##### **Running Title:**

##### **IMPROVING SEED GERMINATION OF**

**BLADDER-SENNA (*Colutea armena* Boiss. & Huet.)**

**EFFECTS OF DIFFERENT SOWING DEPTHS AND GROWING MEDIA ON GERMINATION OF BLADDER-SENNA (*Colutea armena* Boiss. & Huet.) SEEDS**

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**Effects of Different Sowing Depths and Growing Media on Germination of Bladder-senna (*Colutea armena* Boiss. & Huet.) Seeds**

**ABSTRACT**

This study was carried out to determine which sowing depth and growing medium should be preferred to increase germination percentage of *Colutea armena* seeds. Treatments applied to the seeds were 3 different sowing depths (0.5 cm, 1 cm and 1.5 cm) and 4 different growing media (forest soil+sand+manure (2:1:1); peat+manure (2:1); peat+perlite+manure (2:1:1) and peat+forest soil+manure (1:1:1)). The seeds were submersed in concentrated (98%) sulphuric acid for 30 minutes to overcome seed dormancy. The seeds were sown in pot-trays at 24±1°C in the greenhouse. The statistical approach was a randomized complete block design with three replications and 60 seeds were used for each replication. Germinated seeds were observed periodically during 42 days to determine germination percentages and germination rates. Both the highest germination percentage (31.1%) and germination rate (9 days) were obtained in seeds which were sown in the medium of forest soil+sand+manure (2:1:1), in 0.5 cm-sowing depth. On the other hand, the lowest germination percentage (2.8%) was determined from the seeds which were sown in 1 cm-depth in the growing medium of peat+manure (2:1).

**Key words**: *Colutea armena*, germination, sowing depth, growing media

**INTRODUCTION**

Vegetation cover is one of the most important factors in preventing and controlling soil erosion. It gives long-term soil surface protection by providing leaf cover that reduces rain-drop effects. In addition, it helps better soil structure development through establishing a root system, thereby increasing infiltration and soil stability (Pritchett and Fisher, 1987). The genus *Colutea* L. (bladder-senna) includes about 26 species of deciduous shrubs and small trees with a distribution ranging from the Mediterranean region and South-Eastern Europe and North-West Africa (Browicz, 1963). *Colutea armena* (Boiss. & Huet.) is a drought-tolerant plant occurring in rocky and steep landscapes and is known as an important species in preventing soil erosion (Dirr, 1990; Pijut, 2008). *Colutea* species are cultivated in temperate climates primarily for ornamental purposes (Rudolf, 1974; Krüsmann, 1984; Pijut, 2008*). C. arborescens*’ potential as a forage crop was investigated in Spain (Allue Andrade, 1983).

Seeds of many woody plant species cannot germinate even if they are sown under optimal moisture, oxygen and soil conditions (Ürgenç and Çepel, 2001). This problem is called dormancy and its causes are a hard and impermeable seed coat, immature or dormant embryo, absence of endosperm, or thick, fleshy seed cover (ISTA, 1993). Poulsen (1996) reported that dormancy among and within seed lots of the same species varies with provenance, crop year, and individual trees. In addition to this, seedling growing medium and sowing depth of seeds have very important effect on germination percentage and germination rate of seeds (Yahyaoğlu and Ölmez, 2005; Genç and Yahyaoğlu, 2007; Ayan, 2007; Asgharipour, 2011).

There are various germination obstacles in *Colutea* seeds resulting in propagation difficulties (Dirr and Heuser, 1987; Dirr, 1990; Olmez et al. 2007a). A few studies have tried to determine different methods and techniques to overcome seed dormancy in *Colutea* species. The methods and techniques, especially cold stratification and submersion in concentrated H2SO4 are well-known and used to increase germination percentage of *Colutea* seeds (Piotto et al., 2003; Olmez et al., 2007a; Olmez et al., 2007b; Olmez et al., 2008; Olmez and Gokturk, 2009).

The properties of growing media are becoming more and more important for optimal plant growth. A grower requires well prepared growing media which have constant properties the year round (Verdonck and Gabriels, 1988). Horticultural substrates differ from soils because they are removed from their original places or which are produced artificially. Growing media include as well the long-time known horticultural soils which consist out mainly natural organic matter (pine and leaf moulds, all kinds of composts), as the peaty substrates which became more important as artificial substrates (foam plastics, vermiculite, rockwool etc.). (Verdonck et al., 1981). A good growth medium for germination is provided by choosing an appropriate substrate and by appropriate soil preparation and management. For most species sand may be used to improve drainage and aeration. Peat or other material with high organic content improves the water retention capacity. Forest soil is often used as potting media, since it is rich in both organic material and nutrients as well as containing mycorrhiza and other beneficial soil symbionts (Schmidt, 2000).

