



STUDIES ON FLORAL PHENOLOGY IN *PONGAMIA PINNATA* L., A BIODIESEL PLANT

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ABSTRACT: *Pongamia pinnata* seed oil could be as a source of biofuel from which enormous potential of high seed oil can be produced. The collection of pods with higher seed quality characters is much important for production of elite seedlings at nursery and hence studies related to seed maturation were initiated as matured seed is the basic character of quality seed. To study the steps in obtaining quality seed from the tree, studies were initiated on floral phenology. Randomly selected trees from 23 accessions of *Pongamia* planted in August, 2005 were selected for the studies conducted in two consecutive years, i.e. 2012-13 and 2013-14. The results revealed that in *Pongamia* accessions studied, the racemes per branch ranged from 13 to 112, buds per racemes ranged from 25 to 80 and 0-64 total number of flowers opened in a day in the year 2012-13. In the year 2013-14, the racemes per branch ranged from 8 to 246, buds per racemes ranged from 0 to 76 and 14-67 total number of flowers opened in a day. On an average 6.57g and 2.14g fresh and dry biomass, respectively was obtained. These studies will help in further investigation of pod and seed studies.

Key words: *Pongamia pinnata*, floral phenology, pod maturation, fruit colours, seed and seedling quality characters.

INTRODUCTION

Pongamia pinnata (L.) Pierre (Leguminaceae, subfamily Papilionoideae) is a medium sized tree commonly called as Karanja that generally attains a height of about 10-20 m and a trunk diameter of more than 50 cm *Pongamia pinnata* is widely distributed throughout tropical Asia and the Seychelles Islands, South Eastern Asia, Australia, India and naturally distributed along the sea coasts and river banks in India [1]. The species thrives in areas with an annual rainfall of --- mm and a temperature range of 1-38°C. It can resist drought and withstand water logging and slight frost. For the past one decade, oil from *Pongamia* seeds has been seen as a potential source for biodiesel [2]. *Pongamia* seeds contain 30-35% oil and its physical and chemical properties are almost similar to the diesel. However, *Pongamia* oil could not be used as such and this oil needs preheating due to high viscosity and Conradson carbon residue [3, 4]. The *Pongamia* is being cultivated in large number of gardens and widely distributed on road sides in India and has the potential for the biological industry. It has been observed that reproductive biology is very important to determine the seed and fruit set, conservation, pollination and breeding systems that regulate the genetic structure of populations. *Pongamia* has lot of variability in terms of flowering phenology, fruit colour, and fruit maturation period between the ecological zones as well as within the ecological zone. Thus, the knowledge on variability and its association with pod and seed traits is prerequisite for genetic improvement of the species. Hence, it necessitates seed source testing prior to an intensive breeding work [5]. A clear understanding of phenological behaviour on time of anthesis, time and duration of stigma receptivity, fertilization, mode of pollination, seed development is necessary for breeding programmes to obtain better traits [6, 7]. Collection of quality seed is very important in this crop as this oilseeds crop loses viability at faster rate and are described by researchers as micro biotic. Seed maturation is the environmentally influenced genetic factor is the major factor that speaks on the quality of the seed [8]. In this huge tree, application of duration for collection of matured seed is cumbersome and requires an alternate means for collection of quality seed. The size of fruits and seeds has been considered as an important variable in the reproductive biology of plants. But colour of fruit has long been considered as an easier technique for production of quality seeds in forestry. In the past, only very little efforts has been made to study the phenology and seed maturation aspects in *Pongamia* [9]. The present study aims to investigate the floral phenology, developmental variation in fruit and seed, maturation period and evaluating the harvest index based on fruit colour in *Pongamia pinnata*.

MATERIAL AND METHODS

Study Area

The experiment was conducted at Hayatnagar Research farm of Central Research Institute for Dryland Agriculture (17°27'N latitude and 78°35'E longitude and about 515 m above sea level), Hyderabad in Southern part of India. The climate is semi-arid with hot summers and mild winters. The mean maximum air temperature during summer (March, April and May) ranges from 35.6 to 38.6°C, where as in winter (December, January and February) ranges from 13.5 to 16.8 °C. Annual long-term rainfall for the site is about 746.2 mm received predominantly from June to October.

The soils are medium-textured, red soil with shallow depth (Typic Haplustalf as per USDA soil classification)

Tree establishment

In the year 2005, 4 months old nursery raised *Pongamia* plants were planted in the pits of 45 cm³ size during the month of July. The pit mixture contained good dugout soil + 2 kg compost + N, P and K at 42 g, 168 g and 42 g respectively. The 23 accessions screened from 160 plus trees were planted on 07.08.2005 with a spacing of 5 x 5m in a plot size of 225sqm. Each plot of 225sqm contained nine plants of each accessions. In total, there were 23 plots per each replication and the total number of plots were 69 in three replications. The randomly selected trees were used for studying number of inflorescence per branch, date of flower opening, total number of flowers per inflorescence, number of pods set per inflorescence, number of mature seeds harvested per inflorescence, percent pod set.

