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ESTIMATION OF GENETIC PARAMETERS OF *PONGAMIA PINNATA* L. SEEDLINGS IN NURSERY

VENNILA S*[1], S. KALA[2] AND C. CINTHIA FERNANDAZ[3]

[1]Agricultural College and Research Institute, TNAU, Tiruvanamalai 606 753, T.N., India
[2]ICAR-Indian Institute of Soil & water conservation Research Centre, Kota 324 002, Rajasthan, India
[3]ICAR-KVK, Nilgiris, TNAU, T.N., India

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Abstract– The present investigation was carried out at Forest College and Research Institute, Mettupalayam, Tamil Nadu to identify the best CPTs of *Pongamia pinnata* across its natural distribution areas in Coimbatore and Dharmapuri for further collection of seeds for afforestation or breeding purpose. In the nursery experiment the progeny PP 8, PP 12 and PP 14 showed better than others. The evaluation under nursery conditions showed that the progeny PP 14 expressed superiority for all the four traits *viz.*, plant height, collar diameter, number of branches and volume index while the progeny PP 19 also performed well for a minimum of three morphometric traits. In biometric traits, volume index had registered the highest PCV, GCV and genetic advance as percentage of mean followed by number of branches. Volume index was highly and positively associated with basal diameter at phenotypic level and with plant height at genotypic level. In Path analysis indicated that collar diameter and plant height had direct positive effect on volume index. Hence, collar diameter and plant height could be used as selection indices in *Pongamia pinnata*.

INTRODUCTION

Energy security has an important bearing on achieving national economic development goals and improving the quality of life of the people. The level of per capita energy consumption has for long been considered as one of the key indicators of economic growth. In this way, economic development of many developing countries has led to huge increase in the energy demand. As most of the countries now are enjoying rapid development are also large petroleum importers, their dependence on external energy sources from highly unstable regions would increase to uncomfortable levels. Energy security has thus become a key issue for many countries. With the constant increase in population and in the requirements, the situation in the future is going to get even worse. Thus all countries including India are grappling with the problem of meeting this ever-increasing demand of transport fuel within the constraints of international commitments, legal requirements, environmental concerns and limited resources.

Biofuel is an eco-friendly, alternative diesel fuel prepared from domestic renewable resources, i.e. vegetable oils (edible or non-edible oil) and animal fats. India has about hundreds of species which could yield oilseeds that have enough potential for use in biodiesel production. Since India is deficient in edible oils, therefore, the non-edible oils could be the desirable source for production of bio-diesel. In such case, tree borne oilseeds (TBO's) are the best and potential alternative to mitigate the current and future energy crisis and also to transform the vast stretch of wastelands to green oil fields. The potential species identified so far includes *Jatropha curcas, Pongamia pinnata, Madhuca latifolia, Garcinia indica, Azadirachta indica, Calophyllum inophyllum, Simarouba glauca* etc. Besides *Jatropha, Pongamia pinnata* is another versatile species. India is focusing on for promoting the production of biodiesel, as the country has launched a nationwide biofuel mission. Thus with its vast wastelands, and the global community increasingly rooting for alternate fuels, India could well become the global sourcing hub for both feed stock and processed bio-diesel.

The demands for petrol and diesel are rapidly increasing in developing countries. The rate of increase is very high in India (Katwal and Soni, 2003). The consumption was 37 million metric tonnes in 1970, which increased up to 222.79 million metric tonnes during 2020-2021 (Gyanaranjan Sahoo *et al*., 2020). The country is importing about 78% of crude oil and investing a huge amount as a foreign exchange for fulfilling oil requirements. The prices of crude oil are enormously increasing in the international market over the last few years. On the other hand, the excessive use of fossil fuels are releasing a huge quantity of greenhouse gases (GHGs) in the atmosphere and altering the world climate. Growing concern over increasing prices of fossil fuels, depleting oil reserves coupled with environmental degradation has prompted to search alternative, renewable, economically viable and environmentally safe fuels derived from plant origin usually termed as biofuels (Kesari *et al*., 2009). Emphasis is given in India to exploit the potentials of pungam oil as a source of bio-diesel because it has low viscosity, better fuel properties and could be safely blended with petro-diesel even up to 20 % without any modification of existing diesel engines (Shrinivasa, 2001). The pungam oil has proved as an excellent feedstock for bio-diesel production in the country. The planning commission of India has set to blend 5-10 % of bio-diesel from the year 2010 to meet Euro III norms as per the agreement of Kyoto protocol. In this background, pungam by virtue of its broad existence and commercial exploitation over the years has proved to be real alternative for fossil fuels. In this background an attempt has been made to carry out the study.

