laparoscope. On a bright, sunny day, if properly directed and focused, solar energy can be utilized for performing not only laparoscopic operations, but for any studies where optical fibre cables are used.

Population growth is a big challenge in our country, and family planning is highly prioritized by the Government of India. Sterilization is the most common voluntary contraceptive method, and has for many years been performed in camps. In the present study we have used solar energy as an illuminating light source for laparoscopic sterilization because in most of the remote areas there is poor and unreliable power supply. Further improvizations are possible, particularly during field camps, making arrangements for direct reading of the Lux meter and for the reflector and focusing lens to be attached to the laparoscope.

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Evaluation of progenies of candidate plus trees of *Pongamia pinnata* (L.) Pierre. for seed germination and seedling vigour

Pongamia pinnata (L.) Pierre. (family Leguminosae, sub-family Fabaceae) is one of the commercially important multipurpose tree species of India, and is popularly known as 'Karanj'. The species is found commonly in littoral and riverian forests of India[1]. It is considered as a multipurpose tree species due to its various uses like fodder, shade, biofuel, medicinal uses and for nitrogen fixing in agroforestry[2].

Recently, this species has been recognized for its high commercial value, where Karanj seeds are used for oil extraction in biofuel production (35–42%)[3]. Hence the National Oilseeds and Vegetable Oils Development (NOVOD) Board, Gurgaon, India, has initiated a tree improvement programme for tree-borne oil-yielding species (TBOs) in different states with a mandate for population identification, selection of superior genotypes and establishment of seed orchards to produce high-quality fruits/seeds for oil extraction.

Recently, the College of Forestry, Dr Balasaheb Sawant Konkan Krishi Vidyapeeth (DBSKKV), Dapoli, has initiated such work in the Konkan region, Maharashtra. Twenty candidate plus trees (CPTs) were selected in this region based on their superiority with respect to fruit yield, seed quality and oil yield. However, performance of progenies of such superior genotypes needs to be evaluated at different stages from the seedling stage to at least one-third of the rotation of that crop for morphological and reproductive characters like quality and quantity of fruit yield[4].

Progeny evaluation is one of the selection methods followed in tree improvement programmes, where superior genotypes are selected based on the performance of their respective progenies at an early age by providing similar environmental (growing) conditions to progenies of selected genotypes[5]. Individuals selected through this method are known to be superior with respect to their genetic characters. Hence, plus trees are generally graded as elite types based on progeny performance in progeny trials.

With this background, the present study was undertaken at DBSKKV during 2009–2010 to evaluate progenies of selected CPTs of *P. pinnata* for seed germination and seedling growth attributes.

The study area is situated on the west coast of Maharashtra at an altitude of 280 m amsl at 17°45′N lat. and 13°12′E long. in the subtropical region. Pods were collected from 20 CPTs selected by DBSKKV during 2008–2009 (ref. 6) and located in different regions of Konkan Maharashtra. Pods were spread separately on the floor under the shade for one week. Then the seeds were extracted and cleaned. Individual seed lot of different CPTs was sown on raised nursery bed covered with potting mixture consisting of soil, sand and farmyard manure (FYM) in the ratio 2 : 1 : 1 during July. This experiment was laid out in randomized block design with four replications having 100 seeds each. Watering and weeding were attended as and when required. Observation on daily germination count was recorded up to 45 days from the date of first emergence (Figure 1). Further, seedling growth parameters like seedling height, collar diameter, leaf area and number of leaves were recorded in the nursery bed at monthly intervals up to six months. For biomass estimation, eight seedlings from each CPT were uprooted from the nursery bed and these samples were washed in water to remove the soil completely from the root portion. Later, root growth parameters like tap root length, primary root length, number of primary roots and seedling biomass were recorded. Shoot and root vigour indices were calculated using standard formula. The data were subjected to statistical

Table 1. Seed germination percentage, seedling and root growth parameter in candidate plus trees (CPTs) of *Pongamia pinnata*