The aim of this study was to examine the influence of four different growing media (forest soil+sand+manure (2:1:1); peat+manure (2:1); peat+perlite+manure (2:1:1) and peat+forest soil+manure (1:1:1)) and three different sowing depths on germination of *C. armena* seeds.

**MATERIAL AND METHODS**

Ripe fruits were collected in August 2012 from *Colutea armena* individuals (Exposure: South-west, Altitude: 440 m, Latitude: 41° 11' 40" N, Longitude: 41° 50' 65" E) in Artvin located in the North-Eastern part of Turkey. The seeds were separated from the fruit material, rinsed with tap water, dried in the shade, and stored at 4±1°C in plastic bags after the ratios of filled seeds to all the collected seeds were determined.

The following pre-treatments were applied to determine their effects on germination percentage and germination rate of *C. armena* seeds;

* Growing media (forest soil+sand+manure (2:1:1); peat+manure (2:1); peat+perlite+manure (2:1:1) and peat+forest soil+manure (1:1:1)),
* Sowing depths (0.5 cm, 1.0 cm and 1.5 cm).

The seeds were submersed in concentrated (98%) sulphuric acid for 30 minutes (Olmez et al., 2007a) before they were sown in pot-trays.

Seeds were sown into the pot-trays filled with four different growing media, at 24±1°C and 65% humidity in the controlled greenhouse conditions. The experimental design was a randomized complete block with three replications (60 seeds in each replication) for each treatment. Numbers of germinated seeds (evaluation done according to ISTA Rules (1993)) were recorded for 4th, 7th, 10th, 14th and 21st days after the sowing, and recording continued weekly after the 21st day for 42 days.

The GP and GR values were determined for each pre-treatment. The formula used in determining GR values is as follows (Pieper, 1952);



Where;

*GR:* Germination rate

*n:* Number of days for each counting of germinated seeds

*t:* Number of germinated seeds at each counting day

T: Total number of germinated seeds

The whole experiment lasted for 42 days when it was observed that the seeds had stopped germinating. Data from the treatments were analyzed using the SPSS statistical software after arc-sinus transformation was applied to GP values to meet ANOVA assumptions. The multifactor ANOVA and Duncan’s tests were used to compare treatment groups to find out whether they showed any statistically significant differences with significance level (α) set at 0.05.

**RESULTS AND DISCUSSION**

The physical structure of the medium in which seeds are germinated is crucial both for germination and early seedling establishment. A good seed-bed should provide a balance between moisture and aeration. In addition to this, the optimal seeding depth varies with species and it depends on the size of the seeds (Schmidt, 2000). The main purpose of this study was to examine the influence of different growing media and sowing depth on germination percentage and germination rate of *C. armena*. Four substrate components were mixed at different ratios of peat, manure, perlite, forest soil and sand and used three sowing depth.

According to some researchers, *Colutea* spp. seeds did not germinate easily unless the impermeable seed coat was ruptured by mechanical or chemical scarification (Dirr, 1990; Olmez et al., 2007a). For that reason, the seeds were sown in the pot-trays after sulphuric acid scarification for 30 minutes.

Statistical analyses showed that both the highest germination percentage (31.1%) and the best germination rate values (9 days) were obtained from the growing medium of forest soil+sand+manure (2:1:1) and sown in depth of 0.5 cm. At the opposite, the lowest germination percentage (7.03%) was determined from the seeds which were sown in the substrate of peat+manure (2:1) combination (Table 1, Figure 1). It could be said that the mixture of forest soil, sand and manure (2:1:1), having a water retention and porosity better than peat, gave good results, in particular on *C. armena*. D’Angelo and Titone (1988) implied that observations of plants have revealed that a ratio of 30% peat is sufficient to assure good water retention. Best draining components were perlite and argex, used at a percentage not higher than 20%. In our study, the maximum germination percentage value among the growing media including the ratio of 33% peat was 22.8% (Peat+forest soil+manure (1:1:1)) for the seeds that were sown in 0.5 cm-depth (Table 1). This finding is consistent with the results stated by D’Angelo and Titone (1988) and Ayan (2007).

While the treatments including forest soil gave better germination percentages ranging from 18.9% to 31.1%, 0.5 cm-sowing depth gave the best germination percentage and germination rate results (Table 1).

