



## Research Note

# Variability studies for seed and seedling traits in *Pongamia pinnata* (L.) Pierre at Tamil Nadu

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(Received:04 Mar 2015; Accepted:25 Jan 2016)

### Abstract

The present investigation was carried out at Forest College and Research Institute, Mettupalayam, Tamil Nadu to identify the best half sibs of *Pongamia pinnata* across its natural distribution areas in south India for further collection of seeds for afforestation or breeding purpose. The seeds were collected from different agro climatic zones of Tamil Nadu. Seeds were measured for its length, width, thickness, test weight and volume and then sown in nursery to study the variation in germination and initial growth parameters and biomass viz., germination per cent, germination vigour, shoot length, root length and root and shoot dry weight of seedlings. Seeds collected from southern zone were superior compared to seeds from other parts in all the traits considered for the study. These seed sources can be further screened for tree improvement traits considering their immense value in yielding bio diesel.

### Keywords

Seed source, Seed length, Seed width, Test weight, Germination rate, Germination value, Root length

*Pongamia pinnata* is a medium sized glabrous tree with a short bole and spreading crown. The tree is planted for shade and is grown as ornamental tree. It is one of the few nitrogen- fixing trees producing seeds containing 30-40 per cent oil. The natural distribution is along coasts and riverbanks in lands and native to the Asian subcontinent. It is also cultivated along roadsides, canal banks and open farm lands. It is a preferred species for controlling soil erosion and binding sand dunes because of its dense network of lateral roots. Its root, bark, leaves, sap, and flower also have medicinal properties and traditionally used as medicinal plants and now a days it is gaining importance as bio diesel plant. *Pongamia* is an important species with lot of variability, which can be exploited for its improvement farming systems in different agro climatic requirements, evolving the superior seeds. Genetic differences associated with the place of origin have been several times as great as that among individual trees within the population. Hence it becomes necessary to conduct seed source testing prior to a more intensive breeding work (Sniezko and Stewart, 1989). For a successful promotion of large scale plantations there is a need for carefully planned and well directed seed source research. The most successful tree improvement programme is that where proper seed sources were used. The loss from using the wrong sources can be great and even disastrous (Zobel and Talbert, 1984).

The present study was undertaken during the year 2013-14 at Forest College and Research Institute (Mettupalayam), Coimbatore. Which is situated at 11°19'N latitude and 77°56'E longitude and an altitude of 350 m above MSL. The average annual rainfall is 945 mm, most of which is received between June to September. The temperature varies from 15 to 34.9 °C. The extensive survey was undertaken across five different agro climatic zones of Tamil Nadu. A distance of at least 200 mts was maintained between two trees and at least 25 kms between two seed sources. The individual tree was identified based on their phenotypical characteristics and the individual tree identity was also maintained. Seeds were extracted from 100 pods after sun drying for ten days for assessment of seed characteristics. Further same seeds were used for assessing germination and seedling characters. Seed parameters such as seed length, seed width, seed thickness, seed volume and 100 seed weight were recorded for each seed source. The experiment was laid out in completely randomized design with five replications of 100 seeds each. The seeds were sown in the standard nursery bed and regular watering was done. Observations on daily germination were recorded up to 21 days from date of sowing. Germination percentage, peak value, mean daily germination, germination rate and germination value were recorded for each seed source. Seedling parameters such as seedling height, root length, shoot and root dry weight and shoot and root vigour

index were assessed. Data collected was analyzed statistically using Mstac program.

$$\text{Germination per cent} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

$$\text{Germination value (GV)} = \text{PV} \times \text{MDG}$$

Where, PV- Peak Value of germination; MDG - Mean Daily Germination

$$\text{Peak value} = \frac{\text{Total germination per cent}}{\text{Total number of days}}$$

$$\text{Mean daily germination} = \frac{\text{Final germination per cent}}{\text{The number of days that took to reach peak germination}}$$

$$\text{Germination Rate} = \frac{G_1}{T_1} + \frac{G_2}{T_2} + \frac{G_3}{T_3} + \dots + \frac{G_n}{T_n}$$

Where,  $G_1$  - Number of seeds germinated on first day

$G_2$ - Number of seeds germinated on second day

$G_3$ - Number of seeds germinated on third day

$T_1$  - day one,  $T_2$  - Day two,  $T_3$  - Day three

$G_n$ - Number of seeds germinated on nth day

$T_n$  - n<sup>th</sup> day

Shoot Vigour Index (SVI) = Germination percentage X Shoot length (cm)

