BAHÇE 49 (Özel Sayı 1: II. Uluslararası Tarım Kongresi (UTAK 2019)): 13–17 (2020)
ISSN 1300–8943

VARIOUS SCARIFICATION METHODS FOR REDUCING OF HARD SEED IN CICER MILKVETCH (*Astragalus cicer*)

Berna EFE[1], Sabahaddin ÜNAL[2]

[1]Field Crops Central Research Institute, Ankara; ORCID: 0000-0003-2207-6543
[2]Abant Izzet Baysal University Faculty of Agriculture and Natural Sciences, Bolu; ORCID: 0000-0003-3771-4536
Geliş Tarihi / Received: 24.11.2019 *Kabul Tarihi / Accepted: 30.01.2020*

ABSTRACT

Cicer Milkvetch is a legume forage crop having long life- perennial, resistance to cold, non-bloat for animals. The establishment of legume forage crops is very difficult. One of the major constraints in successful stand establishment of forage legumes is hard seed. This trait inhibits and delays the emergence of plant seedling. It leads poor plant growth and low weed competition moreover it causes low yield and poor quality of herbage. For this reason, detecting and knowing of hard seed rates of plant species for sowing rate, uniform emergence and perfect stand establishment are significant. Various methods are used for identifying this rate. In this study, the effects of various scarification methods on hard seed in Cicer Milkvetch were investigated. This test in completely randomized plot design in Lutana variety with four replications was conducted in the department of forage crops and meadow-rangeland in the Central Research Institute for Field Crops in 2018. Treatments are counted following as treatment 1 (heat 1), treatment 2 (heat 2), treatment 3 (freeze-thaw), treatment 4 (mechanical method), treatment 5 (heat 1 + mechanical method), treatment 6 (heat 2 + mechanical method), treatment 7 (freeze-thaw + mechanical method) and treatment 8 (control). When evaluated study results, treatment 3 (57.2%) and treatment 7 (61.6%) negatively effected for seed germination rate and caused a significant decrease in seed germination rate compared to control (81.7%). Other 5 treatments reasoned positively effect on germination seed rate and led an increase in that. The highest germination rate was obtained from treatment 1 (97.0%) and after that treatment 6 (90.0%) was followed it. As a result, mechanical method and heat treatment or combinations of both may be advised to reduce hard seed impact in Cicer Milkvetch.

