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Influence of Cone Collection Date on Cone, Seed and Germination Characteristics in Allepo Pine (*Pinus halepensis* Mill.) in Kashmir Valley, India

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ABSTRACT

Allepo pine is an exotic conifer introduced in Kashmir valley, which can play the vital role in restoration of degraded areas and has the ability to fulfill the minor need of local inhabitants due to its fast growth, long and high fiber content per hectare which is important for pulp and paper industry keeping in view the importance and constraints of regeneration and germination of this species the study was undertaken to investigate the effect of cone collection date on cone, seed and germination as its cone are hard to open which affects the natural regeneration of this valuable exotic pine in its natural habitat at faculty of forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar. The experiment consisted of 16 treatments/collection dates from 15th August to 1st April and was laid out in completely randomized design. The study conducted on maturity indices revealed that seeds were mature when the cone color changed from green to glossy red-brown at maturity on 1st March onwards. The minimum fresh cone weight of 53.86 g and cone-specific gravity of 0.91-0.87 was recorded on 1st April. The maximum seed weight of 3.09 g/100 seeds (g) was recorded on 15th March and remained constant afterward. Whereas maximum germination percent of 43.25 % was recorded 15th February and remained constant afterward. Therefore, the cone color should be considered as an important index of ripeness. The cone should be collected in the month of March when color of cone turns glossy red-brown.

Key words: *Allepo pine, Pinus halepensis, Cone, Maturity indices Germination.*

INTRODUCTION

Exotic pine can play a major role in the restoration of degraded forests and adjoining areas and can fulfill the minor forest-based needs of local communities, because of their fast growth rate and long fibers for pulp and paper due to their capacity of producing high volume/ha. Allepo pine is an exotic conifers species in India and has been introduced to Kashmir valley.

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Although the exact date of its introduction has not been ascertained the tree has been found growing in Shankaracharya reserve forest (Srinagar), situated at an altitude of 1,970 m asl. The Aleppo Pine is a large (25-30 m) coniferous species from the Mediterranean. Its natural distribution extends from Morocco in the west to Jordan in the east, and from France in the north to Palestine in the south. Aleppo Pines have serotinous cones, that is, seeds are produced, stored and protected in the canopy. Cones take three seasons to mature and the viability of canopy-stored seed can be maintained for as long as 20-50 years[4]. It is generally found at low altitudes mostly from 200 m and can even grow at altitude up to 1700 m asl. The bark is an organ red, thick and deeply fissured at the base of the trunk and flanks in the upper crown, the leaves (needles) are very slender 6-12 cm long distinctly yellowish green.

Aleppo Pine cones open and release seed in response to disturbance (e.g. fire and being felled) and their permanent, long-term seed bank is a key feature for post-fire regeneration. Aleppo Pines are prolific seed producer and is estimated produce 25-105 seeds per square meter[4] or 17,400 seeds per year for mature trees[21]. Aleppo Pine seeds are wind dispersed and can carry for considerable distances on prevailing winds, however, the majority of seeds fall to within 40-50 meters of the parent tree[2]. Soil seed banks are significantly short-lived compared to canopy storage. Germinable seed content in the soil has been shown to rapidly deplete following the first rainy season[4].

Allepo pine is widely planted for timber in its native areas. It is also a popular ornamental tree extensively planted in parks and gardens in hot dry areas. The species has been successfully been grown as windbreak and shelterbelt, this species has been also grown on degraded land for the purpose of soil conservation. *Pinus halepensis* is a versatile plant with multifarious uses. The species is a unique source of phytochemical compounds used for chewing and flavoring wine and shows many other biological activities. Studies have revealed that the turpentine obtained from the resin is antiseptic, diuretic, rubefacient and vermifuge. The plant is also known for various alkaloids which have different therapeutic effects. *Pinus halepensis* is also believed to producing the other compounds used during the anti-inflammatory, antimicrobial, antioxidant antiviral, respiratory systems, kidney and bladder disorders[5,23]. Keeping in view the importance and as well as the scanty information with regard to its maturity indices, the present study was endeavored to document and determine the most suitable and best time for the cone/seed collection and to find out the effect of different collection dates on cone characteristics and seed maturity indices

MATERIALS AND METHODS

The valley of Kashmir is situated in western Himalayan range, extends between 32°-20' to 34°-54' N latitude and 73° - 55' to 75° - 35' E longitude. The total geographical area of the valley is about 159480 km^{-2} with the total forest area of 8126 km^{-2} (50.95 %), with an average altitude of 1850 m asl. The river Jhelum, which flows out from the spring at Verinag in Anantnag district, is considered as the lifeline of water resource of the valley and enters Pakistan through a narrow gorge at Baramulla. The study sites exhibit dry temperate climate experiencing four distinct seasons: a severe winter, a cold spring, a mild summer and an autumn. The minimum and maximum temperature ranged between – 4.41 ^{O}C in January to 29.34 ^{O}C in July respectively. The average annual precipitation ranges between 949 –1,100 mm mostly in the form of snow, which covers the mountainous belts for 160 - 195 days/year.

