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Research Article

Nutrient Status in *Pongamia pinnata* L. (Pierre) Seedling from Different Seeds Sources

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ABSTRACT

The present study on nutrient status in Pongamia pinnata L. (Pierre) seedling from different seed sources shown the highest N content (79.16 mg plant $^{-1}$) in leaves, phosphorous content highest (0.81 mg plant $^{-1}$) in leaves, phosphorous content highest in the root (0.79 mg plant $^{-1}$) in Raipur seed sources. The highest potassium content (14.77 mg plant $^{-1}$) in root was observed in the seed source of Raipur. Therefore healthy seedling was grown for plantation purposes. In addition high nutrient content seedling is also desirable to enhance the early growth of Pongamia.

Keywords: *Biofuel, Growth, Plantation, Seedling.*

INTRODUCTION

Pongamia pinnata L. (Pierre), commonly known as Karanj is one among the moderately fast growing multi-purpose trees belongs to the family *Fabaceae*. It is a medium size evergreen tree native to the Western Ghats but distributed throughout India and extends further eastwards, chiefly in the littoral regions of South-East Asia and Australia (Anonymous, 1953). It is a nitrogen fixing and drought tolerant species that thrive under varied climatic and edaphic conditions. *P. pinnata* is an important source of fuel, fodder and small timber in rural India. However, it is economically valued for its seeds, which provide commercially important oil, popularly known as pongam oil is utilized in tanning, pharmaceutical and soap industries (Karoshi & Hegde, 2002). The oil is also used in illumination and as a lubricant. It has low viscosity and excellent fuel properties almost comparable with petro-diesel. Therefore, a lot of emphasis is given in recent years to explore the potential of pongam oil as an alternate source of petro-diesel in India.

The demands for petrol and diesel are rapidly increasing in developing countries. The rate of increase is very high in India. The consumption was 37 million metric tonnes in 1970, which increased up to 222.79 million metric tonnes during 2020-2021.

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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 green house 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. Emphasis is given in India to exploit the potentials of pongam 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 pongam 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. To achieve this, it is planned to grow *P. pinnata* in 0.5 to 1 million ha under different land use systems (Katwal & Soni, 2003). *Pongamia* by virtue of its broad existence and commercial exploitation over the years has proved to be real alternative for fossil fuels. The fast growth, easy adaptability and drought resistant made this species to be a real asset for commercial plantation in India. Further, the options for alternate uses of *Pongamia* tree for green manure (cake), fuel and oil enhance its bio-economic value. *P. pinnata* can thrive under a wide variety of climatic and edaphic conditions. It grows on a variety of soils ranging from sandy soils to stony, murammy and even highly saline to moderately alkaline soils, but it grows luxuriantly on deep well drained alluvial soil with an abundant supply of soil moisture (Luna, 1996). It is a monoecious and cross-pollinated species generally pollinated by wind and honeybees. Due to its wide spread distribution and cross-pollination, a lot of variabilities is found in growth and reproduction behaviour in natural stands. The seeds are mostly heterozygous and considerable variation is encountered in seed size, shape, weight and oil content. The first step in genetic improvement involves understanding the inherent variability existing in different geographical sources and the use of right provenance will help in maximizing the growth and yield of plantations of *P. pinnata*. There is a dearth of information on provenance/seed source variation in relation to growth, biomass and oil yield as well. Nutrients have long been recognized to affect plant biomass and partition of dry matter to leaves, stems and roots (Canham et al. 1996). Among the nutrients, N plays a vital role in the growth and biomass production of seedlings. Similarly, the plants growing under shade conditions often develop thin leaves as compared to light conditions on a dry weight basis (Muthuchelian et al. 1989). There are very few documents available on Nutrient status in the seedling of *Pongamia pinnata L*. Until now, no information is available on the nutrient status of seedling growth due to seed origins, which make optimum scheduling of nursery operations difficult. Therefore, an attempt has been made to carry out the study.