Keywords: Cicer milkvetch, hard seed, scarification methods, germination rate

NOHUT GEVENİNDE (*Astragalus cicer*) SERT TOHUMLUĞUN AZALTILMASI İÇİN ÇEŞİTLİ TOHUM KABUĞU İNCELTME METOTLARI

ÖZ

Nohut geveni uzun ömürlü, soğuğa dirençli, hayvanlarda şişkinlik yapmayan bir baklagil yem bitkisidir. Baklagil yem bitkilerinin tesis edilmesi çok zordur. Baklagil yem bitkilerinin başarılı bir şekilde tesis edilmesinde en önemli kısıtlamalardan biri sert tohumluktur. Bu özellik bitki fidelerinin çıkışını engeller ve geciktirir. Zayıf bitki gelişimi ve düşük yabancı ot rekabeti sağlar, bunun yanında düşük verim ve düşük ot kalitesine neden olur. Bu nedenle bitki türlerinin sert tohumluk oranlarının belirlenmesi ve bilinmesi ekilecek tohum miktarı, uniform çıkış ve uygun tesis yönünden önemlidir. Bu oranın tespit edilmesi için farklı yöntemler kullanılmaktadır. Bu çalışmada, nohut geveninde çeşitli tohum kabuğu inceltme yöntemlerinin sert tohumluk üzerindeki etkileri araştırılmıştır. Bu test 2018 yılında Tarla Bitkileri Merkez Araştırma Enstitüsü Müdürlüğü Çayır Mera ve Yem Bitkileri Bölümünde Lutana çeşidinde tesadüf parselleri deneme desenine göre dört tekerrürlü olarak yapılmıştır. Uygulamalar aşağıdaki gibi sayılmaktadır; uygulama 1 (sıcak 1), uygulama 2 (sıcak 2), uygulama 3 (donma-çözülme), uygulama 4 (mekanik yöntem), uygulama 5 (sıcak 1 + mekanik yöntem), uygulama 6 (sıcak 2 + mekanik yöntem), uygulama 7 (donma-çözülme + mekanik yöntem) ve uygulama 8 (kontrol). Çalışma sonuçları değerlendirildiğinde, tohum çimlenme oranı için uygulama 3 (%57.2) ve uygulama 7 (%61.6) olumsuz yönde etkilenmiş ve tohum çimlenme oranının kontrole (%81.7) kıyasla önemli ölçüde azalmasına neden olmuştur. Diğer 5 uygulama, tohum çimlenme oranı üzerinde olumlu bir etkiye neden olmuş ve bunun artmasına yol açmıştır. En yüksek çimlenme oranı 1. uygulamadan (%97.0) elde edilmiştir ve bundan sonra 6. uygulama (%90.0) bunu takip etmiştir. Sonuç olarak, nohut geveninde sert tohumluk etkisini azaltmak için mekanik yöntem ve sıcak uygulamaları veya her ikisinin kombinasyonları önerilebilir.

Anahtar Kelimeler: Nohut geveni, sert tohumluk, tohum kabuğu inceltme metotları, çimlenme oranı

[1]Sorumlu yazar / *Corresponding author*: bernaefe85@gmail.com

INTRODUCTION

Legume is a member of the *Fabaceae* family which covers 700 genera and about 19.000 species [10]. Many species from this family have been economically significant to humans since last 3000 years when wild *Fabaceae* family was domesticated in America and Asia [14]. By the early 21st century, legume production area has covered approximately 15% of the earth's surface [10, 15].

Legumes such as cicer milkvetch are often grown with grasses and alone to provide nitrogen, thereby reducing the requirement for inorganic supplemental nitrogen material [21] and at the same time increasing total dry matter and protein content of the forage crops.

Cicer milkvetch owns many good qualities that make it a viable choice as a non-bloat legume for hay or pasture. Yields of that are generally comparable to those of alfalfa in many areas with longer growing seasons [4]. Hard seed ness is a genetic character for some legume plant species such as *Medicago species*, *Trifolium species* and *Astragalus species* [18, 15]. Seed scarification, a physical damage to break the hard seed coat without reducing the quality of seeds, has been investigated for more than a century. Seed scarification methods have been improved and changed over time to make these more practical, effective and easy [9, 8, 15].

Many seed scarification methods for *Astragalus species* have been used so far following as heat scarification, freeze -thaw scarification, mechanical scarification and acid scarification. Moreover, many seed scarification treatments for various *Astragalus species* have been discovered in the literature, including dry heat [2], wet heat [1], stratification [16], physical scarification [17], acid [16] smoke water [7], etc. At the same time, various temperatures and different counting days for germination of legume seeds were studied [23]. The aims of this study were to detect available methods or treatments for seed scarification and apply this on forage legume seeds to increase seedling rate, emergence rate, field germination and eventual advance stand establishment.

MATERIAL AND METHOD

Material

This study was carried out under the laboratory condition of the Central Research Institute for Field Crops in 2018. Lutana variety was used as material in experiment.

Method

This test in completely randomized plot design with four replications was conducted.

In this study, the eight treatments covering control with heat, freeze-thaw, mechanical method and their combinations for remove of hard seed effect were implemented. Each plot had 25 seeds and total number of this experiment was 800 seeds.

Treatments are counted following as treatment 1 (heat 1), treatment 2 (heat 1), treatment 3 (freeze-thaw), treatment 4 (mechanical method), treatment 5 (heat 1 + mechanical method), treatment 6 (heat 2 + mechanical method), treatment 7 (freeze-thaw + mechanical method) and treatment 8 (control) (Table 1).