The optimal time to harvest is when a large amount of viable germinable seeds can be collected. In order to determine the best time for collection of seeds of *Pinus halepensis*, the seeds were collected from phenotypically superior trees from district Srinagar. The seed collection for the study was started from 15th of August till their maturation, at an interval of 15 days. The

germination test was performed in Petri plates lined with double fold germination paper at the bottom. The seeds were placed sparsely in Petri plates and moistened. The plates were incubated at 25±1 0C in B.O.D Incubator for a period of 21 days. The plates were kept moist and inspected regularly. Seeds were considered to have germinated as soon as radical emerged. The following parameters were recorded after each collection date.

***Cone color*:** Color change in fruit /cone provides simple and reliable criteria for judging seed maturity (William, 1985) change in cone color was directly related to the maturity of seeds. The cones were harvested with effect from the middle of August and observations with regard to the change in cone color to different shades till their maturation was recorded.

***Seed weight*:** The fresh weight of 100 bold and viable seeds was recorded, using 8 replications with the help of sensitive top pan balance.

***Cone Specific gravity*:** The specific gravity of seeds was determined by water displacement method (Oliver, 1974). The specific gravity of seed was determined by the formula given below:

$$\text{Specific Gravity} = \frac{\text{Fresh seed weight}}{\text{Weight of volume of water displaced by same fresh seed weight}}$$

***Moisture (%)*:** The seeds of *Pinus halepensis* were oven dried at a temperature of 60 ^{0}C till they attained the constant weight. Moisture content was determined by the formula (**Schubert and Adams, 1971**).

$$\text{Moisture\%age} = \frac{\text{Fresh seed weight} - \text{Dry seed weight}}{\text{Fresh seed weight}} \text{x} 100$$

***Germination %*:** The germination test was performed in glass petri plates on the top of the germination paper. The seeds were placed sparsely in petri plates and moistened. Four replications of 100 seeds each were used for the test. Germination percentage was recorded at all stages of maturity immediately after collection. The seeds were counted as germinated when radical emerged. The testing period was 21 days. The germination percent was calculated as per following standard methods[3].

$$\text{Germination \%age} = \frac{\text{Total no. of seeds germinated}}{\text{Total no. of seeds sown in a test}} \text{x} 100$$

RESULTS AND DISCUSSION

Cone color, Cone weight and specific gravity

In conifers color change in cones is a useful index of ripeness. In the present study color of the cone in *Pinus halepensis* changed from dark green in the second fortnight of August to light green and brown and finally glossy red-brown at maturity in the 1st fortnight of March (Table-1; Fig. 1). A relationship between seed maturity and color has been established in several species. Stockler and Jones reported that the cones of *Pinus banksiana* are ripe when half or more of the cone surface is brown and in *Pinus strobus* seeds are mature when the cones turn yellowish green with brown on the tip of scale. Similar results were also reported by Singh[15] in *Celtis australis;* and Sofi[20] in *Aesculus indica.*

The study revealed that cone weight showed a significant decrease towards maturity at all collection dates (Table-1). In the present study *Pinus halepensis* cone weight decreased from 125.67 (August) of immature cones to 53.86 g (March) at the time of maturity. The decrease in cone weight is the result of moisture loss due to desiccation which is a characteristic feature of maturation. In *Dalbergia sissoo,* Joshi[6] reported that

moisture loss coincided with maturity. The results were in harmony with the work done by Mughal and Thapliyal[13] who reported that the cone weight of *Cedrus deodara* decreased from 131.11 to 97.46 g at the time of maturity. In another study, Lavania[10] reported that the fresh weight of *Pinus wallichaiana* cones decreases from 131.82 g (15th September) to 94.63 g (30th October) at the time of maturity.