Consequently, among all the treatments applied to the *C. armena* seeds, the growing medium of forest soil+sand+manure (2:1:1) and sowing depth of 0.5 cm resulted in the highest germination percentage (31.1%) and the shortest time before maximum germination rate (9 days). It is followed by the treatment of sowing in peat+forest soil+manure (1:1:1) and in 0.5 cm-depth with 22.8% of germination percentage and 14 days before maximum of germination rate. Therefore, these results indicate that the substrate by including forest soil, sand and manure (2:1:1) and sowing in depth of 0.5 cm should be used to obtain a good germination from *C. armena* seeds.

**REFERENCES**

Allue Andrade J.L. (1983). Morfoligia clases, atributos, dificultades tratamientos en la produccion germinacion de las semillas de *Colutea arborescens* L. (Morphology, types, attributes, difficulties and treatments in production and germination of seeds of *Colutea arborescens* L.). Anales Del Instituto Nacional De Investigaciones Agrarias Seria Forestal, 7: 129-154.

Asgharipour M.R. (2011). Effects of depth on germination and emergence of field bindweed (*Convolvulus arvensis* L.). Asian Journal of Agricultural Sciences, 3(6): 459-461.

Ayan S. (2007). Kaplı fidan üretimi. In Yahyaoğlu Z., Genç M. (Eds.) Fidan standardizasyonu, Süleyman Demirel Üniversitesi Orman Fakültesi, Yayın No: 75: 301-352.

Browicz K. (1963). The genus *Colutea* L. monograph. Monographie Botanicae, 14: 1-136.

Dirr M.A. (1990). Manual of woody landscape plants, their identification, ornamental characteristics, culture, propagation and uses. Fourth Edition, Stipes Publishing Company, Champaign, IL, 1007 pp.

Dirr M.A., Heuser C.W. (1987). The reference manual of woody plant propagation: from seed to tissue culture. Varsity Press, Athens, Georgia, 239 pp.

Genç M., Yahyaoğlu Z. (2007). Üretme-yetiştirme koşulları ve etkileri. In Yahyaoğlu Z., Genç M. (Eds.) Fidan standardizasyonu, Süleyman Demirel Üniversitesi Orman Fakültesi, Yayın No: 75: 37-216.

ISTA (1993). Rules for testing seeds. Seed Science and Technology, 21(Supplement): 1-259.

Krüssmann G. (1984). Manual of cultivated broad-leaved trees and shrubs. Volume 1, Timber Press, Beaverton, OR, 448 pp.

Olmez Z., Gokturk A., Temel F. (2007a). Effects of cold stratification, sulphuric acid, submersion in hot and tap water pre-treatments on germination of bladder-senna (*Colutea armena* Boiss. & Huet.). Seed Science and Technology, 35: 266-271.

Olmez Z., Temel F., Gokturk A., Yahyaoglu Z. (2007b). Effects of cold stratification treatments on germination of drought tolerant shrubs seeds. Journal of Environmental Biology, 28(2): 447-453.

Olmez Z., Yahyaoglu Z., Temel F., Gokturk A. (2008). Effects of some pretreatments on germination of bladder-senna (*Colutea armena* Boiss. & Huet.) and smoke-tree (*Cotinus coggygria* Scop.) seeds. Journal of Environmental Biology, 29(3): 319-323.

Olmez Z., Gokturk A. (2009). Effects of cold stratification, sulphuric acid, submersion in hot and tap water pretreatments in the greenhouse and open field conditions on germination of bladder-senna (*Colutea armena* Boiss. & Huet.) seeds. African Journal of Biotechnology, 8(13): 2973-2977.

Pieper A. (1952). Das Saatgut. P. Parey Verlag, Berlin, Hamburg, Germany: 275 pp.

Pijut P.M. (2008). *Colutea* L., Bladder-senna. *In*: Bonner F.T., Karrfalt R.P. (Eds.) The woody plant seed manual. USDA Forest Service, Agriculture Handbook 727: 426-427.

Piotto B., Bartolini G., Bussotti F., Asensio A., García C., Chessa I., Ciccarese C., Ciccarese L., Crosti R., Cullum F.J., Noi A.D., García P., Lambardi M., Lisci M., Lucci S., Melini S., Carlos J., Reinoso M., Murranca S., Nieddu G., Pacini E., Pagni G., Patumi M., Garcia F.P., Piccini C., Rossetto M., Tranne G., Tylkowski T. (2003). Fact sheets on the propagation of Mediterranean trees and shrubs from seed. *In*: Piotto B., Noi A.D. (Eds.) Seed propagation of Mediterranean trees and shrubs. APAT, I.G.E.R srl. Rome, Italy: 11-51.

Poulsen K. (1996). Case study: Neem (*Azadirachta indica* A. Juss.) seed research. *In*: Ouedraogos A.S., Poulsen K., Stubsgaard F. (Eds.) Proceedings of an international workshop on improved methods for handling and storage of intermediate/recalcitrant tropical forest tree seeds. June 8-10, Umlebaek, Denmark: 14-22.

