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Correlation Dynamics of Germination Value, Germination Energy Index and Germination Speed of Pongamia Pinnata (L.) Pierre Seeds of Pendra Provenance, Chhattisgarh, India

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ABSTRACT

Pendra provenance is considered to be the origin place of Pongamia pinnata in Chhattisgarh. This forest tree species is an important part of the forest ecosystem of this region. To analyse germination behaviour of Pongamia pinnata, fresh seed from fully grown mature trees were collected. The healthy seeds were soaked in distilled water for 24 hours at room temperature (280C±20C). After presoaking seeds were laid for germination in petriplates having Whatmann filter paper at the laboratory condition. Four replicates of fifty seeds were kept for detailed observation. The time, rate, homogeneity, and synchrony of the germination of seeds were the important aspects for correlating the germination dynamics of Pongamia pinnata. The germination of the seeds started after second day. The emergence of the radicle has been considered as germination for seeds. The 64% germination has been observed for this experiment. The germination speed advanced and reached to its maximum value on 10th day of germination and the peak value was also maximum on the same day. The daily germination percent was found highest on 8th and 10th day during germination. The average germination value, germination energy index and germination speed were 87.5±5.12, 33.99±1.24 and 18.84 respectively. It was observed that these parameters were linearly correlated and influenced by each other. To find out their rate of dependency correlation matrix was done and it was found that a significant positive correlation (0.84 to 0.99) exist between different germination parameters of Pongamia pinnata at 0.05 level of probability.

Keywords: Pendra provenance, Pongamia pinnata, Germination, correlation matrix.

INTRODUCTION

The Pendra provenance comes under high plateau region of Bilaspur district of Chhattisgarh. The Pendra lies at 81° 95' 00" East Longitude and 22° 76' 67" North latitude and is situated at an elevation of 591 meters above the sea level. The region is characterized by a diverse forest resources of Achanakmar Amarkantak Biosphere Reserve dominated by Sal(*Shorea robusta*). Pendra is also known by the rich diversity of *Pongamia pinnata* having rich content of oil in its seeds, moreover is considered to be the origin of *Pongamia* in the central India.

Pongamia pinnata is predominantly cultivated through seeds in the region and the genetic diversity is conserved by the storage of seeds upto its seed viability. Its is a perennial, fast-growing, leguminous tree, grows about 15-25 m tall, widely distributed in India, south-east Asia, Oceania, northern Australia, East-African coast and southern China (Murphy et al., 2012). In addition, Pongamia has been introduced to other parts of the world, including the United States (Biswas et al., 2011; Kazakoff et al., 2011). As a nodulating and nitrogen-fixing legume the nitrogen (N) fertilizer requirements of Pongamia are potentially minimal or eliminated. *Pongamia pinnata* is an economically potential tree species gaining interest globally because of its feasible contribution towards production of commercial biofuels. In the traditional system of medicines, such as Ayurveda and Unani, the *Pongamia pinnata* plant is used for anti--inflammatory, anti-plasmodial, anti-nonciceptive, anti-hyperglycamic, anti-lipidperoxidative, anti-diarrhoeal, anti-ulcer, anti-hyperammonic and antioxidant activity (Chopade et al.2009).

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The germination behavior of forest tree species varies in accordance with the different provenance. The provenance is one of the major aspect for phenotypic and genotypic variations (Gupta and Sehgal 1999).Studies on germination and vegetative growth behavior of forest tree species with respect to their provenance can be useful in forest tree improvement programmes. For a successful promotion of large scale plantations of this tree species there is a need for carefully planned and well directed seed source research. The most successful and important tree improvement programme is that where proper seed sources are used. The loss from using the wrong seed sources can be great and even disastrous (Zobel and Talbert, 1984)

In the present study correlation dynamics of seed germination of *Pongamia pinnata* have been analysed and its correlative significance have been worked out. The results will be helpful for its improvement programme.

