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RESEARCH ARTICLE

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Provenance variation studies in seedling traits of *Pongamia pinnata* (L.) Pierre. A potential agroforestry tree

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ABSTRACT

Screening of 40 candidate plus trees from naturally available *Pongamia pinnata* genetic resources was carried out to elucidate the variation in seedling traits to select the best planting material for higher productivity. The experiment was conducted at Regional Agricultural Research Station, Bijapur, Karnataka during 2005-2006. Among the CPTs, highest (94.33 %) germination percentage was recorded by CPT 11, plant height in CPT 20 (59.33 cm), collar diameter in CPT 32 (0.73 cm), number of leaves in CPT 20 (40.00), root length in CPT 3 and CPT 11 (41.33 cm), shoot length in CPT 23 (21.00 cm), crown spread in CPT 26 (35.33 cm), seedling dry weight in CPT 20 (6.35 g) and highest seedling vigour index(4552) was recorded by CPT 11 (Zone-3). Among the 10 agroclimatic zones of Karnataka CPTs of zone-5 was found superior in performance.

KEY WORDS : Pongamia, Seed source, Pod, Trait, CPTs

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INTRODUCTION

Pongamia pinnata is a medium sized semi-evergreen drought resistant nitrogen-fixing leguminous tree known to withstand water logging and mild frost, with high tolerance to salinity (Scott *et al.*, 2008). Pongamia seeds yield non edible pongamia oil, which is used for tanning and soap making and also as biodiesel. It is an excellent coppicer and is frequently pollarded for green manure. Its leaves, flower, bark, wood and oil are having medicinal properties. The seed cake is used as cattle and poultry feed and biogas production. Furthermore, the waste pulp is used as an organic fertilizer (Shrinivasa, 2001).

Besides these advantages, pongamia seed oil as bio-diesel is fast emerging as a viable alternative to fossil fuel. In meeting the future demands for bio-diesel it will be important to establish extensive commercial-scale pongamia plantations. However, the progress will be hampered by several factors *viz*., shortage of elite planting material, low viability of the seeds and insufficient seed germination due to fungal damage and presence of a hard seed coat that reduces germination capability. Moreover, the constraint of plants established by vegetative propagation through stump cuttings are not deep rooted and are easily uprooted (Azam *et al.*, 2005).

Hence, the challenging task, as of today is to screen the naturally available *P. pinnata* genetic resources to select the best planting material for higher productivity. Seeds from proven source or plus trees form the backbone of any successful tree improvement and afforestation programme. Quality seed has been recognized as an important input in forestry and is considered essential for increasing production and also seed polymorphism has been found to play great role in seed germination, survival and seedling growth. Keeping all this in view, an effort has been made to evaluate the extent of variation in seedling traits on germination collected from Candidate Plus trees (CPTs) of various zones of Karnataka, India.

MATERIALS AND METHODS

An extensive wild germplasm exploration survey was conducted at Regional Agricultural Research Station, Bijapur, Karnataka to identify the high yielding CPTs of

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Pongamia pinnata at fruiting stage from different predominant naturalized locations in Karnataka, India. The selection was made on phenotypic assessment of economic interest characters *viz.,* yield potential, crown spread, total height, girth at breast height, age of the tree, free from pest and diseases *etc*. A total of 40 CPTs (morphologically superior trees) covering 10 agro-climatic zones of Karnataka were collected with 4 CPTs in every agro-climatic zone. From each CPTs 2 kg mature capsules were collected during February-March, 2005. The pods were cleaned and stored in muslin bags at ambient conditions. The seeds were separated from pods and sown in polybags laid out in completely randomized block design in the month of March 2006. The observations were recorded on silvicultural parameters at 120 days after germination on plant height, collar diameter, number of leaves, crown spread, root length, shoot length and seedling dry weight. The length from the collar region to the tip of the shoot apex was measured for five randomly selected plants in each treatment. The average of five plants measurement was recorded as shoot length (cm). The length from collar region to the tip of the root was measured for five randomly selected plants in each treatment. The average of five plants measurement was recorded as root length (cm). Seedling vigour index was calculated by adding the values of root length and shoot length which was randomly selected and multiplied with their corresponding germination percentage and the values were recorded. (Abdul- Baki and Anderson, 1973)

Seedling vigour index = Germination in (%) × (Root length + Shoot length in cm)