All data were performed with analysis of variance and later averages were grouped using LSD (0.05) test. Then cluster Analysis was made with Euclidean Distance and Complete Linkage.

Table 1. Experiment treatments and their explanations

No	Treatments	Explanations
1	Heat 1	Seeds were put in hot water bath having a temperate of 80°C for 10 minutes [6].
2	Heat 2	Seeds were put in oven with a temperate of 60°C for an hour [13].
3	Freeze-thaw	Seeds were kept in dry ice condition (-20°C) for 5 days and melt in room condition [5].
4	Mechanical	The coat of seeds was scarified as mechanical or physical damage [13].
5	Heat 1 + Mechanical	First mechanical treatment was applied to the seeds and then second heat 1 treatment was implemented.
6	Heat 2 + Mechanical	First mechanical treatment was applied to the seeds and then heat 2 treatment second was realized.
7	Freeze-thaw + Mechanical	First mechanical treatment was applied on seeds and then second freeze-thaw treatment was implemented.
8	Control	No application was made to the seeds in the control process, but germinated at room temperature.

RESULTS AND DISCUSSIONS

Germination Rates

Germination rates (GRs) at the treatments were statistically analyzed (Table 2). Mean GR was 81.0%. The GRs of the highest, and the lowest were 97.0% and 57.2%, respectively. First group treatments, called a group (1, 6, 4 and 2), covered four GRs between 97.0% and 88.0%. Second group, AB included in GRs between 90.0% and 88.00%. Third group, B contain GRs between 90.0% and 81.7%. Last group, C had GRs between 61.6% and 57.2%. Two treatments as freeze-thaw and freeze-thaw + mechanical negatively effected to GR. All other treatments positively influenced GR. Heat and mechanical treatments stimulated GR. Treatments and their effects in hard seed scarification are discussed and commented in different ways by authors. They are obtained under the following subjects such as heat, freeze-thaw and mechanical applications. Heat scarification using the dry heat in oven seems to be effective on hard seed reduction and germination improvement when appropriate treatment time and temperature are used [11, 20]. The variation in GR may be caused by the difference in seed coat structures [15]. Statwick [22] recommended that firstly *Astragalus* rare species be pre-treated using physical scarification, secondly other methods should be optimized for wasting precious time and seeds, then they should be used. Austin [3] found that the practicality of scarification raised the levels of germination. Zarekia et al. [25] advised that mechanical seed scarification be performed before planting herbaceous *Astragalus*. Researches showed that seed scarification could increase seed germination percentage of *Astragalus* species [12, 24].

The GRs of the eight treatments are shown in the graph and these applications are clearly visible and comparable to each other (Figure 1). The three and seven of treatments are clearly seen that lower GTs than others. The five treatments (1, 2, 4, 5 and 6) had more GRs than 81.7%.

Cluster Analysis for Germination Rates

Similarity and distance levels of treatments were detected by Cluster Analysis (Table 3).

Similarity and distance levels of the highest and the lowest are 94.97% and 0.00%; 39.83% and 2.00%, respectively. There appears highest similarity level (94.97%) between the treatments of 2 and 4. There occur the lowest similarity levels such as 57.72% and 0.00% between treatment 1 and treatment 2, 3, respectively. There seem the highest distance levels such as 16.83% and 39.83% between treatment 1 and treatment 2, 3, respectively.

In this study, two main groups are divided according to similarity levels for GRs of 8 treatments (Figure 2). Treatments in the first main group were divided into two sub-group. First sub group had only treatment 1, second sub group owned as the treatments of 2, 4, 5, 6 and 8 numbers. This sub group was also divided into two various group having the treatments of 2, 4, 6 numbers and 5, 8 numbers. The second main group had two treatments such as 3 and 7 numbers.