MATERIALS AND METHODS

The present study was carried out in the experimental field of Department of Forestry, Indira Gandhi Agricultural University, Raipur (C. G.) during 2003-2004. The study area, is located in eastern India, situated at latitude 21^0 12' North and longitude 81^0 36' East with an elevation of 289.6 m above mean sea level. The climate of the study site is sub humid tropical with an average annual rainfall of 1250 mm. Almost 80 % of rainfall occurs during the rainy season from the last week of June to the second week of September. May is the hottest month and December is the coldest month of the year. The mean monthly maximum temperature ranges from 27^0C in December to 42^0C in May and the minimum temperature from 13.2^0C in December to

28.3^0C in May. The maximum temperature occasionally rises above 45^0C in May, while the minimum falls below 8^0C in December. The relative humidity is generally high during the rainy season from July-August, which reaches up to 80 % and it goes below 30 % during hot summer in April-May. Mean monthly meteorological data during the study period as recorded at meteorological observatory, IGAU, Raipur. The survey was conducted in different agroclimatic zones of Chhattisgarh, Orissa, Madhya Pradesh, and Andhra Pradesh. Based on edopho-climatic characteristics, five distinct provenances were delineated. Each provenance covered a large geographical area constituting at least two agro-climatic zones. The seed source represents a particular agroclimatic zone of that provenance. Healthy and mature stands were demarcated in the field. Five average size (90 ± 10.5 cm dbh; 8.5 ± 2.5 m height) trees were randomly selected from each stand. The details of the provenances and seed sources are given in Table 1.

Table 1: Geographical location of seed sources of *P. pinnata L.* (Pierre)

Provenance	Source	Latitude	Longitude	Annual Rainfall (mm)	Temperature (°C)		Soil Type
					Max.	Min.	
Chhattisgarh	Raipur	21^0 12' N	81^0 36' E	1250	45.2	9.2	**Vertisols**
	Ambikapur	23^0 10' N	83^0 15' E	1379	44.1	3.4	**Inceptisols**
Madhya Pradesh	Jabalpur	23^0 12' N	79^0 57' E	1331	44.7	4.5	**Vertisols**
	Nainpur	22^0 25' N	80^0 06' E	1386	43.6	6.2	**Entisols**
North Andhra Pradesh	Karimnagar	18^0 25' N	79^0 09' E	810	45.4	14.2	**Inceptisols**
Central Andhra Pradesh	Kessargutta	17^0 20' N	78^0 28' E	893	43.1	13.4	**Alfisols**

Approximately 3-5 Kg pods were collected from five selected trees in each source of different provenances during April-May 2003. Pods of each source were kept separately for drawing samples.

Seeds collected from six sources (Raipur, Ambikapur, Jabalpur, Nainpur, Karimnagar and Kessargutta) were grown in the Nursery at Experimental Farm, Department of Forestry, Raipur (C.G.) during July-August, 2003. Irrigation and intercultural operations were regularly carried in nursery beds. After one month, healthy and uniform size (collar diameter 2.5 ± 0.5 mm and height 8.5 ± 0.6 cm) seedlings were selected and transplanted in 10'x12' poly bags filled with 1:1:1 clay soil, sand and organic compost. Bigger size poly bags were used to prevent root coiling. Different treatments were imposed in a factorial CRD design with three replications. The treatments consist of two nitrogen levels (Low – 5 g plant^{-1}, High – 15 g plant^{-1}), two light regimes (Low – 50 %, High – 100 %) and six sources. Ten seedlings were maintained for each treatment. A total of 720 seedlings (2 nitrogen x 2 light x 6 sources x 3 replications x 10 plants/treatment) were raised in the experiment. Each block contained 240 seedlings, which maintained in such a way that half of the seedlings were kept under shade (low – 50 % light) and remaining in open sky (high – 100 % light) conditions. Seedlings were weekly irrigated and weedings were done at monthly intervals. Observations on growth were recorded in three randomly selected plants in each treatment at fifteen days interval up-to three months.

Total N, P, K in plant parts were analyzed in different sources. The available nutrients (N, P, K) were estimated before and after seedling establishment. Total N was measured by Kelplus (Pelican equipment) based on Micro Kjeldal principle. P and K were estimated after digesting the samples in the triple acid mixture (HNO_3, H_2SO_4 and HCl_4 in 5:2:1 ratio). Total P was determined by vanado-molybdate phosphoric yellow colour method and K by flame photometer method (Jackson, 1967).

