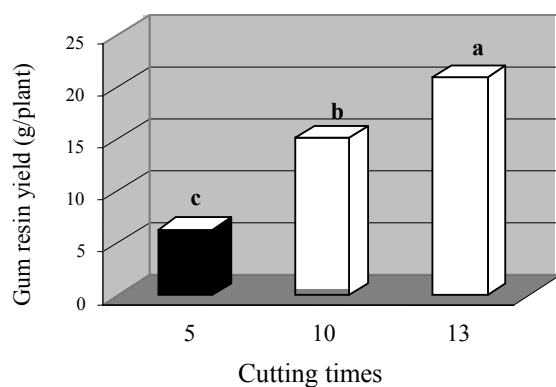


Figure 3. Gum resin yield at different times of cutting of asafetida.

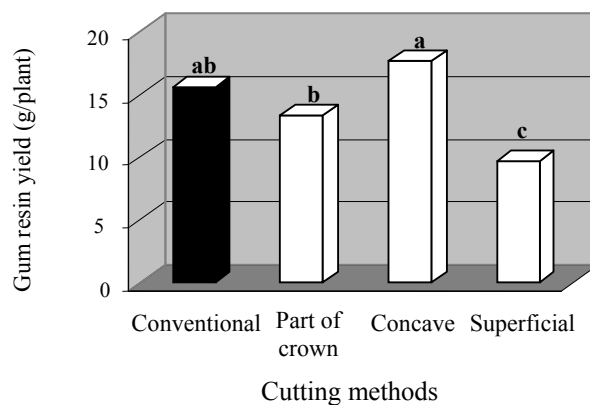


Figure 4. Gum resin yield of asafetida using different cutting methods.

The interaction between harvesting methods and times of cutting was also significant. The highest gum yield was obtained by using concave harvesting method with 10 cutting times. The lowest yield was achieved by using superficial method with 5 cutting times (Figure 5). Furthermore, 25.2 g of gum per plant was collected when using the concave method with 10 cutting times, which is a considerable amount.

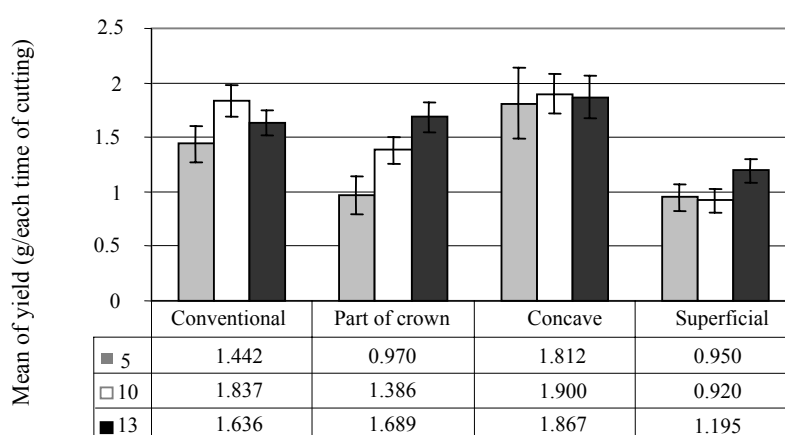


Figure 5. Interaction between cutting methods and cutting times on gum resin yield. Vertical bars indicate the standard errors.

The highest regeneration percentage (90–100%) of plant in the second year was observed in the superficial method with 5 cutting times, but in conventional cutting method with 13 cutting times, only 10% of the plants survived (Figure 6). The lowest regeneration (0–10%) was observed in conventional cutting method with 13 times of cutting (Figure 6, Table 2).

The results showed that, although conventional method mostly applied by local people provide high gum yield, this method destroys the crown buds of the plant and plant cannot survive in the next year. The best harvesting method which provides a considerable yield and also gives a chance to plants for regeneration and surviving is concave harvesting method with 10 cutting times.

The results of the study are confirmed in other studies. Shad (1995) reported that four cutting times at harvesting period with a 6-day interval between cutting and harvesting was the best collection method. He indicated that the new method of cutting increased the gum yield per plant from 2.150 g/plant in conventional

method to 3.546 g/plant. Nonetheless, Askarzadeh (1999) observed no significant differences in gum yield between different cutting methods.



Figure 6. Regeneration of the asafetida plants in the second year.

Table 2. Regeneration of asafetida plants after different cut-off frequency and cutting methods.

Cut-off frequency	Regeneration (%)	Cutting methods	Regeneration (%)
5 times	95a	Superficial cutting	80a
10 times	35.9b	Cutting a part of crown	72.51ab
13 times	7c	Concave cutting	33.43ab
		Conventional cutting	10c

Means followed by the same letter within a column are not significantly different at $P < 0.05$ according to Duncan's multiple range test.

Gums and resins form an important group of non-wood forest products. The industrial applications of gum and resin have expanded tremendously in recent years. Millions of people worldwide, especially in developing countries, depend on collection of gums, resins and latex as a means for their livelihood. Commercial tapping of gum and resin is done by making deep cuts on the crown which may disable plant regeneration. Based on the absence of cultivation of these plants, there is a grave concern about the loss of the wild germplasm. Simple and effective tapping techniques which ensure optimum yield and regeneration of tapped trees have been developed for gum, which ensures sustainable production of these materials (Balakrisnan, 2000).

Conclusion

According to the results, regeneration rate and gum production, treatment with 10 times of cutting by concave method could be the best recommendation for a sustainable production, with consequent social, environmental and global benefits. Further studies are needed to understand how to introduce *asafetida* in the cropping systems with more details on the application of organic fertilizer, cutting methods, times of cutting, gum resin yield and its differences in health benefits.

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UTICAJI RAZLIČITIH METODA SEČENJA I BROJA SEČENJA NA RAST I PROIZVODNJU GUME BILJKE *FERULA ASSA-FOETIDA*

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R e z i m e

Ferula assa-foetida L. je važna industrijska i lekovita biljka u Iranu koja je uglavnom rasprostranjena u aridnim i semiaridnim područjima pokrajine Horasan u severoistočnom delu zemlje. Guma ove biljke ima široku upotrebu u farmaceutskoj industriji. Ova biljka je ugrožena zbog sve veće seče i neodgovarajućih metoda sečenja. Cilj ovog rada je bio da se ocene uticaji različitih metoda sečenja (konvencionalni metod, sečenje krune, konkavno i površinsko sečenje) i broja sečenja (5, 10 i 13 puta) na prinos gume ove vrste u njenom prirodnom staništu u oblasti Mazar u Badžestanskom okrugu. Tretmani su proučavani u faktorijskom eksperimentu koji je postavljen po metodu blok sistema sa potpuno slučajnim rasporedom u tri ponavljanja. Rezultati su pokazali značajne razlike među metodama i brojem sečenja. Prinos gume je bio uslovljen brojem sečenja i najviši prinos je dobijen primenom deset sečenja. Najviši i najniži prinosi gume su uočeni kod konkavnog metoda sa 10 sečenja (25,24 g po biljci) odnosno kod površinske metode sa 5 sečenja (2,02 g po biljci). Rezultati su pokazali da konvencionalna metoda sečenja uništava pupoljke u kruni, što uzrokuje i uginuće biljke. Najviši prinosi gume i najbolja regeneracija biljaka su postignuti korišćenjem konkavnog metoda sa 10 sečenja.

Ključne reči: metode sečenja, asafetida, stanište, lateks.

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