The collar diameter was recorded using vernier caliper (cm). The crown spread of seedlings in north-south and east-west direction was measured, its average was expressed as crown spread (cm). The data recorded on various characters during the course of investigation were subjected to Fisher's method of analysis of variance and interpretation of data was made as per the procedure given by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The mean performance of 40 CPTs for seedling characters showed significant difference among the provenances (Table 1). The data on germination percentage revealed significant difference due to provenance. The germination percentage varied between 17.00 and 94.00 per cent among the 40 CPT's evaluated, highest (94.33 %) germination percentage was recorded by CPT 11 (Zone-3) and was lowest (17.00 %) with CPT 39 (Zone-10). The highest (75.5 %) mean germination was recorded by the CPT's of zone seven (CPT 25, 26, 27 and 28). The lowest (19.5 %) mean germination was recorded by the CPT's of zone ten (CPT 37, 38, 39 and 40) of Karnataka. The plant height after 120 days of germination varied from 23.33 to 59.33 cm. Among the provenances CPT 20 showed highest plant height (59.33 cm) followed by CPT 18 (57.33 cm) and lowest plant height was recorded in CPT 37. Among different agro climatic zones, zone -5 recorded the highest mean plant height and the plant height was lowest with zone-10. The collar diameter of the seedlings varied from 0.43 to 0.73 cm, with highest collar diameter in CPT 32 (0.73 cm) followed by CPT 4, CPT 20 (0.70 cm) and lowest was in CPT 8 (0.43 cm). Among the provenances number of leaves varied from 7.33 to 40.00 with more number of leaves in CPT 20 (40.00) followed by CPT 18 (37.00) and least number of leaves were in CPT 35 (7.33). The root length of the provenances varied from 41.33 to 19.33 cm, among the provenances highest root length was recorded in CPT 3 and CPT 11 (41.33 cm) followed by CPT 21 (35.66 cm) and the lowest root length was recorded in CPT 25 (19.33 cm). The shoot length of the provenances varied from 6.66 to 21.00, with highest shoot length in CPT 23 (21.00 cm) followed by CPT 22 (16.00 cm) and minimum shoot length was recorded in CPT 10, CPT 16 and CPT 30 (6.66 cm). Among the CPTs crown spread varied from 16.66 to 35.33 cm, the highest crown spread was recorded in CPT 26 (35.33 cm) followed by CPT 14 (34.00 cm) and minimum crown spread was recorded CPT 39 (16.66 cm). The seedling dry weight of CPTs varied from 3.23g to 6.35g, among the CPTs maximum seedling dry weight was in CPT 20 (6.35 g) followed by CPT 2 (5.84 g) and minimum was in CPT 4 (3.23 g). Among the 10 agro-climatic zones of Karnataka highest mean plant height, collar diameter, number of leaves, root length, shoot length, crown spread and seedling dry weight were maximum in zone-5 and the least values were recorded in zone-10.

The data on vigour index showed significant difference due to provenance. The vigour index among 40 CPT's evaluated varied between 4552 and 537. The highest (4552) vigour index was recorded by CPT 11 (Zone-3) followed by CPT 12 (4118) and was lowest (537.00 with CPT 39 (Zone-10). Among 10 agro climatic zones, the CPT's of zone-3, 7 and 8 found to be superior over CPT's of other zones and were at par with each other with respect to vigour index. The CPT's of coastal zone (Zone-10) were found to be inferior among all other zones tested.

