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Identification of Candidate Plus Trees and Seed Source Variability in *Pongamia pinnata* (L.) Pierre

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ABSTRACT

Karanj (*Pongamia pinnata* is a medium sized tree native to humid and subtropical environment. Twenty seed sources as Candidate Plus Tree (CPTs) of *Pongamia pinnata* werecollected from Konkan region of Maharashtra from different agro climatic zones. The CPTs were selected on the basis of character like height, girth, average age, numberof pod per branch, average number of pod per meter, etc. Large variation was recorded in CPTs collected. The oil contain varies from 31.17 to 42 percent was recorded. The variability in seed source attributes is largely attributed to the heterogeneity of the genotypes and the genotype x environment interactions.

INTRODUCTION

Karanj (*Pongamia pinnata*(L.) Pierre) belonging to family Leguminoceae, subfamily Papilionoideae) is a medium sized tree that generally attains a height of about 10-20 meters and a trunk diameter of more than 50 cm. It is native to humid and subtropical environments. Karanj thrives in areas having an annual rainfall ranging from 500 to 2500 mm. in its natural habitat, the maximum temperature ranges from 27 to 38 ^{o}C and the minimum 1 to16 ^{o}C. Mature trees can withstand water logging and slight frost. Karanj can grow on most soil types ranging from stony to sandy to clay, including Vertisols. It does not do well on dry sands. The natural distribution of Karanj is along coasts and river banks in India. It is also commonly found in Raighad district of Maharastra all along the river bank and largely planted all along road side inKokan region of Maharashtra.

The species has drawn the attention for its oil as a source of biodiesel. Seeds of Karanj have about 30-35 % oil and up to 27-28 % oil can be extracted in crusher and most of the physical and chemical properties of the oil is almost similar to those of the diesel, though 'conardson carbon' residue is higher in case of it and due to high viscosity preheating is needed to start a diesel engine (Shrivastava and Prasad 2000). Pongamia oil is commonly known as Honge oil. Oil is also used as a fuel for cooking and lamps, as a lubricant, water-paint binder, pesticide, and tanning industries. Extracts from the plant are known for the medicinal properties and their effects on a wide array of organisms including insect and pests, molluses and nematodes.

The effectiveness of tree improvement programme depends upon the nature and magnitude of existing genetic variability and also on the degree of transmission of traits or heritability, because genetic variation is the fundamental requirement for maintenance and long-term stability of forest ecosystem. The rate of tree improvement can be increased or decreased by influencing the selection differential or heritability,

or by reducing the total variance. The knowledge of genetic variability and association between pod and seed traits is considered to provide considerable help in genetic improvement of the species. Hence, the present investigation was envisaged to evaluate the source variation in different pod and seed parameters collected from various agro-climatic zones of Konkan region of Maharashtra.

MATERIALS AND METHODS

The present study was conducted for selection of Candidate Plus Tree(CPT's) in Konkan region of Maharashtra. The survey for the selection of CPTs was carried out during month of Feb to May 2009 in different agro climatic zones of Konkan region. Trees growing at one location were considered to be one population. 20 locations with 25-30 random trees from each location were scored for various morphological characters, fruiting behaviour namely seed production(on score high / medium / low),seed size ,pod size, number of fruit per bunch,100 seed weight andvolume, girth, height, crown height ,crown diameter , canopy cover. Among the population one or two superior individual based on phenotypic character was selected as CPT. Almost 20 tree marked as CPT's were collected. The latitude and longitude recorded with the help of GPSand other parameters of each selected tree is given in Table 1.

Mature Pods of such selected trees were collected for analysis the seed attributes/characters. Pod and seed characters viz. length (mm), breadth (mm), thickness (mm) and weight (gm) were recorded of all the genotypes. A total of 100 pods of each CPT (four replications) were taken and average was computed for the pod and seed characters. The oven dry, cleaned kernels were crushed in crusher and oil extracted in Super Critical Fluid Extractor using CO_2 as extracting agent under high pressure. To study the variability in seed source the observations recorded were subjected to statistical methods to estimate the variability.