Studies on floral phenology

Twenty three trees belonging to different accessions were randomly selected from the plantation and one inflorescence from each tree was tagged at the initiation of flowering and was observed up to pod maturation. During maturation the data on number of flowers per inflorescence, pod per inflorescence, and number of seeds per inflorescence were observed twice a day in the morning and evening for the period of 30 days and observations were pooled as weekly intervals. In addition to that, pod setting percentage, seed setting percentage and pod to seed setting percentage were also calculated adopting the following formulae.

$$\text{Pod setting percentage} = \frac{\text{Number of pods formed}}{\text{Total number of flowers per inflorescence}} \times 100$$

$$\text{Seed setting percentage} = \frac{\text{Number of seeds formed}}{\text{Total number of flowers per inflorescence}} \times 100$$

$$\text{Pod to seed set percentage} = \frac{\text{Number of seeds in number of pods}}{\text{Total number of pods per inflorescence}} \times 100$$

RESULTS AND DISCUSSION

Flowering phenology

It was observed that *Pongamia pinnata* initiated flower buds from mid-April to mid of May. The data (Table 1) showed that in a day 0-64 of flowers were observed per inflorescence, which had the range varying from 25-80 buds per racemes. Where as the he racemes obtained were in the range of 13 to 112 respectively in 2012 -13. However, in 2013-14, number of racemes per branch ranged from 8-246, number of racemes ranged from 0-76 and number of flowers opened in a day ranged from 14-67 per inflorescence (Table 2). On an average fresh and dry biomass of 6.57g and 2.14g was observed (Table 3). Formation of flowers, pod or seed setting characters are highly variable in *Pongamia* trees from locality to locality, the variation may be related with genetic effect of the tree (Nelsonnavamaniraj, 2005) and the environmental factors prevailing at the particular locality [11]. Similar variation in seed setting and percentage was also reported in different crops by different researchers [19, 12, 13, 14, 5, 16, 17, 18]. The results observed in the present study reflected the same kind of pattern.

Table 1: Pongamia flowering observation in the year 2012-2013

NOVOD National trial				
Row no	Pt no	No of racemes/branch	No of buds /racemes	Total No of flowers opening in days
2	1	23	42	35
5	1	26	64	61
6	1	80	56	54
9	1	48	64	44
10	1	36	54	53
17	3	112	51	50
18	1	49	35	22
20	1	76	62	44
27	2	56	36	54
29	2	47	48	44
30	1	30	35	35
31	1	60	30	30
32	1	60	54	54
34	3	60	32	26
36	1	26	39	31
37	1	24	80	0
38	1	78	65	64
22	1	29	30	30
23	1	27	44	42
24	1	16	25	24
21	1	54	60	59
35	1	13	58	58
3	3	55	36	38
4	3	76	66	64
33	3	58	46	46
8	2	30	48	48

Table 2: Pongamia flowering observation in the year 2013-2014

Row no	Pt no	No of racemes/branch	No of buds /racemes	Total No of flowers opening in days
4	1	8	54	54
9	1	42	35	32
10	1	50	40	37
18	2	32	38	37
22	2	13	46	43
23	1	15	57	54
12	1	68	28	28
24	1	15	66	63
15	1	77	53	51
21	3	32	67	67
8	1	95	69	67
19	2	52	62	62
25	3	90	42	42
2	1	246	49	31
4	2	24	0	24
5	2	64	55	43
6	1	124	75	61
8	1	46	34	24
10	1	62	46	46
11	2	73	46	35

Table-2: cont.....

15	3	42	26	16
16	3	20	37	34
17	2	38	36	33
18	3	86	47	36
19	1	20	37	27
20	1	74	72	31
21	2	20	38	37
22	1	68	64	53
23	1	25	56	37
24	4	54	42	20
28	3	34	38	14
29	4	78	54	43
30	1	76	45	35
31	1	70	36	30
32	3	86	76	55
33	5	46	66	44
34	4	56	70	45
35	4	120	74	62
36	1	40	54	45
37	1	130	56	20
38	4	60	45	27

Table 3: Pongamia Racemes and dry biomass wt (g) (April-2014)

Row no	Pt no	Fresh Avg	Dry Avg
1	5	4.994	1.695
2	3	6.76	2.281
3	5	5.981	1.943
4	3	7.765	2.3224
5	1	9.487	3.351
6	4	6.271	1.8857
7	2	4.6	1.594
8	3	9.918	3.202
9	3	6.239	2.027
10	3	6.1826	1.814
11	4	8.208	2.297
12	4	7.741	2.352
14	1	6.381	2.204
17	3	5.715	1.849
19	4	5.978	1.931
21	4	5.37	1.885
22	4	6.041	2.348
23	5	4.78	1.645
Avg		6.578422	2.145894

CONCLUSION

From the above results the study concluded that Pongamia trees produced flowers per day per inflorescence in the range from 0 to 64 in 2012-13 and 14-67 in 2013-14. Pongamia fruits (pods) attain physiological maturation in 26 weeks after anthesis, and the seed collected at this stage recorded higher quality seed and seedling characters. Fruit (pod) colours of Pongamia vary at the time of bulk collection of seeds viz: green, light brown and dark brown. Among the three colours of fresh fruits the highest germination of 96 per cent was recorded in the seeds of light brown colored fruits suggesting that the collection of light brown fruits is advised to obtain the seeds with maximum germination capacity, which could also serve as harvest index for collection of quality seeds in Pongamia.

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