Root Vigour Index (RVI) = Germination percentage X Root length (cm)

Shoot Vigour index (SVI) = Germination percentage × shoot length (cm)

Root Vigour index (RVI) = Germination percentage × root length (cm)

Data from this study revealed that seed traits for all seed sources showed significant differences (Table. 2). The seeds collected from krishnagiri region were longest, thickest and had higher mass as well as seed volume compared to all other seed sources. Seed length amongst various seed sources varied from 16.42 mm to 22.58 mm, seed width from 11.55 mm to 18.09 mm. Pod length and pod width varied from 34.87 mm to 51.20 mm and 18.17 mm to 30.14 mm respectively. The 100 seed weight ranged between 68.240 g to 154.728 g. These variations may be due to the fact that, this species grows over a wide range of climatic conditions as well as soil types and altitudes. Similar findings were revealed by Sudhir Kumar (2003) in *Jatropha curcas* and Vasanth Reddy *et al.* (2007) in *Pongamia pinnata*.

Analysis of variance (ANOVA) revealed that the results were statistically significant for all the germination attributes (Table. 3). Overall germination per cent was on/or above the 60 per cent. Maximum germination per cent was found in Hosur region (85.33 %), owing to higher mean daily germination (2.55), Germination value (7.33) and peak value of germination (2.84). It was followed by Krishnagiri region (85.33 %) and Theni region (81.67 %) seed sources, whereas, minimum germination per

cent was recorded on Dharapuram region (61.00 %). The size and shape of seeds is variable depending on the structure and form of the ovary and environmental conditions under which plant is growing. It is evident from the result that seeds from krishnagiri region was found to be superior with respect to germination percentage. This is in line with study made by Dwivedi (1993) in *Azadirachta indica* and Devagiri *et al.* (1998) in *Dalbergia sissoo*. They found that the variation observed in the seed characters may be attributed to adverse environment and differences in their distribution range this in turn affect the germination of seeds. Seedlings of Krishnagiri region recorded higher shoot length (44.50 cm), root length (37.30 cm), shoot dry weight (4.31 g), root dry weight (3.68 g), shoot vigour index (3794.20) and root vigour index (3177.40), oil content (37.5%).

From the Genotypic Correlation studies, it is inferred that seed weight (1.559), germination percent (0.418), germination value (0.384), Peak value (0.419), Mean daily germination (0.420), shoot length (0.150), Root length (0.331), shoot vigour index (0.339) and root vigour index (0.688) showed positive but non-significant correlation with oil content (Tables 5 and 6). The characters *viz.*, Pod length (-0.332), Pod width (-0.004), seed length (-0.324), seed width (-0.074), shoot dry weight (-0.098), root dry weight (-0.201) exhibited negative non-significant genotypic correlation with oil content.

It is concluded that from the phenotypic correlation studies, pod width (0.015), Seed weight (0.018), germination percent (0.141), germination value (0.124), peak value (0.140), rean daily germination (0.149), shoot length (0.002), root length (0.022), root dry weight (0.040), shoot vigour index (0.066) and root vigour index (0.084) showed positive but non-significant correlation with oil content (Tables 5 and 6). Pod length (-0.160), seed length (-0.143), seed width (-0.045), shoot dry weight (-0.061) exhibited negative non-significant phenotypic correlation with oil content.

A highly significant and positive correlation existed between mean daily germination (0.149), germination percent (0.141), peak value (0.140), root vigour index (0.084) and shoot vigour index (0.066). Significant correlation among various seed germination and seedling traits suggests that test weight may prove to be important criteria in selection of geographic seed sources for raising stock for bulk commercial plantations.



This study identifies two best sources for *Pongamia pinnata* Pierre based upon seed and seedling traits from Hosur and Krishnakiri which were sampled. On a short term basis, breeding zones may be set up in these environmentally homogeneous areas. However, this may be preliminary as only seedling traits have been considered. Hence, seed source screening provides a great opportunity to the tree breeder to screen and capture natural variation for success of afforestation, besides providing information on the raw material for breeding and evolving improved planting stock within a seed source.

#### Acknowledgment

Acknowledgments are due to department of tree breeding, forest college and research institute (FC&RI) and UGC – government of India funded by the whole project. Gratitude is expressed towards my guide and all the scientist for their kind and support. Thanks are also due UGC- RGNF for the project for further execution.