RESULTS AND DISCUSSION

Populations were surveyed in the Konkan region for identification of CPT's of *P. pinnata*. Amongst these 20 candidates plus tree were selected from Konkan region of Maharashtra. The analysis of variance indicated that there was significant variation among the 20 candidate plus trees for all pod and seed characters studied (Table 2). Maximum pod length (69.69 mm) was observed in KKVPP-10 and minimum (41.50 mm) in KKVPP-15 Pod thickness also varied significantly among all the CPTs. Avg. pod weight varied from 2.80 g in KKVPP-15 to7.64 g in KKVPP-4. Maximum value for seed length (27.75 mm) was observed in KKVPP-2. Maximum avg. seed weight (3.18 g) was recorded in the seeds collected from KKVPP-4. The seed thickness varied from 5.00 in KKVPP- 3 to 10.00 in KKVPP-4 (Table 2). Oil content varied from 31.17% to 42.00% (Table 1).

The above result for variation in fruit and seed characters among different CPTs or seed sources are similar to those reported by Sharma et al. (1994) in *Prosopis juliflora*, Bahadur and Hooda (1995) in *Prosopis cineraria* , Thakur et al.(2008) in *Terminalia chebula*,Chhillar et al. (2002) in *Acacia nilotica*,Dhillon et al.(1995) in *Dalbergia sisoo*. Divakara, et al. (2010), Sunil et al. (2009),Ukey et al. (2008), Narkhede et al. (2009), Reddy et al.(2008) and Kaushik et al.(2007) in *Pongamia pinnata*.

One way ANOVA of the CPT's was observed to be statistically significant, thus the variation existing in the seed source is due to phenotypical and genotypic differences. the plant height recorded ranged between 4-17 m, with the average height of 9.45 m. The CPT selected were from the natural forest areas thus were having different ages (15-50 years). The canopy diameter was recorded between 7-19 m, having 39.55 pod per meter length. The estimated seed yield per tree recorded was 10.24 kg-115.11 kg. The similar seed source variability was recorded by Narkhede et al.(2009). In Neem large scale variation was observed by Jain et al. (2003). They reported that the variation in different seed source due to the fact that the species grows over a wide range of latitude and longitude. The variability in seed source was largely attributed to the heterogeneity of the genotypes and the genotype X environment interactions (Thompson 1973).

The magnitude of differences between PCV

Table 1: Ancillary data for the CPT's selected in *Pongamia pinnata* from Konkan Region of Maharashtra