Moisture content as reflected in specific gravity has been used as an index of maturity for cone picking and is well established in a number of species. Cone-specific gravity also followed the cone weight pattern as it also decreased as the cones proceeded towards maturity. In the present study, the cone-specific gravity of *Pinus halepensis* decreased from 1.12 in August to 0.91 at maturity in March. These results also get support from the work of Mughal and Thapliyal[12] who reported that the specific gravity in *Cedrus deodara* decreased from 1.0 in August to 0.78 at maturity in October. The cones start opening as the specific gravity decreased below 0.91. The results get support from the study of Singh and Kachari[17] who reported that the specific gravity of *Pinus kesiya* (Khasi pine) varied from 0.80 to 1.24.

Seed weight, seed moisture content and Seed germination (%)

Seed mass may affect different juvenile and adult characters and is one of the earliest indicators of offspring quality. In the present study, the seed contents changed from gelatinous or milky stage in the month of August to firm endosperm and well-developed embryo with easily differentiated radical and plumule. In the present study, the fresh seed weight recorded an increase from 2.14 g/100 seeds on the first collection to 3.86 g/100 seeds at the time of maturity on 1st March,(Table-1) which is a function of resource allocation during maturity. On the other hand, the dry seed weight also increased from 1.19 g/100 seed on the first collection to 3.09/100 seeds at the time of maturity on 1st March. During the developmental stage, most of the nutrients are translocate from the cones into the seeds thus increasing their weight. Relative high seed weight is often desirable. These results get support from the work of Mughal and Thapliyal (2006) who reported that the germination percentage increased with the increase in seed weight of *Cedrus deodara.* In another study Mughal *et al.*[13] recorded an increase in seed weight from 0.98 g/100 seeds on the first collection to 1.13 g/100 seeds at the time of maturity in November. Lavania *et al.*[10] recorded that the mean fresh weight (3.14 g) of 100 seeds of blue pine increased from first to last cone collection date (15th September to 30th October). The increase in fresh weight of seeds with the progressive cone collection dates were also recorded by Lavania and Singh (2002) in *Abies pindrew* and Lavania *et al.*[11] in *Picea smithiana.* The increase in seed weight might be attributed to the organic matter accumulation in seeds.

The moisture content of seeds recorded a decrease from 44.09 percent on the first collection to 19.85 percent at the time of maturity which is as a result of the development of solid endosperm from the milky stage while conditions when seeds are immature. It may also be due to the loss of moisture with desiccation. The results are in line with the findings of Singh and Kachari[17] who reported that the moisture content of Khasi pine seeds collected on different dates varied from 36.42 per cent of immature to 9.58 per cent of mature seeds. Lavania *et al.*[10] also recorded in loss of moisture content up to 12.30 in seeds of *Pinus wallichiana* at the time of maturity.

Seed germination per cent increases as the cones mature. A good number of authors have correlated seed germination percent with a maturity of seeds. In the present study seed germination increased as the cones starting maturing and the germination increased steadily from 0.37 per cent on 15th November to 43.25 per cent on 1st March (Fig. 2). Thus positive correlation was observed with seed weight and germination percent. Studies conducted on seed germination and seedling establishment in the natural forest of spruce and silver fir in Kotgrah Forest Division, H.P. showed that in both the species the seed

dispersal in October had lower germination percentage than seed dispersed in November[19]. Maximum germination is related to the maturity of the seed. It is admitted the fact that has been established with other forest tree species also. Seed germination per cent increases as the fruit matures. This is a result of loading the seed with carbohydrates, fats, and proteins which proceed gradually across the season to maturity and is commonly defined by germinability. In another study, similar results were recorded by Singh[18] who observed an increase in germination percentage from 0.5 to 32.14 per cent in seeds of fir (*Abies pindrew*) when collected in August to October. The results also get support from a number of researcher workers like Singh and Kachari[17] in *Pinus kesiya*, Mughal and Thapliyal[12] in *Cedrus deodara,*

Table 1: Variation in cone and seed characteristics of *Pinus halepensis* during different collection dates

Collection Date	Cone color	Cone weight (g)	Cone specific gravity	Fresh weight of 100 seed (g)	Dry wt. of 100 seed (g)	Moisture content of seed (%)
15th Aug.	Dark green	125.67	1.12	2.14	1.19	44.09
1st Sept.	Dark green	123.19	1.09	2.33	1.4	44.05
15th Sept.	Dark green	120.59	1.08	2.56	1.64	35.87
1st Oct.	Light green	116.45	1.07	2.9	2	31.04
15th Oct.	Light green	110.42	1.04	3.11	2.22	28.62
1st Nov.	Light green	103.31	1.02	3.3	2.45	25.61
15th Nov.	Light green	97.94	1.01	3.49	2.65	24.12
1st Dec.	Light brown	91.05	1	3.58	2.76	22.87
15th Dec.	Light brown	87.19	0.98	3.69	2.89	21.88
1st Jan.	Light brown	81.24	0.96	3.75	2.95	21.33
15th Jan.	Brown	72.49	0.96	3.79	3.01	20.66
1st Feb.	Brown	67.31	0.94	3.82	3.04	20.32
15th Feb	Brown	60.75	0.92	3.84	3.06	20.22
1st Mar.	Glossy red brown	53.86	0.91	3.86	3.09	19.85
15th Mar.	Glossy red brown	45	0.87	3.87	3.1	19.85
1st April	Glossy red brown	41.4	0.86	3.84	3.1	19.85
CD (P ≤ 0.05)		**5.91**	**0.033**	**0.057**	**0.057**	**0.028**

