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ANALYSIS OF GROWTH AND YIELD IN *PLUMBAGO* SPP.

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Abstract: Studies on growth and yield of *Plumbago rosea* and *Plumbago zeylanica* were undertaken in the College of Horticulture, Kerala Agricultural University, Thrissur during 1995 to 1998. Studies on growth up to 18 months after planting revealed that the two species exhibited a linear pattern of growth. There was no significant difference in fresh root yield of the two species. However, *P. rosea* recorded 7.78 per cent higher yield than *P. zeylanica* at 18 months after planting. The dry root yield was found to be significantly higher in *P. zeylanica* and the percentage of increase in yield in *P. rosea* was 83.5. It was observed that retention of crop in the field up to 18 months increased dry root yield by 2.27 times in *P. rosea* and 2.01 times in *P. zeylanica* as compared to harvesting at 12 moths after planting.

Key words: Growth, *Plumbago rosea, Plumbago zeylanica,* yield.

INTRODUCTION

Rose coloured leadwort or 'chethikoduveli' or 'citraka' *(Plumbago rosea)* and white flowered leadwort or 'vellakoduveli' *(Plumbago zeylanica)* are the two medicinally important species. The freshly harvested plumpy roots after curing and drying are used for many ayurvedic preparations. The roots are digestive stimulants. It is pungent, astringent, diuretic, germicidal, vescicant and abortifacient. It overcomes flatulence, oedema, piles, coughs, worms, diseases due to 'vata' and 'kapha' predominance and haemorrhoidal anal inflammation. The drug also cures enlargement of abdomen, anaemia, diabetes, leucoderma, leprosy, diarrhoea, dyspepsia and elephantiasis. Plumbago enters in the composition of preparations like *Citrakasavam, Citrakachurnam, Dasamularistam, Gulgulutiktakam, Yogarajachurnam* etc., which are ayurvedic preparations. *P. zeylanica* is also used in veterinary medicines against stomach troubles (Sikawar, 1994). As in any other medicinal plant, the problems in popularizing this crop are lack of awareness, insufficient land availability and lack of technical know-how. The present study was undertaken at the College of Horticulture, Thrissur for the period from 1995 to 1998 with the objectives of analyzing growth at different stages of harvest starting from 6 months to 18 months after planting and arriving at the optimum stage of harvest.

MATERIALS AND METHODS

The experiment was laid out in split plot design with seven stages of harvest as main plots and species as the subplots. The two species studied were *Plumbago rosea* ('chethikoduveli') and *P. zeylanica* ('vellakoduveli' or 'thumbakoduveli'). The seven stages of harvest were, 6, 8, 10, 12, 14, 16 and 18 months after planting (MAP).

The planting material was collected from Valakkavu of Thrissur district. Two-noded semi-hard-wood cuttings were planted at the rate of four per polybags containing potting mixture. Three-month-old rooted cuttings were planted as intercrop in 20-year-old coconut plantation. The main plots of 3.5 m x 3.0 m were taken and divided into two subplots. The rooted cuttings were planted at a spacing of 70 cm x 15 cm in ridges of 50 cm height. At the time of planting, a basal dressing of cow dung @ 8 t ha^{-1} was given. Top dressing was done after 2 months of planting @ 25: 25: 25 kg N:P:K ha^{-1}. After 10 months of planting, the second dose of cow dung was applied @ 8 t ha^{-1}. Earthing up and weeding were carried out as per the package of practices recommendations of the Kerala Agricultural University (KAU, 1993).

Ten plants each per replication were uprooted at 6, 8, 10, 12, 14, 16 and 18 MAP. The plants were washed free of soil and observations per plant on height, inter-nodal length, total leaf area, length of root, girth of root, number of roots, fresh weight of roots, dry weight of roots, fresh weight of stem, dry weight of stem, fresh weight of leaves and dry weight of leaves were recorded. The data were analyzed statistically.