MATERIALS AND METHODS

The mature pods of *Pongamia pinnata* were collected from from Pendra provenance (Chhattisgarh, India) during the month of May. The collected pods were air dried for three days in the open sunlight. After three days pods start rupurting and seeds were extracted from the pods. The extracted seeds were graded and air dried.

The air dried seeds were then soaked in distilled water for 24 hours at room temperature (at $28^0C \pm 2^0C$).After presoaking seeds were laid for germination in petriplates having Whatmann filter paper at the laboratory. Four replicates of fifty seeds were kept for detailed observation. The moisture has been maintained by spraying distilled water.

Germination was defined by the presence of a radicle. Daily germination data have been recorded for different germination parameters. The germination value (Czabator 1962), germination energy index and speed (Maguire (1962) were analysed on the basis of data recorded on daily basis. To find out the correlation dynamics between germination energy index, germination value and germination speed the correlation matrix was done.

RESULTS

Pongamia pinnata pods are 4.5cm long and 2 – 2.5cm wide, broad pointed at both ends, green in early period but turns yellowish – grey when ripe with charcoal black dots found on the surface of pod and generally one to two seeded. Seeds of *Pongamia pinnata* are elliptical, reniform, compressed, reddish brown, fairly hard, 2-2.5cm long and 1.5 -2cm wide and have a thin seed coat (Fig:a,b and c).