(Figures in parenthesis are square root transformed values).

Fig. 1: Pinus halepensis cones/ seeds showing change in color during different stages of maturity

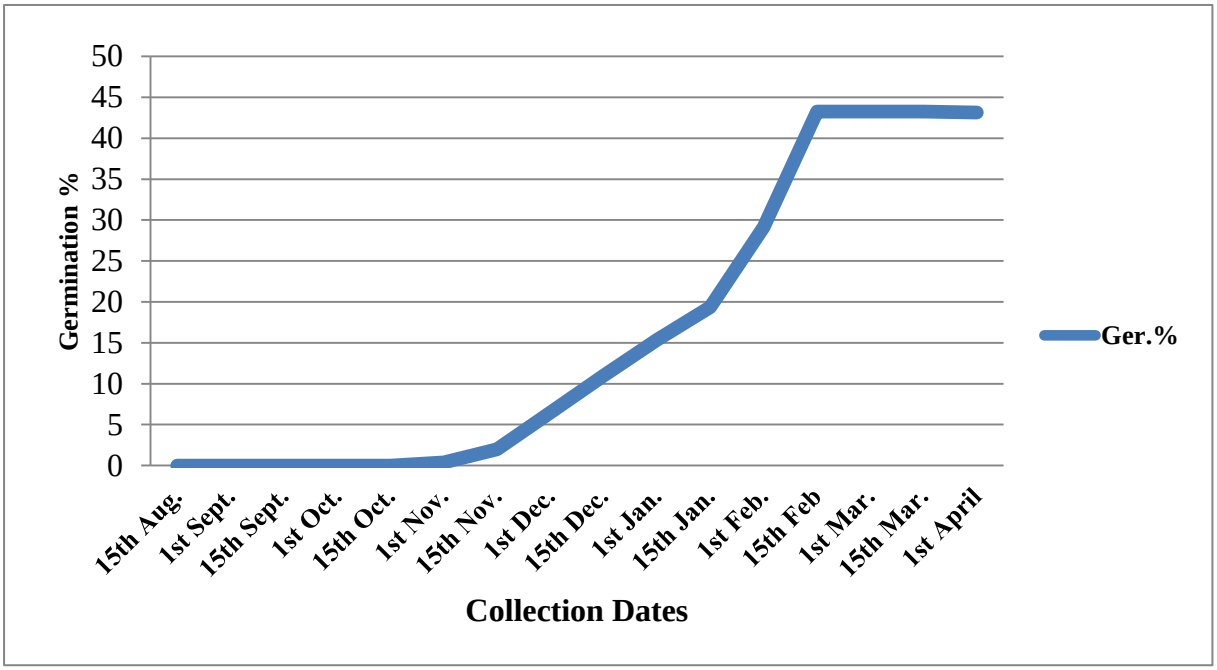

Fig. 2: Effect of different cone collection dates on germination per cent of *Pinus halepensis*

CONCLUSION

The study conducted on maturity indices revealed that cones having glossy red-brown have matured seeds. The cone weight decreased with the advancement of maturity (below 53.86 g). The specific gravity of mature cones decreased below 0.91 and germination percentage of seed collected from such cones varied from 43.12 to 43.25 percent. The mean fresh weight (2.14 - 3.87 g) and dry weight (0.19 - 3.10 g) of 100 seeds increased from first to 16th (last) cone collection date. The moisture content of the seed decreased as the seed matured and the moisture content of mature seed varied from 19.65 to 19.85 per cent. Seed germination increased as cone collection dates progressed. Germination percent steadily increased from cone collection date of 15th November to 1st April. Therefore a successful attempt has been made to overcome the problem of propagation by way of identifying proper date and stage of seed harvesting. On the basis of studies conducted it is concluded that seeds of Allepo pine should be collected early in the spring (1st week of March onwards) when the color of cone turns glossy red-brown indicating their maturity.

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