	Location	Latitude	Longitude	Age of tree (yr)	Tree ht (m)	canopy diameter	Number of pod in 1 m	seed yield (kg)	Oil contain in (%)
KKVPP-1	Soangaon,Alibaug	18° 42' 47.6"	72° 53' 39.3"	20-25	7.5	9.2	35	18.67	34.23
KKVPP-2	Pezari, Poynad.	18° 40' 50.5"	72° 59' 29.5"	45-50	9.5	12.4	57	79.48	31.17
KKVPP-3	Sarve, Phansad.	18° 25' 29.3"	72° 55' 29.6"	15-20	8	7.9	40	10.24	38.41
KKVPP-4	Roha.	18° 25' 37.5"	73° 10' 10.9"	35-40	7	9.7	62	58.43	33.04
KKVPP-5	Bamnoli, Mangaon.	18° 14' 08.6"	73° 16' 07.4"	20-25	10.5	10	30	17.81	33.43
KKVPP-6	Bamnoli, Mangaon.	18° 14'12.9"	73° 16' 06.9"	20-25	7	8.45	35	17.51	34.02
KKVPP-7	Talsure, Dapoli.	17° 45' 35.0"	73° 13' 03.8"	30- 35	10	15	45	58.22	38.22
KKVPP-8	Ladghar, Dapoli.	17° 43' 33.7"	73° 09' 06.7"	30-35	10	12	30	23.06	38.40
KKVPP-9	Bhandarwada, Ladghar, Dapoli.	17° 43' 16.3"	73° 08' 29.8"	45-50	17	19	32	61.62	36.40
KKVPP-10	Karajgaon, Dapoli.	17° 42' 14.7"	73° 08' 23.3"	15-20	4	8	51	23.00	35.74
KKVPP-11	Gimhavane, Dapoli.	17° 45' 44.0"	73° 10' 22.6"	35-40	9	15	29	35.39	37.52
KKVPP-12	Gimhavane, Dapoli.	17° 46' 16.7"	73° 09' 29.1"	45-50	8	19	40	70.19	34.80
KKVPP-13	Asudbag, Dapoli.	17° 46' 59.9"	73° 08' 02.8"	45-50	8	17	53	115.12	34.20
KKVPP-14	Kudawale, Dapoli.	17° 47' 34.6"	73° 14' 08.9"	30-35	14.5	15	32	36.00	32.82
KKVPP-15	Khed.	17° 43'	73°25'	35-40	10	15	35	26.82	34.88
KKVPP-16	Guhagar.	17° 30' 30.5"	73° 11' 02.5"	30-35	11	13	40	40.59	37.49
KKVPP-17	Sangmeshwar.	17° 07' 78.3"	73° 29' 15.7"	20-25	10	12	30	21.38	42.00
KKVPP-18	Devbaug, Malwan.	15° 59' 52.1"	73° 29' 23.0"	30-35	11	10.7	45	31.93	36.56
KKVPP-19	Devbaug, Malwan.	15° 59' 13.6"	73° 29' 27.3"	30-35	9	10.75	40	30.48	34.00
KKVPP-20	Bijghar, Dodamarg.	14° 42'	72° 53'	30-35	7	9	42	16.35	36.08

Table 2: Variation for pod and seed characters amongst the CPT's of *Pongamiapinnata*

	POD					SEED					
	Length (mm)	Width (mm)	Thickness (mm)	Weight (gm)	volume (cc)	Length (mm)	Width (mm)	Thickness (mm)	Weight (gm)	VOL (cc)	Seed to kernel ratio
KKVPP-1	52.83	24.33	11.65	4.59	4.10	23.44	16.77	8.21	2.00	1.83	2.29
KKVPP-2	68.67	28.27	12.35	6.28	5.84	27.76	19.97	8.45	2.89	2.67	2.18
KKVPP-3	44.58	25.96	9.60	3.37	3.08	20.67	17.28	6.00	1.31	1.20	2.58
KKVPP-4	63.38	28.94	14.76	7.64	7.48	26.55	19.97	10.00	3.19	2.65	2.42
KKVPP-5	54.03	27.98	10.79	4.28	3.88	22.21	17.88	7.41	1.89	1.63	2.29
KKVPP-6	62.15	28.33	12.21	5.63	5.38	23.62	19.42	8.30	2.23	1.93	2.57
KKVPP-7	52.56	27.46	9.90	3.83	3.55	22.66	18.42	6.86	1.83	1.64	2.09
KKVPP-8	52.48	27.97	10.20	4.04	3.73	22.58	18.26	6.93	1.70	1.61	2.38
KKVPP-8	56.15	24.85	10.87	4.10	3.78	22.13	16.27	7.95	1.70	1.81	2.41
KKVPP-10	69.69	28.47	11.90	5.73	5.33	23.34	18.19	8.16	2.24	1.98	2.61
KKVPP-11	54.09	28.43	10.64	4.03	3.85	21.80	18.10	7.07	1.73	1.51	2.33
KKVPP-12	65.29	32.66	10.01	5.07	4.85	21.98	16.78	6.06	1.55	1.40	3.28
KKVPP-13	58.36	29.57	11.56	5.05	4.81	24.09	19.64	7.76	2.39	2.20	2.11
KKVPP-14	63.98	24.71	9.69	3.92	3.68	19.65	16.63	7.12	1.59	1.48	2.47
KKVPP-15	41.50	21.06	9.96	2.80	2.55	21.15	14.71	6.28	1.08	1.00	2.59
KKVPP-16	52.80	26.61	11.57	4.46	4.03	21.23	16.72	8.16	1.91	1.70	2.34
KKVPP-17	50.30	22.36	10.31	3.59	3.23	21.14	15.59	7.39	1.57	1.46	2.29
KKVPP-18	50.30	25.75	11.59	4.36	4.00	23.75	16.51	7.76	1.97	1.81	2.22
KKVPP-19	66.70	29.85	13.10	6.03	5.58	22.56	17.45	8.78	2.10	1.82	2.87
KKVPP-20	49.67	26.92	9.98	3.37	3.00	21.45	17.45	6.49	1.53	1.36	2.21
Mean	56.48	27.02	11.13	4.61	4.28	22.69	17.60	7.56	1.92	1.73	2.43