Statistical analysis

It was carried out as repeated measure factorial experiment under a completely randomized design having a source, nitrogen and light as the factors (Snedecor & Cochran, 1967) replicated thrice.

RESULTS AND DISCUSSION

Results on nutrient content (N, P and K) in leaves, shoots and roots of different sources at 45 and 120 days are presented in Table 2.

Nitrogen content

N content in leaves varied from 10.25 to 14.97 mg plant^{-1} and 49.26 to 79.16 mg plant^{-1} at 45 and 120 days, respectively. It increased from 4 to 30 mg plant^{-1} from 45 to 120 days. Highest N content (79.16 mg plant^{-1}) was found in Raipur source followed by Ambikapur, Nainpur and Jabalpur sources. Lowest (49.26 mg plant^{-1}) N was found in Kessargutta source, which was statistically at par with Karimnagar source (Table.2).

N content in shoots varied from 5.33 to 6.58 mg plant^{-1} and 14.19 to 18.15 mg plant^{-1} at 45 days and 120 days, respectively. Maximum (18.15 mg plant^{-1}) N content in shoots was found in Ambikapur followed by Jabalpur and Raipur sources. It was minimum (14.19 mg plant^{-1}) in Karimnagar source. However, it was statistically at par with Nainpur and Kessargutta sources.

N content in roots is comparatively higher than leaves. Highest (66.88 mg plant^{-1}) N content in roots was found in Jabalpur source followed by Raipur, Ambikapur, Nainpur sources. Kessargutta source showed lowest (55.82 mg plant^{-1}) N content, which was statistically at par with Karimnagar source. It increased from 7 to 11 per cent between 45 to 120 days.

Phosphorus content

Among different sources, P content in leaves was highest (0.81 mg plant^{-1}) in seedlings of Raipur source followed by Ambikapur and Jabalpur sources at 120 days, while it was lowest (0.69 mg plant^{-1}) in Karimnagar source (Table 2).

Shoots showed lowest P content compared to other plant components of seedlings (Table.2). Among various sources tested, highest (0.22 mg plant^{-1}) P was found in Kessargutta and Nainpur sources followed by Karimnagar source which were statistically at par with Jabalpur source. Raipur source showed lowest (0.18 mg plant^{-1}) P content in shoots, which was statistically at par with Ambikapur source.

P content in roots also varied significantly ($P \leq 0.05$) in different sources (Table 2). It varied from 0.16 to 0.25 mg plant^{-1} and 0.42 to 0.79 mg plant^{-1} at 45 days and 120 days, respectively. Maximum P content in roots was found in Raipur source followed by Karimnagar, Kessargutta, Ambikapur and Jabalpur sources. It was lowes t (0.42 mg plant^{-1}) in Nainpur source.

Potassium content

K content in leaves varied from 2.44 to 3.13 mg plant^{-1} and 11.61 to 17.39 mg plant^{-1} at 45 days and 120 days, respectively. It was highest in Raipur source followed by Ambikapur, Karimnagar, Jabalpur and Kessargutta sources, which were statistically at par with each other. Lowest (11.61 mg plant^{-1}) K content in leaves was found in Nainpur source (Table 2).

In shoots, K content varied significantly in different sources at 45 and 120 days. At initial stage, it was low but increased with an increase number of days. K content in shoots was maximum (4.65 mg plant^{-1}) in Jabalpur source and minimum in Nainpur source. Karimnagar and Kessargutta sources were statistically at par for K in shoots (Table 2).

K content in roots varied from 2.82 to 4.72 mg plant^{-1} and 8.87 to 14.77 mg plant^{-1} at 45 and 120 days, respectively. Among different sources, highest (14.77 mg plant^{-1}) K content in roots was observed in seedlings of Raipur source followed by Ambikapur, Jabalpur, Nainpur and Karimnagar sources. K content was lowest (8.87 mg plant^{-1}) in Kessargutta source.