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**Table.1 *Pongamia pinnata* seed source collection from different place in Tamil Nadu**

Source	Latitude	Longitude	Altitude
FCRIPP 1 (Anjetti)	12°19'N	77°45'E	1816
FCRIPP 2 (Denkanikottai)	12°31'N	77°46'E	2919
FCRIPP 3 (Hosur)	12°43'N	77°49'E	2895
FCRIPP 4 (Krishnagiri)	12°30'N	78°12'E	1630
FCRIPP 5 (Pennagaram)	12°07'N	77°53'E	1703
FCRIPP 6 (Dharmapuri)	12°05'N	78°05'E	1579
FCRIPP 7 (Harur)	12°02'N	78°28'E	1170
FCRIPP 8 (Palacodu)	12°17'N	78°04'E	1708
FCRIPP 9 (Chinnalapatti)	10°16'N	77°55'E	1021
FCRIPP10(Thirumangalam)	9°49'N	77°59'E	403
FCRIPP 11 (Theni)	9°59'N	77°27'E	1094
FCRIPP 12 (Cumbum)	9°43'N	77°16'E	1460
FCRIPP 13 (Bodi)	10°01'N	77°21'E	1207
FCRIPP 14 (Orathanadu)	10°38'N	79°15'E	121
FCRIPP 15 (Tanjore)	10°50'N	79°07'E	135
FCRIPP 16 (Pattukottai)	10°25'N	79°19'E	61
FCRIPP 17 (Mettupalayam)	11°17'N	76°57'E	108
FCRIPP 18 (Sirumugai)	11°19'N	77°01'E	991
FCRIPP 19 (Dharapuram)	10°43'N	77°31'E	807
FCRIPP 20 (Vedaranyam)	10°22'N	79°49'E	15
FCRIPP 21 (Arakkonam)	13°06'N	79°40'E	266
FCRIPP 22 (Thiruvallur)	13°15'N	80°00'E	113
FCRIPP 23 (Viluppuram)	11°55'N	79°30'E	134
FCRIPP 24 (Tindivanam)	12°13'N	79°37'E	148
FCRIPP 25 (Mannargudi)	10°41'N	79°25'E	61
FCRIPP 26 (Perundurai)	11°15'N	77°36'E	910
FCRIPP 27 (Sivagangai)	9°51'N	78°30'E	315
FCRIPP 28 (Manamadurai)	9°40'N	78°26'E	248
FCRIPP 29 (Nagercoil)	8°11'N	77°23'E	315
FCRIPP 30 (Puducherry)	11°54'N	79°47'E	61



**Table 2. Seed characteristics as influenced by various agro climatic zones of Tamil Nadu**

Seed source	Pod length (mm)	Pod width (mm)	Seed length (mm)	Seed width (mm)	100 Seed weight (g)
FCRIPP 1 (Anjetti)	44.77	21.88	19.43	13.46	102.380
FCRIPP 2 (Denkanikottai)	48.96	24.37	19.94	16.10	130.538
FCRIPP 3 (Hosur)	40.71	19.92	18.64	13.33	107.270
FCRIPP 4 (Krishnagiri)	51.20	30.14	22.58	18.09	154.728
FCRIPP 5 (Pennagaram)	44.11	20.01	18.76	12.30	100.506
FCRIPP 6 (Dharmapuri)	43.11	24.58	19.07	14.77	108.798
FCRIPP 7 (Harur)	40.46	20.45	19.75	14.26	102.045
FCRIPP 8 (Palacodu)	45.00	22.21	20.68	16.15	111.722
FCRIPP 9 (Chinnalapatti)	38.01	21.05	17.52	13.50	105.438
FCRIPP10(Thirumangalam)	41.90	21.12	18.78	14.99	96.890
FCRIPP 11 (Theni)	42.93	23.76	18.52	14.53	89.607
FCRIPP 12 (Cumbum)	40.64	23.68	18.25	13.26	128.908
FCRIPP 13 (Bodi)	35.11	15.88	17.05	11.55	68.240
FCRIPP 14 (Orathanadu)	42.09	19.15	18.19	14.46	133.900
FCRIPP 15 (Tanjore)	38.60	19.08	16.42	13.31	160.545
FCRIPP 16 (Pattukottai)	39.86	18.17	17.68	14.38	125.974
FCRIPP 17 (Mettupalayam)	34.87	20.45	19.87	12.44	96.398
FCRIPP 18 (Sirumugai)	40.55	23.16	21.83	13.49	134.110
FCRIPP 19 (Dharapuram)	46.64	23.15	22.40	15.05	151.403
FCRIPP 20 (Vedaranyam)	45.90	22.68	21.75	12.85	125.776
FCRIPP 21 (Arakkonam)	40.36	20.85	19.36	12.81	117.455
FCRIPP 22 (Thiruvallur)	50.64	23.40	22.32	14.12	131.265
FCRIPP 23 (Viluppuram)	47.61	19.93	22.42	12.89	120.374
FCRIPP 24 (Tindivanam)	42.26	20.03	19.70	13.25	115.979
FCRIPP 25 (Mannargudi)	50.46	23.18	22.14	11.67	120.798
FCRIPP 26 (Perundururai)	43.10	20.70	20.69	12.10	126.489
FCRIPP 27 (Sivagangai)	46.38	19.84	20.81	11.85	119.456
FCRIPP 28 (Manamadurai)	36.00	21.22	20.73	15.66	121.478
FCRIPP 29 (Nagercoil)	47.45	19.13	19.69	14.57	126.458
FCRIPP 30 (Pudycherry)	39.03	19.57	20.07	13.95	134.738
<b>SEd</b>	3.173	2.386	1.276	1.166	0.816
<b>CD (0.05)</b>	6.347	4.774	2.553	2.333	1.633