and GCV was minimum indicating the little role of environment in expression of various traits. In general, all characters studied in the magnitude of PCV were greater over the respective GCV. Average pod volume (27.24 and 27.10), average pod weight (25.19 and 25.01) shows higher estimates of both PCV and GCV, respectively (Table 3). Similar type of observations were reported by Divakara, et al. (2010), Sunil et al.(2009) and Kaushik et al.(2007)in *Pongamia pinnata*, in which the CPT's collected from different locations exhibits variability in respect to character under study.

Heritability in broad sense was categorized as very high (above 95%) for all characters, which from 95.75 per cent (seed thickness) to 99.55 per cent (pod length). The genetic gain in the character studied ranges between 10.57 (pod to seed ratio) to 55.61 (100 pod volume). The present investigation are in line with those of Divakara et al. (2010), Kaushik et al. (2007) in respect of heritability values for different traits understudy.

Thus from the studies it is evident that the CPT's selecting in the three districts of Konkan regions, representing different agroclimatic zones, had wide range of variability in respect of all the characters studied. The existing variability in respect of seed yield and oil yield potential could be very well utilized for making of trees, as promising seed sources for mass multiplication of the species and future selection of plus trees.

CONCLUSIONS

In general KKVPP-02 (Pezari, Poynad) and KKVPP-04 (Roha) was observed to be best CPTs in terms of growth parameters, while KKVPP-10 (Karajgaon, Dapoli) CPT could be the best in respect of number of pods.KKVPP-04(Roha), KKVPP-02(Pezari, Poynad), KKVPP-13 (Asudbag, Dapoli) and KKVPP-19 is superior in respect of seed length, thickness, width and weight. KKVPP-04 (Roha) followed by KKVPP-02 (Pezari, Poynad) are superior in terms of seed width, thickness and weight.Maximum seed oil percent was recorded by the genotype KKVPP-17 (Sangmeshwar) followed by KKVPP-03 (Sarve, Phansad), KKVPP- 08(Ladghar, Dapoli) and KKVPP-07 (Talsure, Dapoli). Hence it can be concluded that the CPTs KKVPP-02 and KKVPP-04 are best followed by KKVPP- 03, KKVPP-07, KKVPP- 08, KKVPP- 10, KKVPP- 17 and KKVPP-19.

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Table 3: Variability estimates for different characters of CPT's in *Pongamia pinnata*

	Pod				Seed		
	Length(mm)	Thickness(mm)	Weight(gm)	volume (cc)	Width(mm)	Thickness(mm)	VOL (cc)
Vg	62.80652	1.637708	1.329048	1.347464	1.668037	0.939514	0.172323
Ve	0.283735	0.054414	0.018737	0.013936	0.030845	0.04168	0.001653
Vp	63.09025	1.692122	1.347785	1.361401	1.698882	0.981194	0.173977
PCV	14.06445	11.68521	25.18944	27.24158	7.405822	13.10926	24.0597
GCV	14.03279	11.4958	25.01374	27.10179	7.338284	12.8278	23.94512
H	99.5503	96.7843	98.6098	98.9763	98.1844	95.7521	99.0497
GA	16.28886	2.59351	2.358292	2.378984	2.636279	1.953859	0.851071
GG	28.84247	23.29747	51.16889	55.54318	14.979	25.85793	49.09201

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