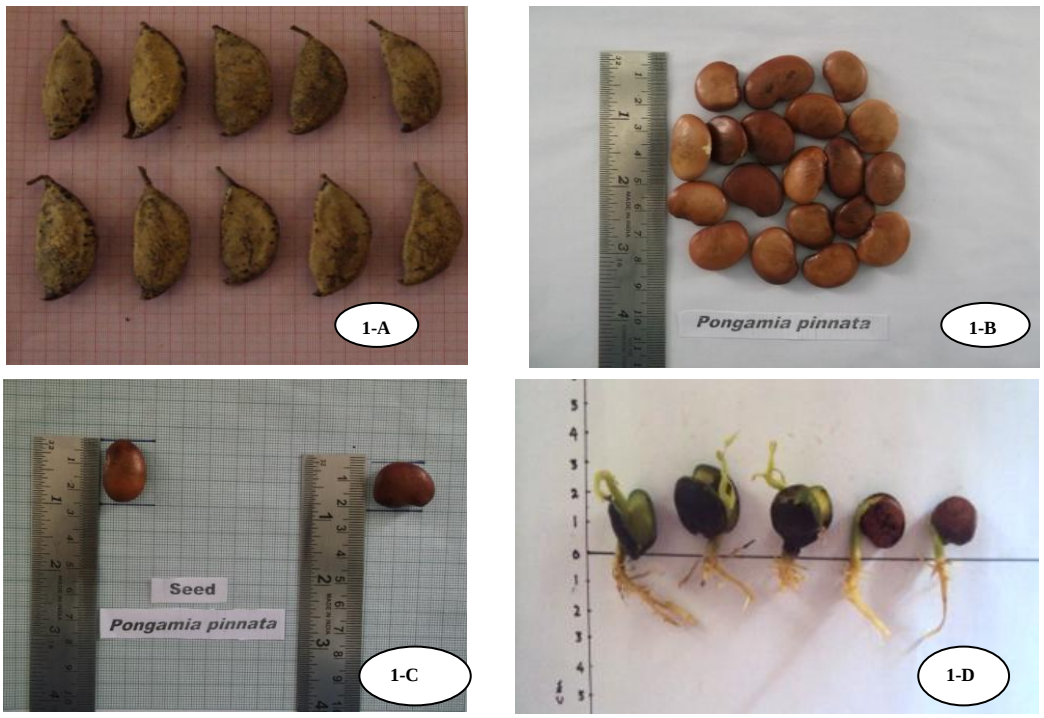


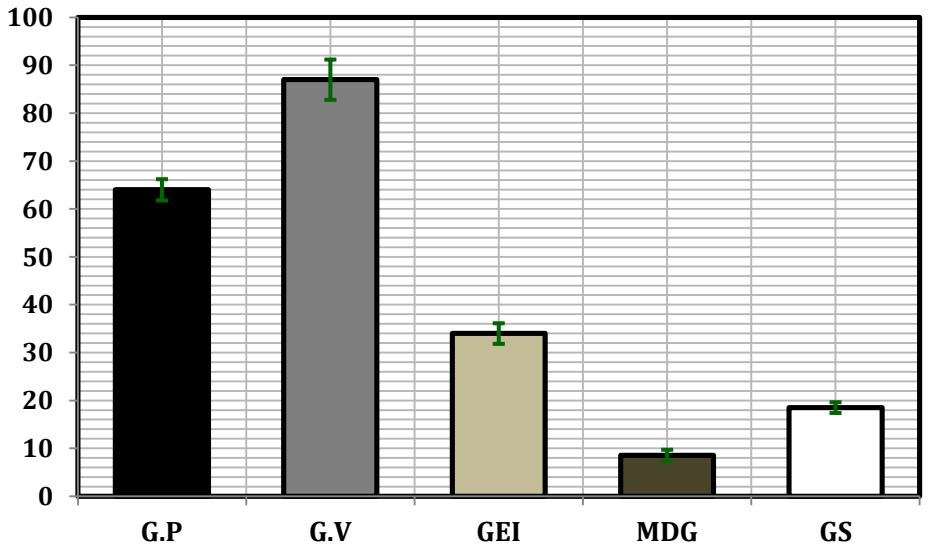
Fig1. ***A,B and C-*** *Shows pod,seed shape and seed dimension of Pongamia pinnata*

Fig1. ***D-*** *Shows root and shoot growth pattern in Pongamia pinnata during germination*

Table1. *Phenogram of Pongamia pinnata*

Months / Plant part	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leaf Fall												
New leaf												
Flower												
Pod ripen(Following Flowering)												
Seed ripe(Following Flowering)												

The different phenological events of the *Pongamia pinnata* found in the Pendra provenance of Chhattisgarh, India are shown in the Table-1.Seeds ripe in the month of April-May (Following Flowering) and shed its pods in the month of May –June before the onset of monsoon. The natural regeneration starts during the monsoon season and seedlings grow immediately as it has no specific dormancy.



The data shown in the graph are mean ± SD of four replicates. Bars represent standard deviation within treatment means.

Fig2. *Pongamia pinnata- Germination percentage,Germination value (GV), Germination Energy Index(GEI), and Germination speed (GS) .of Pendra provenance,Chhattisgarh ,Central India*

The Fig-(2) shows the germination value, germination energy index and other related attributes. Germination value is an index of combining speed and completeness of seed germination (Czabator 1962). The value of germination value (87.5±1.55) was observed during present experimentation. The germination value is closely related to the survival of seedlings (Djavanshir and Pourbeik 1976).

The germination Energy Index is an indicator for the potential of a seed to germinate. The germination energy index of *Pongamia pinnata* for Pendra provenance was recorded as 33.64±0.84. The germination energy of *Pongamia pinnata* was higher in this study than the values obtained by Kumar et al, 2007 and Swapna and Rajendrudu 2015 in *Pongamia pinnata*.

Table2. *Correlation matrix for germination attributes of Pongamia pinnata of Pendra provenance, Chhattisgarh of Central India.*

	G.V	GEI	MDG	GS
G.V	1			
GEI	0.901*	1		
MDG	0.947*	0.846*	1	
GS	0.992*	0.870*	0.975*	1

*****= *Significant at P≤ 0.05*

A positive correlation was observed between the different germination parameters .A positive correlation between germination value and germination energy index(r= 0.901) was observed. The correlation values are high between other germination parameters studied (Table-2) Exponential smoothed forecasting of the data was done to remove most of the jaggedness (the jumping around) of the germination based data of *Pongamia pinnata*.