**Table 3. Seed germination attributes in different Agro climatic zones of Tamil Nadu**

Seed source	Germination percent	Germination value	Peak value	Mean daily germination
FCRIPP 1 (Anjetti)	84.00	7.04	2.80	2.51
FCRIPP 2 (Denkanikottai)	77.00	5.97	2.57	2.31
FCRIPP 3 (Hosur)	85.33	7.33	2.84	2.55
FCRIPP 4 (Krishnagiri)	85.33	7.26	2.84	2.55
FCRIPP 5 (Pennagaram)	72.67	5.31	2.42	2.19
FCRIPP 6 (Dharmapuri)	73.00	5.42	2.43	2.20
FCRIPP 7 (Harur)	69.33	4.86	2.31	2.10
FCRIPP 8 (Palacodu)	78.67	6.25	2.62	2.35
FCRIPP 9 (Chinnalapatti)	65.00	4.35	2.17	1.99
FCRIPP10(Thirumangalam)	71.00	5.08	2.37	2.14
FCRIPP 11 (Theni)	81.67	6.67	2.72	2.45
FCRIPP 12 (Cumbum)	78.33	6.22	2.61	2.36
FCRIPP 13 (Bodi)	69.33	4.80	2.31	2.06
FCRIPP 14 (Orathanadu)	74.33	5.57	2.48	2.24
FCRIPP 15 (Tanjore)	70.33	5.03	2.34	2.13
FCRIPP 16 (Pattukottai)	81.67	6.67	2.72	2.45
FCRIPP 17 (Mettupalayam)	79.67	6.45	2.66	2.40
FCRIPP 18 (Sirumugai)	81.00	6.57	2.70	2.43
FCRIPP 19 (Dharapuram)	61.00	3.83	2.03	1.84
FCRIPP 20 (Vedaranyam)	61.00	3.82	2.03	1.88
FCRIPP 21 (Arakkonam)	69.00	4.81	2.30	2.09
FCRIPP 22 (Thiruvallur)	77.67	6.27	2.59	2.33
FCRIPP 23 (Viluppuram)	80.67	6.51	2.69	2.42
FCRIPP 24 (Tindivanam)	76.00	5.84	2.53	2.29
FCRIPP 25 (Mannargudi)	73.00	5.45	2.43	2.18
FCRIPP 26 (Perundurai)	62.00	4.25	2.07	1.89
FCRIPP 27 (Sivagangai)	57.67	3.43	1.92	1.76
FCRIPP 28 (Manamadurai)	67.00	4.56	2.23	2.03
FCRIPP 29 (Nagercoil)	68.67	4.97	2.29	2.08
FCRIPP 30 (Pudycherry)	77.00	6.02	2.57	2.31
<b>SEd</b>	8.022	1.129	0.267	0.229
<b>CD (0.05)</b>	16.04	2.258	0.534	0.459