Pritchett W.L., Fisher R.F. (1987). Properties and management of forest soils. Second Edition, John Wiley and Sons, New York, USA.

Rudolf P.O. (1974). *Colutea arborescens* L. (Bladder-senna). *In*: Schopmeyer C.S. (Ed.) Seeds of woody plants in the United States. Agric. Handbook 450, USDA Forest Service, Washington DC, USA.

Schmidt L. (2000). Germination and seedling establishment. *In*: Schmidt L. (Ed.) Guide to handling of tropical and subtropical forest seed. Chapter 10, Danida Forest Seed Centre: 11-12.

Ürgenç S., Çepel N. (2001). Ağaçlandırmalar için tür seçimi, tohum ekimi ve fidan dikiminin pratik esasları. Türkiye Erozyonla Mücadele, Ağaçlandırma ve Doğal Kaynakları Koruma Vakfı (TEMA) Yayınları, Yayın No: 33, İstanbul: 250 pp.

Verdonck O., Gabriels R. (1988). Substrate requirements for plants. Acta Horticulturae (ISHS), 221: 19-24.

Verdonck O., De Vleeschouwer D., De Boodt M. (1981). The influence of the substrate to plant growth. Acta Horticulturae (ISHS), 126: 251-258.

Yahyaoğlu Z., Ölmez Z. (2005). Tohum teknolojisi ve fidanlık tekniği. Kafkas Üniversitesi Artvin Orman Fakültesi, Ders Notu, Yayın No: 1, Artvin: 142 pp.

Table 1. Results of statistical analyses showing the relationship of the germination percentage and germination rate with different treatments (Means in column with the same letter are not significantly different at α = 0.05)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Growing Media** | **F-Ratio** | **GP (%)** | **F-Ratio** | **GR (days)** |
| Peat+manure (2:1) | 16.226\* | 7.03a | 3.855NS | 11 |
| Peat+perlite+manure (2:1:1) | 10.18a | 16 |
| Peat+forest soil+manure (1:1:1) | 12.40a | 12 |
| Forest soil+sand+manure (2:1:1) | 23.88b | 11 |
| **Sowing Depth (cm)** | **F-Ratio** | **GP (%)** | **F-Ratio** | **GR (days)** |
| 1.0 |  | 9.86a |  | 13 |
| 1.5 | 7.554\*\* | 10.41a | 0.220NS | 12 |
| 0.5 |  | 19.86b |  | 12 |
| **Growing Media\*Sowing Depth** | **F-Ratio** | **GP (%)** | **F-Ratio** | **GR (days)** |
| Peat+manure (2:1)-1.0 cm |  | 2.77a |  | 9a |
| Peat+manure (2:1)-1.5 cm | 116.314\*\*\* | 6.67b | 24.545\*\*\* | 11bc |
| Peat+forest soil+manure (1:1:1)-1.0 cm |  | 6.67b |  | 13de |
| Peat+forest soil+manure (1:1:1)-1.5 cm |  | 7.77b |  | 10ab |
| Peat+perlite+manure (2:1:1)-1.0 cm |  | 8.33b |  | 18g |
| Peat+perlite+manure (2:1:1)-1.5 cm |  | 8.33b |  | 15f |
| Peat+manure (2:1)-0.5 cm |  | 11.67c |  | 12cd |
| Peat+perlite+manure (2:1:1)-0.5 cm |  | 13.89c |  | 14ef |
| Forest soil+sand+manure (2:1:1)-1.5 cm |  | 18.89d |  | 12cd |
| Forest soil+sand+manure (2:1:1)-1.0 cm |  | 21.66e |  | 13de |
| Peat+forest soil+manure (1:1:1)-0.5 cm |  | 22.78e |  | 14ef |
| Forest soil+sand+manure (2:1:1)-0.5 cm |  | 31.11f |  | 9a |

*\** VS: Growing media, significantly different at α= 0.05, \*\* VS: Sowing depths, significantly different at α= 0.05,

\*\*\* VS: Growing media\*sowing depths, significantly different at α= 0.05, NS: Not significant at α= 0.05

Figure 1. Germination percentage (GP) and germination rate (GR) of the seeds that were sown in different growing medium (**1:** Forest soil+sand+manure (2:1:1); **2:** Peat+manure (2:1); **3:** Peat+perlite+manure (2:1:1); **4:** Peat+forest soil+manure (1:1:1)) and depth (**1:** 0.5 cm; **2:** 1.0 cm; **3:** 1.5 cm) combinations