DISCUSSION

Several methods and mathematical expressions to measure the process of germination have been proposed (Czabator 1962, Nichols & Heydecker 1968, Goodchild & Walker 1971, Scott et al. 1984 and Brown & Mayer 1988).A tree starts its life from the growth in embryo present inside the seed as a miniature plant. The various molecular mechanisms are associated in the phase transition from a seed to a seedling. Germination an events that occur in the embryo after imbibitions by the quiescent seed, and which are completed upon emergence of the radicle from the seed coat (Bewley, 1997).The germination capacity of one seed, based on a binary answer (germinated/non germinated), is one qualitative attribute of the germination process, generally converted in a quantitative attribute, commonly percentage. Modelling of the seed germination in a proper and authentic way is required for the improvement of the forest tree species. Only germination does not determine that a species has an efficient germination behavior but also the rate, speed, percentage, its vigor and establishment of the germinated seeds are involved in determining the germination potential of a seed. Moreover how these parameters are associated with each other provides us a good deal and understanding in studying the germination related problems in different forest tree species under different site conditions.In the present study correlation dynamics of germination value, germination energy index and germination speed of *Pongamia pinnata* have been done(table). The seed sources with higher germination value , germination index and germination speed are endowed with higher seedling vigour , thus can be important in selection criteria for breeding and improvement of this species. The proveance based germination studies of forest tree species can help in making elite decision for afforestation and reforestation programmes. Variations in germinability of seeds in relation to provenances have been reported in many forest tree species eg. *Albizia lebbek* (Kumar and Toky 1993), *Pinus pinaster* (Falleri 1994), *Acacia nilotica* (Ginwal *et al*. 1995), etc. Ginwal *et al*. 2005 have observed the seed source variation in morphology, germination and seedling growth of *J. curcas* in central India.

In the present study it has been found that all the germination parameters were positively correlated. The correlation between Germination value and germination energy index was found statistically significant ($r = 0.901$, $p<.05$).This type of relationship between different germination parameters in *Pongamia pinnata* are in accordance with the findings of Msuya and Stefano 2010, Patil et al 2011. Generally, any effect on one germination parameter was also associated in a complementary trend with effects on the other germination parameters (Santana & Ranal, 2006). Significant correlation among various seed germination parameters can prove to be important criteria in selection of geographic seed sources for raising stock for bulk commercial forest tree plantations.

In *Pongamia pinnata* correlation dynamics shows that the seeds have good and fast potential for germination immediately after the harvesting of the seeds.

REFERENCES

[1] Bewley JD (1997) Seed Germination and Dormancy. Plant Cell.9: 1055–1066.

[2] Biswas B, PT Scott, and PM Gresshoff (2011) Tree Legumes as Feedstock for Sustainable Biofuel Production: Opportunities and Challenges. Journal of Plant Physiology. 168: 1877-1884.

[3] Brown, RF & Mayer, D.G. (1988) Representing cumulative germination. 1. A critical analysis of single-value germination indices. Annals of Botany 61: 117-125.

[4] Czabator FJ (1962) Germination value: an index combining speed and completeness of *Pine* seed germination. Forest Science 8: 386-396.

[5] Dandoy E, Schyns R, Deltour L, and Verly WG (1987) Appearance and repair of apurinic/apyrimidinic sites in DNA during early germination. Mutat. Res.181: 57–60.

[6] Chopade VV, Tankar AN, Pande VV, Tekade AR, Gowekar NM, Bhandari SR, Khandake SN (2008) *Pongamia pinnata* Phytochemical constituents, traditional uses and pharmacological properties: A review. Int J Green Pharm , 2: 72-5.

[7] Falleri E (1994) Effect of water stress on germination in six provenances of *Pinus pinaster* Ait. *Seed Sci. Tech.*, 2: 591-599.