MATERIALS AND METHOD

Pungam seeds were collected from 20 identified candidate plus trees from across its natural distribution areas in Coimbatore and Dharmapuri of Tamil Nadu (Table 1). Physiologically matured pods were collected and extracted quality seeds. The seeds were directly sown in polybags (15 x 25 cm size) filled with mixture of red soil, sand and FYM (2:1:1). This study was conducted in Forest College and Research Institute, Mettupalayam using Completely Randomized Design with five replications. The observations were taken 90 days after sowing (DAS) of seeds. The variation in the growth attributes like collar diameter (mm), plant height (cm) and number of leaves was taken. Analysis of variance was carried out following the

Table 1. Variation in progeny performance traits of *Pongamia pinnata* (3 MAS)

Progenies	Height (cm)	Collar diameter (mm)	Number of Branches	Volume Index	Sturdiness quotient
PP 1	21.40	2.84	3.00	172.60	11.26
PP 2	26.20	3.09	2.60	250.10	12.06*
PP 3	16.60	2.06	2.30	70.44	12.05*
PP 4	18.20	2.91	3.00	154.10	11.73
PP 5	29.40*	3.61	3.20	383.10	10.97
PP 6	28.80*	3.32	2.80	422.20	10.29
PP 7	26.00	4.03*	2.40	422.20	12.66*
PP 8	30.80**	4.20**	4.40**	543.30**	11.20
PP 9	27.20	3.96*	3.00	426.50	10.32
PP 10	25.20	3.51	3.40	310.40	11.10
PP 11	22.20	3.53	2.40	276.60	10.97
PP 12	32.20**	4.12**	5.20**	549.90**	11.10
PP 13	30.60**	3.80	4.20**	441.80	11.04
PP 14	32.80**	4.84**	5.80**	604.30**	10.11
PP 15	33.60**	3.20	4.00**	344.00	8.20
PP 16	29.80**	4.11**	3.20	503.30*	8.67
PP 17	29.80**	3.95	3.60**	464.90	12.97**
PP 18	29.00*	3.91	2.30	443.30	11.46
PP 19	29.60**	4.42**	2.20	578.20**	9.60
PP 20	23.20	3.28	3.20	331.40	10.38
Mean	26.80	3.66	3.09	408.79	10.77
SEd	0.93	0.34	0.41	151.48	1.08
CD (0.05)	1.82	0.30	0.42	79.60	1.68

procedure given by Panse and Sukhatme (1978). The variability, heritability in broad sense, genetic advance as percent of mean, phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were worked out for seed traits and oil content as suggested by Lush (1940), Johnson *et al*. (1955) and Burton (1952).

RESULTS AND DISCUSSION

Significant differences were found among 20 progenies of *Pongamia pinnata* for five growth parameters *viz.*, plant height, collar diameter, number of branches, volume index and sturdiness quotient under nursery condition. In the present investigation, three progenies *viz.*, PP 14, PP 19 and PP 12 exhibited superiority for three characters namely Seedling height, collar diameter and volume index. Similarly the progenies PP 15, PP 14, PP 12 and PP 8 exercised superiority for Seedling height while the progeny PP 17 exhibited superiority for sturdiness quotient. However the progeny PP 14 recorded superiority in terms of collar diameter (Table 1). A plethora of researchers have already evidenced on the comparative performance of various progeny of *Pongamia pinnata* and *Calophyllum inophyllum* at the nursery stage (Palanikumaran, 2015). Singh *et al*., (1996) reported the year to year variations in the performance of poplar progeny the nursery, which also lent support to the variable performance of progeny in the current study. In the present investigation out of 20 progenies evaluated in Pungam four progenies *viz.*, PP 8, PP 12, PP 14 and PP 19 proved to be superior performers.