CPT	Location	Germination (%)	Seedling height (cm)	Collar diameter (mm)	Leaf area (cm^2)	Number of leaves	Root length (cm)	No. of root nodules	Primary root length (cm)	Number of primary roots	Shoot vigour index	Root vigour index
KKVPP-01	Alibaug	47.50 (43.55)	20.85	8.63	20.26	9.00	20.35	12.5	27.00	6.03	990.37	966.62
KKVPP-02	Poynad	85.50 (71.26)	46.20	7.50	17.84	8.50	12.20	14.00	36.50	6.59	3950.10	1043.10
KKVPP-03	Phansad	55.00 (48.22)	32.65	6.15	14.03	17.50	17.70	14.00	30.00	6.85	1795.75	973.50
KKVPP-04	Roha	35.50 (36.49)	39.60	7.81	18.25	11.00	17.50	13.00	20.50	7.04	1405.80	621.25
KKVPP-05	Mangaon	52.50 (46.69)	32.50	7.73	27.66	6.50	19.00	14.50	26.00	7.14	1706.25	997.50
KKVPP-06	Mangaon	48.50 (44.14)	41.05	5.06	21.45	7.00	21.85	13.00	30.00	5.47	1990.92	1059.72
KKVPP-07	Dapoli	77.00 (62.19)	33.20	9.37	17.58	16.50	14.10	15.00	33.00	6.62	2556.40	1085.70
KKVPP-08	Ladghar	52.50 (46.43)	40.30	6.70	17.83	7.00	16.55	13.50	32.50	6.72	2115.75	868.87
KKVPP-09	Ladghar	26.50 (30.78)	33.70	6.24	18.80	11.50	21.85	11.50	30.50	5.78	893.05	579.02
KKVPP-10	Dapoli	59.75 (50.74)	33.95	8.17	19.82	7.50	17.65	11.50	22.50	7.65	2028.51	1054.58
KKVPP-11	Dapoli	81.00 (67.35)	35.55	7.12	19.62	16.00	15.70	14.00	28.50	7.23	2879.55	1271.70
KKVPP-12	Dapoli	72.50 (59.24)	33.55	5.69	21.39	16.00	20.90	14.00	30.00	6.50	2432.37	1515.25
KKVPP-13	Asudbag	37.00 (36.42)	45.25	7.39	19.17	10.00	24.85	12.50	18.00	6.14	1674.25	919.45
KKVPP-14	Kudawale	24.50 (29.63)	27.65	5.66	20.59	7.50	18.35	8.50	25.00	6.50	677.42	449.57
KKVPP-15	Khed	16.50 (23.88)	29.15	5.19	20.10	4.50	16.35	3.50	27.50	7.15	480.97	269.77
KKVPP-16	Guhagar	79.50 (63.14)	21.15	5.20	19.13	2.50	17.55	2.50	35.00	6.00	1681.42	1395.22
KKVPP-17	Sangmeshwar	70.00 (57.60)	35.95	6.22	18.33	11.50	16.55	13.50	36.50	6.76	2516.50	1158.50
KKVPP-18	Devbaug	49.00 (44.42)	41.25	6.74	17.96	14.50	18.15	13.00	34.50	7.07	2021.25	889.35
KKVPP-19	Devbaug	54.50 (47.76)	29.55	8.05	18.54	16.00	21.60	12.00	36.00	7.39	1610.47	1177.20
KKVPP-20	Dodamarg.	46.00 (42.69)	22.40	6.72	18.01	7.50	18.55	14.50	29.50	7.05	1030.40	853.30
Mean		53.53	33.77	6.86	19.32	10.40	18.37	12.03	29.45	6.68	1821.87	957.46
SD		19.68	7.12	1.18	2.48	4.28	2.93	3.40	5.25	0.56	820.84	303.29
SEm		8.73	7.75	1.21	3.02	4.23	2.14	1.22	4.88	3.26	190.20	130.40
CD at 0.05%		17.49	16.23	NS	6.34	8.85	6.33	3.63	NS	9.65	531.92	257.91

Figure 1. Progeny trial of *Pongamia pinnata* undertaken in nursery condition. ***a***, Seed sowing; ***b***, Germinating seeds; ***c***, Seedling in nursery, and ***d***, Uprooted seedlings.

analyses using statistical software Mstat-c following appropriate methods[7].

Seed germination is one of the important characters that helps calculate seed rate for seedling propagation. In the present study, greater variation for seed germination among progenies of 20 CPTs was recorded, which ranged from 16.50 (KKVPP-15) to 85.5% (KKVPP-02). Six out of 20 CPTs showed maximum seed germination (more than 70%), whereas three CPTs recorded very poor seed germination of less than 30% (Table 1). This variation could be due to genotype differences as seeds from all the progenies are raised under similar environmental conditions. Sometimes seed dormancy may also influence seed germination, which is controlled by genetic factors[8]. Reports of seed dormancy in this species are scanty, but in other tropical species, seed dormancy that affects seed germination has been documented[9].