Table 2. Analysis of variance

Treatments	Germination rates (%)	Groups
1	97.0	A
6	90.0	AB
4	88.0	AB
2	88.0	AB
5	84.7	B
8	81.7	B
7	61.6	C
3	57.2	C
Averages	81.0	
F (treatment, 0.05)	13.11**	
LSD (0.05)	11.44	
CV %	9.61	

**Significant at the 1% level of significance.

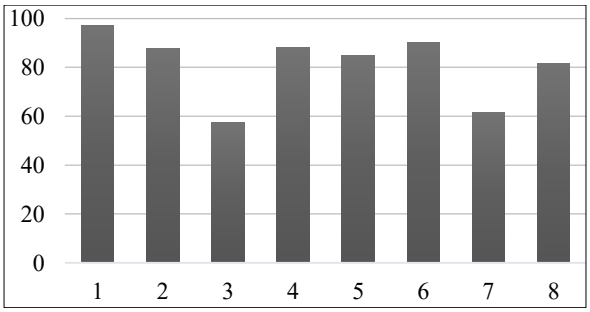

Figure 1. Germination rates at the various treatments

Table 3. Similarity and distance levels of treatments in cluster analysis

Treatments		Similarity level (%)	Distance level (%)
2	4	94.97	2.00
5	8	89.31	4.25
2	6	88.72	4.49
3	7	85.07	5.94
2	5	78.20	8.67
1	2	57.72	16.83
1	3	0.00	39.83

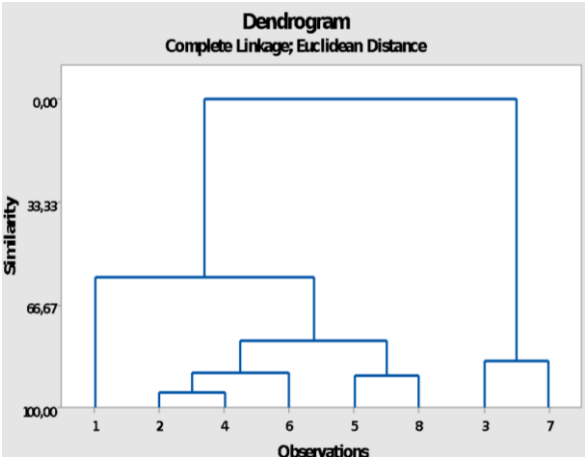

Figure 2. Dendrogram for treatments according to similarity

CONCLUSIONS

In this study, 8 various treatments were implemented for determining of their effects in hard seed rate of Cicer Milkvetch. These treatments were compared with control (no any application). The study results indicated that mechanical method and heat treatments or combinations of both reduced hard seed impact in Cicer Milkvetch. Moreover, the freeze-thaw and freeze thaw + mechanical method caused high hard seed rate in that.