Genetic estimation and association studies

In the present investigation, volume index had registered high phenotypic and genotypic coefficient of variation followed by collar diameter. Similarly volume index exhibited high heritability and genetic advance followed by collar diameter and height (Table 2). Similar findings were earlier reported in *Populus deltoides* (Singh *et al.*, 2001); *Tectona grandis* (Gera *et al.*, 2001) and also in *Calophyllum inophyllum* (Palanikumaran, 2015). This heritability estimates are reliable genetic measure for selection along with expected genetic gain (Johnson *et al*., 1955). Hence, high heritability for height, number of branches, collar diameter and low heritability value for volume index, which indicates that a considerable portion of variance is additive. Thus among the biometric traits studied, volume index, collar diameter and plant height displayed higher PCV and GCV, higher heritability and genetic advance as percentage of mean which indicate a greater scope of genetic gain through selection.

Growth is a complex factor associated with many characters which are interrelated themselves. Such inter-relationship among various growth

Table 2. Genetic estimates for morphometric traits under nursery condition (3 MAS)

Traits	PCV (%)	GCV (%)	Heritability (%)	GA (%) of mean
Seedling height	25.05	13.79	30.32	21.43
Collar diameter	29.11	13.37	21.12	12.66
Number of branches	44.85	21.60	23.20	15.65
Sturdiness quotient	29.97	5.75	13.68	2.27
Volume index	65.79	26.55	16.30	22.08

Table 3. Phenotypic correlation coefficient for morphometric traits under nursery condition (3 MAS)

Traits		Seedling Height	Collar diameter	Number of Branches	Sturdiness quotient
Seedling Height	P	1.000**	0.400**	0.312**	0.407**
	G	1.000**	0.789**	0.786**	0.436**
Collar diameter	P		1.000**	0.134	0.635**
	G		1.000**	0.102	0.309**
No. of Branches	P			1.000**	0.083
	G			1.000**	1.385**
Sturdiness quotient	P				1.000*
	G				1.000**

**Significant at 1% level

Table 4. Path coefficient analysis of morphometric traits on Sturdiness quotient under nursery condition (3 MAS)

Traits	Seedling Height	Collar diameter	No. of Branches	Sturdiness quotient
Seedling Height	0.1092	0.7766	-0.1393	0.0762
Collar diameter	0.0862	0.9840	-0.0181	-0.0541
Number of Branches	0.0859	0.1007	-0.1771	0.2420

Residual effects = 0.1761 (Diagonal values are direct effect)

parameters is essential to understand the relative importance of each characters involved (Deepak Pandey *et al.,* 1997). In the current study, among the four characters studied, sturdiness quotient registered a higher magnitude of phenotypic association with plant height, basal diameter and number of branches. These traits also had positive and significant genotypic correlation with sturdiness quotient (Table 3).

In path analysis, seedling height exercised maximum positive direct effect on sturdiness quotient followed by the number of branches (Table 4). Parthiban (2001) reported that collar diameter had maximum positive effect on volume index in *Tectona grandis*. Basal diameter had the maximum direct effect on volume in *Santalum album* suggesting a better scope for improvement of volume by selecting this trait (Reddy and Subramanian, 1998). Similar positive direct effect on collar diameter, plant height and number of branches was also established in *E. tereticornis* clones (Sasikumar, 2003). Jayaprakash (2000) also observed the exertion of positive and direct effect of collar diameter on volume in *A. nilotica.* However, basal diameter exhibited a negative direct effect on sturdiness quotient but a positive indirect effect through seedling height and no of branches on Sturdiness quotient. Thus, the present investigation envisaged that high and positive association coupled with intensive direct effect of Number of Branches followed by plant height could be used as valuable, reliable and relevant yardsticks for the selection in tree improvement programme.

CONCLUSION

It was concluded that, potentially huge genetic variability existed in progeny of *Pongamia pinnata*. Among the 20, four progenies *viz.*, PP 8, PP 12, PP 14 and PP 19 were found superior for all the traits studied. Hence, selection, mass propagation and popularization of these progenies for industrial plantations would help to improve the overall productivity of pungam. Higher genotypic correlation coefficient of seedling characters revealed that the traits are genetically controlled and selection can be very effective in further tree improvement programme.

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