Significant differences in seed quality parameters like

Table 1 : Provenance effect on seedling characters of *Pongamia pinnata*

CPTs	Zone	Place	Germination (%)	Plant height (cm)	Collar diameter (cm)	Number of leaves	Root length (cm)	Shoot length (cm)	Crown spread (cm)	Seedling dry weight (g)	Seedling vigour index
1	I	Bidar	50.00 (45.00)	38.00	0.56	28.00	29.33	13.33	26.66	5.74	2131
2	I	Bidar	69.00(56.18)	26.33	0.63	20.66	21.00	12.66	23.00	5.84	2322
3	I	Bidar	62.00(51.96)	29.00	0.56	21.00	41.33	07.33	26.33	5.51	3117
4	I	Bidar	82.66(65.43)	38.33	0.70	27.00	30.66	12.00	24.66	3.23	3528
5	II	Gulbarga	70.00(56.79)	41.00	0.53	26.33	28.00	11.00	28.33	4.67	2731
6	II	Gulbarga	80.00(63.51)	45.00	0.56	27.33	31.33	11.33	30.00	4.54	3424
7	II	Gulbarga	63.00(52.54)	48.00	0.60	24.66	21.33	10.00	30.66	4.63	1973
8	II	Gulbarga	40.33(39.43)	26.00	0.43	24.66	29.00	08.33	25.33	4.25	1505
9	III	Bijapur	37.00(37.46)	33.00	0.56	23.00	31.33	07.33	25.00	4.26	1433
10	III	Bijapur	32.00(34.44)	35.66	0.56	26.66	29.00	06.66	30.33	5.41	1142
11	III	Bijapur	94.33(72.59)	37.00	0.53	23.33	41.33	08.66	26.66	5.58	4552
12	III	Bijapur	87.00(68.90)	46.00	0.53	24.33	35.66	11.66	24.33	5.31	4118
13	IV	Chitradurga	79.00(62.73)	42.33	0.60	25.66	24.33	07.33	24.66	4.01	2502
14	IV	Chitradurga	83.00(65.69)	39.00	0.53	25.00	33.33	11.33	34.00	4.66	3707
15	IV	Chitradurga	61.00(51.36)	38.33	0.56	21.66	22.66	13.33	33.66	3.87	2194
16	IV	Chitradurga	32.00(34.43)	33.33	0.53	25.33	22.00	06.66	21.00	4.20	915
17	V	Bangaluru	52.00(46.17)	47.66	0.63	35.66	27.66	09.33	27.00	5.13	1924
18	V	Bangaluru	67.00(54.94)	57.33	0.63	37.00	23.33	12.33	29.66	4.52	2330
19	V	Bangaluru	58.33(42.12)	48.66	0.56	34.66	28.66	07.00	31.00	4.44	1605
20	V	Bangaluru	58.00(49.60)	59.33	0.70	40.00	24.00	09.33	29.00	6.35	1929
21	VI	Hassan	55.00(47.87)	42.00	0.53	19.66	35.66	10.33	27.33	4.42	2530
22	VI	Hassan	51.00(45.57)	33.33	0.43	17.33	30.33	16.00	21.33	4.04	2363
23	VI	Hassan	50.00(45.00)	32.33	0.56	22.00	25.33	21.00	25.66	4.11	2410
24	VI	Hassan	67.00(54.94)	33.00	0.53	19.66	32.33	09.33	18.66	3.44	2533
25	VII	Shimoga	74.00(59.41)	41.33	0.60	29.33	19.33	13.33	24.66	4.25	2745
26	VII	Shimoga	58.00(49.60)	43.66	0.60	25.66	21.66	11.66	35.33	5.05	2224
27	VII	Shimoga	76.00(60.68)	43.00	0.63	25.66	24.00	13.33	31.00	5.07	3437
28	VII	Shimoga	81.00(64.26)	44.00	0.60	25.00	33.33	07.00	24.66	5.07	2866
29	VIII	Dharwad	87.00(68.90)	45.33	0.70	20.66	34.44	11.33	21.33	3.81	3900
30	VIII	Dharwad	62.33(53.14)	37.66	0.63	14.33	23.33	06.66	26.00	4.32	2085
31	VIII	Dharwad	83.00(65.67)	32.00	0.56	20.66	35.33	09.00	23.00	4.58	3185
32	VIII	Dharwad	73.33(58.91)	40.33	0.73	21.33	25.33	08.00	21.00	4.67	2258
33	IX	Sirsi	67.00(54.94)	42.66	0.56	21.00	29.66	07.00	19.33	4.33	2303
34	IX	Sirsi	37.00(37.46)	35.66	0.50	11.66	32.33	12.33	23.66	5.24	1656
35	IX	Sirsi	64.00(53.13)	36.33	0.56	07.33	20.66	12.66	24.33	4.33	2220
36	IX	Sirsi	27.00(31.29)	37.33	0.56	17.33	20.66	10.00	26.00	4.70	887
37	X	Mangalore	20.00(26.55)	23.33	0.50	12.66	20.66	10.00	23.33	4.94	613
38	X	Mangalore	21.00(27.26)	29.00	0.46	16.00	19.33	08.66	20.66	4.27	595
39	X	Mangalore	17.00(24.33)	25.33	0.50	11.00	22.00	12.33	16.66	4.56	537
40	X	Mangalore	20.00(26.57)	28.00	0.46	07.66	29.00	13.50	18.66	4.32	852
S.E.±			3.16	1.31	20	1.41	0.007	1.22	1.43	0.15	193
C.D. (P=0.05)			9.03	3.70	0.11	3.98	2.80	3.43	4.01	0.43	543

germination, root length, shoot length and vigour index were observed, among 40 Candidate plus trees of 10 different agro climatic zones of Karnataka. The range varied from 17.00 to 94.00 per cent in germination, 19.33 to 41.33 cm in root length, 6.66 to 21.00 cm in shoot length and 537.00 to 4552.00 in seedling vigour index. Further, the highest mean data with respect to germination (76.42 %), root length (34.33 cm), shoot length (14.16 cm) and vigour index (2857) oil content (38.45 %) were recorded by Zone 8 and Zone 5, respectively. This revealed that

superiority of these zones over other agro climatic zones of Karnataka state. This is mainly attributed to genetic factors besides, the temperature, relative humidity, rainfall distribution and soil conditions that exist in these agro climatic zones chiefly influenced the seed quality parameters. These findings are in conformity with the findings of Mohit gera (1995) in *Dalbergia sissoo*, Kumar and Toky (1996) in *Albizia lebbeck* and Suresh *et al.* (1997) in *Acacia nilotica*.

Significant variations in plant height, number of leaves, crown spread, collar diameter and seedling dry weight due to provenance were noticed, which ranged from 23.33 to 59.33 cm in plant height and 7.33 to 40.00 for leaf number. The zonal mean values pertaining to plant height, number of leaves, crown spread, collar diameter and seedling dry weight (47.80cm, 30.24, 24.88cm, 0.58cm and 0.49 g, respectively) found to be superior in zone- 5 compared to all other agro climatic zones of the state. It can be attributed to the favourable edaphic and climatic factors that prevailed in zone 5 that had influenced the superiority of candidate plus trees (CPT 17, 18, 19 and 20) with respect to above attributes over other agro climatic zones of the state. Similar results were also reported in *Eucalyptus* and *Acacia nilotica* (Balakrishna and Toky, 1995).

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