REFERENCES

1. Acharya, S.N., Kastelic, J.P., Beauchemin, K.A., Messenger, D.F., 2006. A review of research progress on cicer milkvetch (*Astragalus cicer* L.). *Can. J. Plant Sci. 86:49-62.*
2. Albrecht, M.A., Penzagos, J.C.Z., 2012. Seed germination ecology of three imperiled plants of rock outcrops in the southeastern United States. *Journal of the Torrey Botanical Society 139(1):86-95. (doi:10.3159/torrey-d-11-00066.1).*
3. Austin, R.D., 1969. Evaluations on germination procedure, mechanical scarification and environmental variation on germination of cicer milkvetch (*Astragalus cicer* L.) seed.
4. Baldridge, D.E., R.G. Lohmiller, eds. 1990. Montana interagency plant materials handbook. *Montana State University, Bozeman, MT. 337p.*
5. Busse, W.F., 1930. Effect of low temperatures on germination of impermeable seeds. *Bot. Gazette, 89:169-179.*
6. Can, E., Çeliktaş, N., Hatipoğlu, R., Avcı, S., 2009. Breaking seed dormancy of some annual medicago and trifolium species by different treatments. *Turk. J. Crops 14(2):72-78.*
7. Chou, Y.F., Cox, R.D., Wester, D.B., 2012. Smoke water and heat shock influence germination of shortgrass prairie species. *Rangeland Ecology & Management 65(3): 260-267 (doi:10.2111/rem-d-11-00093.1).*
8. Dittus, D.A., Muir, J.P., 2010. Breaking germination dormancy of Texas native perennial herbaceous legumes. *Native Plants 11:5-10.*
9. Dixon, H.H., 1901. Vitality of seeds. *Nature 64:256-257.*
10. Graham, P.H., Vance, C.P., 2003. Legumes: Importance and constraints to greather utilization. *Plant Physiol. 131:872-877.*
11. Harrington, G.T., 1916. Agricultural value of impermeable seeds. J. Agric. Res., 6: 761-796.
12. Isivand, H.R., Arefi, H.M., Afshari, R.T., 2006. The investigation of seed germination and breaking dormancy in *Astragalus siliquosus*. *Iranian Jour. Rangelands and Forests Plant Breeding and Genetic Research 13:84-67. (In Persian).*
13. Islam, M.A., Kimura, E., 2010. Enhancing establishment of forage legumes through seed scarification and use of cover crop. *Reflections, pp:38-4.*
14. Kaplan, L., Lynch, T.F., 1999. Phaseolus (fabaceae) in archaeology: AMS radiocarbon dates and their significance for pre-Colombian agriculture. *Econ. Bot. 53:261-272.*
15. Kimura, E., Islam, M.A., 2012. Seed scarification methods and their use in forage legumes. *Res. J. Seed Sci. 5(2):38-50.*
16. Long, Y., Tan D.Y., Baskin C.C., Baskin J.M., 2012. Seed dormancy and germination characteristics of *Astragalus arpilobus* (*Fabaceae*, subfamily *Papilionoideae*), a central Asian desert annual ephemeral. *S. Afr. J. Bot. 83:68-77.*
17. Miklas, P.N., Townsend, C.E., Ladd, S.I., 1987. Seed coat anatomy and the scarification of cicer milkvetch. *Crop Science 27(4):766-772 (doi:10.2135/cropsci1987.0011183x002700040032x).*
18. Miller, D.A., Hoveland, C.S., 1995. Other temperate legumes. *Forages, The Science of*

Grassland Agriculture, Edi: Barnes R.F., Miller, D.A. and Nelson C.J., 1:273-281.

19. Rincker, C.M., 1954. Effect of heat on impermeable seeds of alfalfa, sweet clover and red clover. *Agron. J. 46:247-250.*
20. Rutar, R., Stjepanovic, M., Popovic, S., Bukvic, Z., Pacek, D., 2001. Effect of temperature on germination and hard alfalfa seed. *CIHEAM 2:137-139.*
21. Smoliak, S., Hanna, M.R., 1977. Seedling competition some forage legumes mono and mixed culture under greenhouse conditions. *Can. J. Plant Sci. 57:897-903.*
22. Statwick, J.M., 2016. Germination pretreatments to break hard-seed dormancy in *Astragalus cicer* L. (*Fabaceae*). *Peer J. 4: e2621; (doi: 10.7717/peerj.2621).*
23. Townsend, C.E., McGinnies, W.J., 1972. Temperature requirements for seed germination of several forage legumes. *Agronomy Journal 64(6):809-812.*
24. Zarekia, A., Jafari, A., Zandi Esfahan, E., Fallah Hosseini, L., 2013. Study on germination of some perennial herbaceous *Astragalus*. *Iranian Jour. Range and Desert Research. 20(1):88-100. (In Persian).*
25. Zarekia, S., Jafari, A.A., Esfahan, E.Z., 2014. Effects of seed scarification on vegetation parameters in some *Astragalus* species under field conditions (Case Study: Homand Absard, Damavand, Iran). *Journal of Rangeland Science 4(2):151-158.*