**Table 4. Seedling and biomass attributes of *Pongamia pinnata* in different Agro Climatic zones of Tamil Nadu**

Seed source	Shoot length (mm)	Root length (mm)	Shoot dry weight	Root dry weight	SVI	RVI	Oil percent
FCRIPP 1 (Anjetti)	30.5	29.6	3.19	2.68	2565.6	2488.0	32.5
FCRIPP 2 (Denkanikottai)	31.6	30.4	3.12	2.67	2426.4	2340.2	34.5
FCRIPP 3 (Hosur)	29.8	31.6	3.99	2.59	2579.6	2452.1	33.5
FCRIPP 4 (Krishnagiri)	44.5	37.3	4.31	3.68	3794.2	3177.4	37.5
FCRIPP 5 (Pennagaram)	24.9	24.1	3.18	2.84	1815.2	1757.8	31.5
FCRIPP 6 (Dharmapuri)	23.8	24.9	3.04	2.56	1708.5	1801.2	33.5
FCRIPP 7 (Harur)	25.6	24.9	3.18	3.14	1778.3	1727.8	31.5
FCRIPP 8 (Palacodu)	23.8	22.6	3.03	2.51	1841.2	1763.1	34.5
FCRIPP 9 (Chinnalapatti)	28.8	27.4	3.75	3.33	1844.1	1785.9	27.5
FCRIPP10(Thirumangalam)	21.9	22.4	2.88	2.60	1548.9	1582.7	30.0
FCRIPP 11 (Theni)	19.5	18.8	2.66	2.39	1588.5	1538.3	28.5
FCRIPP 12 (Cumbum)	21.6	21.2	3.24	2.87	1687.2	1659.4	32.5
FCRIPP 13 (Bodi)	24.3	22.8	2.72	2.26	1680.3	1571.8	27.5
FCRIPP 14 (Orathanadu)	28.7	22.7	3.47	3.18	2166.9	1710.9	31.0
FCRIPP 15 (Tanjore)	31.5	28.5	3.82	3.31	2237.2	2023.8	35.5
FCRIPP 16 (Pattukottai)	33.2	27.6	3.13	2.60	2715.3	2266.2	32.0
FCRIPP 17 (Mettupalayam)	29.5	24.0	3.87	2.86	2347.0	1922.4	33.0
FCRIPP 18 (Sirumugai)	30.1	25.2	3.67	2.74	2456.6	2038.0	27.5
FCRIPP 19 (Dharapuram)	23.3	15.1	3.84	2.93	1411.9	945.2	29.0
FCRIPP 20 (Vedaranyam)	26.4	24.4	3.16	3.31	1618.4	1498.4	32.0
FCRIPP 21 (Arakkonam)	36.1	30.3	3.74	3.03	2501.2	2104.5	28.5
FCRIPP 22 (Thiruvallur)	22.2	20.1	2.21	2.06	1891.1	1892.4	37.5
FCRIPP 23 (Viluppuram)	25.2	23.9	3.17	2.89	2035.1	1935.9	28.5
FCRIPP 24 (Tindivanam)	27.7	24.4	3.15	3.37	2132.3	1858.8	33.5
FCRIPP 25 (Mannargudi)	42.0	28.6	4.01	2.94	3176.2	2083.9	35.5
FCRIPP 26 (Perundururai)	41.9	31.0	3.73	3.16	2575.1	1919.7	28.5
FCRIPP 27 (Sivagangai)	40.1	35.0	3.93	2.68	2547.6	2030.1	31.0
FCRIPP 28 (Manamadurai)	41.9	31.2	3.23	2.72	2970.3	2099.4	32.5
FCRIPP 29 (Nagercoil)	36.7	24.0	3.84	3.48	2514.9	1675.9	29.0
FCRIPP 30 (Puducherry)	39.8	31.1	3.67	3.23	3123.3	2440.2	32.0
<b>SEd</b>	5.15	3.64	0.53	0.43	516.7	388.5	0.421
<b>CD (0.05)</b>	10.30	7.30	1.07	0.86	1033.6	777.2	0.842



**Table 5. Genotypic correlation of seed and seedling attributes of *Pongamia pinnata* in different agro climatic zones**