[8] Goodchild NA & Walker MG (1971) A method of measuring seed germination in physiological studies. Annals of Botany 35: 615-621.

[9] Ginwal HS, Rawat PS, Gera M, Gera N and Srivastava R L (1995). Study on the pattern of seed germination of various subspecies cum provenances of *Acacia* Willd. ex. Del. under nursery conditions. *Ind. For*., 121 (1): 29-38.

[10] Ginwal HS, Phartyal SS, Rawat PS and Srivastava RL (2005) Seed source variation in morphology, germination and seedling growth of *Jatropha curcas* in central India. *Silv. Genet*., 54 (2): 76-80.

[11] Gupta T and Sehgal RN (1999) Genetic estimates for the seed traits of *Toona ciliata*. *Range Mgmt. Agrofor*., 20 (2): 188-193.

[12] Kumar santosh, Radhamanai , Singh K Anuradh and Varaprasad K S (2007) Germination and seed storage in *Pongamia pinnata*. L. current science. 93(7): 910-911 .

[13] Kazakoff SH, PM Gresshoff & PT Scott, (2011) *Pongamia pinnata*, a sustainable feedstock for biodiesel production. In: Halford NG, Karp A, editors. Energy Crops, Cambridge, UK: Royal Society for Chemistry.233-258.

[14] Kumar N and Toky O P (1993) Variation in pod and seed size among *Albizia lebbek* provenances. Nitrogen Fixing Tree Res. Reports.2: 64-67.

[15] Maguire JD (1962) Seed of germination aid in selection and evaluation for seedling emergence and vigour. JCrop Science., 2: 176-177.

[16] Mavi K, Demir I & Matthews S (2010), Mean germination time estimates the relative emergence of seed lots of three cucurbit crops under stress conditions. Seed Sci. & Technol. 38: 14-25.

[17] Maguire JD (1962) Speed of germination - aid in selection and evaluation for seedling emergence and vigor. Crop Science 2: 176-177.

[18] Msuya DG & Stefano J (2010) Responses of Maize (*Zea mays*) Seed Germination Capacity and Vigour to Seed Selection Based on Size of Cob and Selective Threshing. World Journal of Agricultural Sciences 6 (6): 683-688.

[19] Murphy HT, DA O Connell, G Seaton, RJ Raison, LC Rodriguez, AL Braid, DJ Kriticos, T Jovanovic, A Abadi, M Betar, H Brodie, M Lamont, M McKay, G Muirhead, J Plummer, NL Arpiwi, B Ruddle, PT Scott, C Stucley, B Thistlethwaite, B Wheaton, P Wylie & PM Gresshoff (2012) A common view of the opportunities, challenges and research actions for *Pongamia* in Australia. BioEnergy Research. 5(3): 778-800.

[20] Nichols MA & Heydecker W (1968) Two approaches to the study of germination data. Proceedings of the International Seed Testing Association. 33: 531-540.

[21] Patil V M, Police Shivanna H, P Surendra, GO Manjuna TH, A Krishna and GV Dasar (2011) Variability studies for seed and seedling traits in Pongamia pinnata (L.)Pierre. Karnataka J. Agric. Sci.24 (2): 201-203.

[22] Santana DG & Ranal MA (2006) Linear correlation in experimental design models applied to seed germination.Seed Science and Technology. 34: 241-247.

[23] Scott SJ, Jones RA, Willams WA (1984) Review of data analysis methods for seed germination. J Crop Science., 24: 1192 -1199.

[24] Swapna B and and Rajendrudu G (2015) Seed Germination of Pongamia Pinnata (L.) Pierre under Water Stress. Research Journal of Recent Sciences.4(6): 62-66 .

[25] Vazques-Ramos JM and Sanchez M de la (2003) The cell cycle and seed germination. Seed Science Research. 13: 113-130.

[26] Zobel B and Talbert J (1984) Applied Forest Tree Improvement. John Wiley and Sons, New York: 505.