The use of proper seed source will ensure better survival and maximize productivity in stands. The performance of genotype can be altered through manipulating environment by managerial interventions. Seed sources is essential for developing quality planting stock needed for growing successful plantation in a given region. Use of proper seed source and improved management practices (N, P, K) will enable to capture maximum productivity gains in quickest possible time (Leaky et al. 1982 & Foster et al. 1984). The seed sources of dry regions did not adjust the sub humid environmental conditions of Raipur and thus resulted in poor growth and development. This is in line with the findings of Wang et al. (1998), where the seed sources of *Betula papyrifera* planted from the extreme environment (hot-dry) failed to survive in a provenance trial established in a humid environment. More wat er and Nutrient improve improves nutrient availability and phosphorous absorption (Karama & Manwan, 1990). All these factors favorable for seedling growth, plant biomass probably the synergetic combination of factors (Rout & Nayak, 2015) of growing media and nutritional factors (Sahni et al. 2008).

Table 2: Nutrient status (mg plant^{-1}) in seedling components of different sources of *P pinnata L.* (Pierre)

Source	Nitrogen content in leaves (mg plant^{-1})		Nitrogen content in roots (mg plant^{-1})		Nitrogen content in shoots (mg plant^{-1})		Total N (mg plant^{-1})		Phosphorus content in leaves (mg plant^{-1})		Phosphorus content in roots (mg plant^{-1})		Phosphorus content in shoots (mg plant^{-1})		Total P (mg plant^{-1})		Potassium content in leaves (mg plant^{-1})		Potassium content in roots (mg plant^{-1})		Potassium content in shoots (mg plant^{-1})		Total K (mg plant^{-1})	
	Before	**After**	**Before**	**After**	**Before**	**After**	*Before*	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	*Before*	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	*Before*	**After**
Raipur (S_1)	14.97	79.16	23.04	66.22	5.82	16.85	**43.83**	**162.23**	0.14	0.81	0.25	0.79	0.05	0.18	**0.44**	**1.78**	3.13	17.39	4.68	14.77	1.38	4.31	**9.19**	**36.47**
Ambikapur (S_2)	11.53	63.70	22.05	64.05	6.58	18.15	**40.16**	**145.90**	0.12	0.75	0.16	0.55	0.06	0.18	**0.34**	**1.48**	2.44	13.98	4.34	13.28	1.51	4.55	**8.29**	**31.81**
Jabalpur (S_3)	12.21	53.80	24.29	66.88	5.33	17.63	**41.83**	**138.31**	0.16	0.72	0.16	0.54	0.05	0.20	**0.37**	**1.46**	2.79	12.55	4.28	12.97	1.27	4.65	**8.34**	**30.17**
Nainpur (S_4)	11.03	54.28	25.92	58.48	6.04	15.27	**42.99**	**128.03**	0.14	0.71	0.17	0.42	0.07	0.22	**0.38**	**1.35**	2.27	11.61	4.72	11.40	1.27	3.65	**8.26**	**26.66**
Karimnagar (S_5)	10.25	51.39	18.91	55.86	5.37	14.19	**34.53**	**121.44**	0.13	0.69	0.19	0.63	0.06	0.20	**0.38**	**1.52**	2.68	13.88	2.82	9.58	1.30	3.81	**6.80**	**27.77**
Kessargutta (S_6)	11.64	49.26	23.02	55.82	6.08	15.18	**40.74**	**120.26**	0.15	0.69	0.21	0.58	0.08	0.22	**0.44**	**1.49**	2.91	12.78	3.21	8.87	1.52	3.92	**7.64**	**25.57**
***CD at 5%**	**2.08***	**7.11***	**3.47***	**5.66***	**0.86***	**1.83***			**0.02***	**0.08***	**0.05***	**0.107***	**0.027***	**0.048***			**0.503***	**1.89***	**0.602***	**1.09***	**0.298***			

CD- Critical difference, Before - 45 Days, After-120 Days

CONCLUSION

It was concluded that source of seed from Raipur produces healthy seedling as it promotes better growth. Growth and Nutrient status is a good prediction for field performance since it integrate with nutrients.

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