Characters	PL	PW	SL	SW	S Wt.	GP	GV	PV	MDG	Shoot length	Root length	SDW	RDW	SVI	RVI	Oil %
<b>PL</b>	1.00	0.52	0.74	0.34	5.57	0.05	0.11	0.05	0.05	0.10	-0.16	0.07	-0.05	0.12	-0.18	-0.33
<b>PW</b>		1.00	0.49	0.57	-2.81	0.34	0.37	0.34	0.34	-0.36	-0.39	-0.35	-0.58	-0.35	-0.31	0.00
<b>SL</b>			1.00	0.05	5.06	-0.31	-0.25	-0.31	-0.33	0.47	0.12	0.65	0.31	0.46	-0.04	-0.32
<b>SW</b>				1.00	-4.18	0.65	0.65	0.65	0.65	-0.41	-0.48	-0.99	-0.50	-0.26	-0.14	-0.07
<b>S Wt.</b>					1.00	7.53	7.39	7.56	7.47	-2.39	0.32	-6.10	-2.30	0.09	6.05	1.56
<b>GP</b>						1.00	1.00	1.00	1.00	-0.64	-0.53	-1.31	-1.22	-0.41	0.03	0.42
<b>GV</b>							1.00	1.00	1.00	-0.59	-0.50	-1.25	-1.19	-0.36	0.07	0.38
<b>PV</b>								1.00	1.00	-0.64	-0.53	-1.31	-1.21	-0.41	0.03	0.42
<b>MDG</b>									1.00	-0.64	-0.51	-1.30	-1.17	-0.41	0.05	0.42
<b>Shoot length</b>										1.00	0.88	0.83	0.56	0.96	0.64	0.15
<b>Root length</b>											1.00	0.34	0.07	0.82	0.82	0.33
<b>SDW</b>												1.00	1.34	0.53	-0.49	-0.10
<b>RDW</b>													1.00	0.27	-0.65	-0.20
<b>SVI</b>														1.00	0.74	0.34
<b>RVI</b>															1.00	0.69
<b>Oil %</b>																1.00

PL - Pod length; PW - Pod width; SL - Seed length; SW - Seed width; S Wt. - Seed weight; GP - Germination per cent; GV - Germination value; PV - Peak value; MDG - Mean Daily Germination; SDW - Shoot dry weight; RDW - Root dry weight; SVI - Shoot Vigour Index; RVI - Root Vigour Index





**Table 6. Phenotypic correlation of seed and seedling attributes of *Pongamia pinnata* in different agro climatic zones**

Characters	PL	PW	SL	SW	S Wt.	GP	GV	PV	MDG	Shoot length	Root length	SDW	RDW	SVI	RVI	Oil %
<b>PL</b>	1.00	0.37	0.42	0.21	0.03	0.07	0.09	0.07	0.06	0.03	0.02	0.01	0.02	0.07	0.06	-0.16
<b>PW</b>		1.00	0.20	0.31	-0.06	0.04	0.04	0.04	0.05	-0.10	-0.03	-0.03	-0.08	-0.06	0.00	0.02
<b>SL</b>			1.00	0.02	0.12	-0.06	-0.03	-0.10	-0.06	0.21	0.02	0.15	0.05	0.16	-0.03	-0.14
<b>SW</b>				1.00	0.02	0.11	0.11	0.11	0.12	-0.15	-0.12	-0.20	-0.26	-0.09	-0.03	-0.05
<b>S Wt.</b>					1.00	0.02	0.01	0.02	0.01	-0.09	-0.11	0.04	0.04	-0.08	-0.09	0.02
<b>GP</b>						1.00	1.00	1.00	1.00	-0.09	0.05	-0.12	-0.14	0.41	0.61	0.14
<b>GV</b>							1.00	1.00	1.00	-0.07	0.06	-0.11	-0.13	0.42	0.61	0.12
<b>PV</b>								1.00	1.00	-0.09	0.05	-0.12	-0.14	0.41	0.61	0.14
<b>MDG</b>									1.00	-0.09	0.05	-0.11	-0.13	0.41	0.61	0.15
<b>Shoot length</b>										1.00	0.76	0.62	0.33	0.86	0.56	0.00
<b>Root length</b>											1.00	0.39	0.25	0.71	0.81	0.02
<b>SDW</b>												1.00	0.54	0.53	0.28	-0.06
<b>RDW</b>													1.00	0.27	0.14	0.04
<b>SVI</b>														1.00	0.82	0.07
<b>RVI</b>															1.00	0.08
<b>Oil %</b>																1.00

PL - Pod length; PW - Pod width; SL - Seed length; SW - Seed width; S Wt. - Seed weight; GP - Germination per cent; GV - Germination value; PV - Peak value; MDG – Mean Daily Germination; SDW - Shoot dry weight; RDW - Root dry weight; SVI - Shoot Vigour Index; RVI - Root Vigour Index