Shivanna *et al.*[10] recorded variation in seed germination among different seed sources ranging from 69.61% to 89.20%. Similarly, seed source variation has also been recorded in *Acacia nilotica* for seed germination (69.33–80.66%)[11]. It shows that seed source and individual trees have more influence on seed germination.

The seedling growth parameter showed significant variation among progenies, except collar diameter and primary root length (Table 1). After six months, seedling height greatly varied among progenies of CPTs, from 20.85 (KKVPP-01) to 46.2 cm (KKVPP-02). Six CPTs showed higher seedling height of more than 40 cm. Leaf area is one of the potential characters of the plant that positively influences seedling growth. In the present study, leaf area varied from 14.03 to

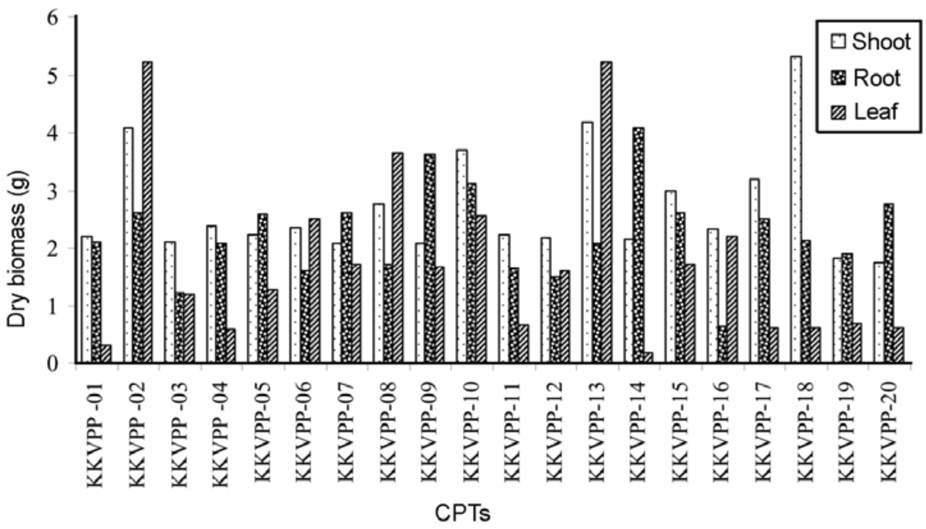

Figure 2. Dry biomass of shoot, leaf and root of seedlings of different candidate plus trees (CPTs) in *P. pinnata*.

27.66 cm^2 among progenies of CPTs. Such a range of variations has also been recorded among CPTs for other seedling parameters like number of leaves (2.5–17.5), root length (12.2–24.85 cm), and number of primary roots per seedlings (18–36.5). Shoot and root vigour indices varied significantly among genotypes. Shoot vigour index varied from 480.97 to 3950.1. The root index also followed a similar trend (269.77–1515.25) among CPTs. This kind of trend has also been documented among seed sources for vigour indices in many tropical species like *A. nilotica*[11] and *Prosopis julifera*[12].

Figure 1 shows photographs on seed germination, progeny trial and uprooted seedlings. Root nodules are characteristic of nitrogen-fixing species. Here, the number of root nodules per seedling varied from 2.5 to 15.0. Thus, KKVPP-02 can be recommended for growing in different agroforestry systems like alley cropping and multipurpose tree garden[13]. Toky *et al.*[14] recorded genetic variability among the progenies of *A. nilotica* for nitrogen-fixing ability.

Biomass is the indictor of seedling vigour, which was measured by recording the biomass (Figure 2). The shoot weight ranged from 1.75 to 5.32 g, root weight from 0.64 to 4.07 g, and leaf weight from 0.18 to 5.22 g. Dry biomass of shoot, leaf and root did not show significant difference among progenies of 20 CPTs, where these individuals were grown in a nursery that may have been exposed to competition for light, nutrients and moisture. The results of the present study show that KKVPP-02 located in the Pezari Poynad region performed better with respect to seed germination, whereas CPTs like KKVPP-06 and KKVPP-7, KKVPP-11, KKVPP-13, KKVPP-17 and KKVPP-18, performed better with respect to seedling growth attributes compared to others. Hence the progenies of these CPTs can be promoted for afforestation and reforestation programmes in this region.

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