RESULTS AND DISCUSSION

The data on influence of stages of growth on plant height, inter-nodal length and leaf area

have been furnished in Table 1. The weather data collected during the experimental period are given in Table 2. The plant height was significantly higher in *P. zeylanica* (120.46 cm). The interaction between the species and stages of harvest was significant at 1 per cent level .The plant height in *P. zeylanica* steadily increased from 88.48 cm at 6 MAP to 148.47 cm at 14 MAP and thereafter there was no significant difference in this character. Height at 16 MAP was on par with that at 14 and 18 MAP. In *P. rosea*, plant height showed a steady increase from 38.07 cm at 6 MAP to 69.8 cm at 16 MAP. Thereafter no significant difference was noticed. The heights at 16 MAP and 18 MAP were on par. It is evident

Table 1. Influence of stages of harvest on plant height, length of inter-node and total leaf area

Stages of harvest	Plant height (cm)		Inter-nodal length (cm)		Total leaf area (m^2 $plant^{-1}$)	
	P. rosea	*P. zeylanica*	*P. rosea*	*P. zeylanica*	*P. rosea*	*P. zeylanica*
6 MAP	38.07	88.48	5.20	4.73	0.02	0.12
8 MAP	45.23	93.70	7.03	6.43	0.06	0.13
10 MAP	43.33	86.40	6.10	5.73	0.03	0.13
12 MAP	56.00	123.67	6.53	3.97	0.05	0.67
14 MAP	58.93	148.47	4.87	5.00	0.10	0.27
16 MAP	69.87	157.20	5.03	3.93	0.17	0.51
18 MAP	68.07	145.30	4.83	3.47	0.14	0.14
Mean	54.21	120.46**	5.66**	4.75	0.08	0.28**
Stages of harvest						
SEm±	5.489		0.372		0.004	
CD (0.05)	16.65		1.13		0.01	
Stages of harvest *vs.* Species						
SEm ±	7.681		0.359		0.004	
CD (0.05)	23.29		1.07		0.01	

MAP = Months after planting ** Significant at 5 % level

Table 2. Weather data during the experimental period

Month	Max. Temp. (°C)	Min. Temp. (°C)	Rainy days	RH (%)	Total rainfall (mm)	Sunshine (hours)
Jan-96	33.1	22.4	0	71	0	292.7
Mar-96	36.4	26.3	0	82	0	281.3
May-96	32.8	25.2	4	91	95.6	240.1
Jul-96	28.8	23.1	25	96	588.7	84.6
Sep-96	29.2	23.7	17	94	391.6	128.6
Nov-96	31.5	23.6	2	84	23.1	211.6
Jan-97	32.0	22.9	0	78	0	297.1
Mar-97	35.7	24.0	0	82	0	298.0
May-97	34.4	24.5	4	87	63.0	208.8
Jul-97	28.6	21.8	28	95	979.2	58.6
Sep-97	30.6	23.4	13	93	164.0	204.4
Nov-97	31.6	23.2	7	88	211.3	158.5
Jan-98	33.1	22.8	0	78	0	288.5
Mar-98	36.2	23.6	1	86	11.0	310.4
May-98	34.1	25.2	9	90	203.0	235.4
Jul-98	29.2	23.6	28	96	752.9	101.6

that the plant height of both the species increased up to 16 MAP, when the plants started flowering. The inter-nodal length was significantly higher in *P. rosea.* The mean value for inter-nodal length of *P. zeylanica* was 4.75 cm as compared to 5.66 cm in *P. rosea.* The data on interaction between stages of harvest and species indicated significant difference. The inter-nodal length was the highest at 8 MAP in both the species. Total leaf area per plant was significantly higher in *P. zeylanica* (0.28 m^2 per plant) as compared to 0.08 m^2 per plant in *P. rosea.* The interaction between stages of harvest and species was also significant.

Table 3. Effect of different stages of harvest on root parameters

Stages of harvest	Root length (cm)		Root girth (cm)		Root number/plant	
	P. rosea	*P. zeylanica*	*P. rosea*	*P. zeylanica*	*P. rosea*	*P. zeylanica*
6 MAP	29.07	37.63	1.97	1.10	7.37	13.2
8 MAP	30.93	40.76	1.97	1.13	7.87	16.73
10 MAP	35.33	44.2	2.23	1.33	11.67	15.93
12 MAP	40.77	47.13	2.53	1.57	12.13	15.3
14 MAP	41.4	56.1	2.7	1.83	12.8	18.7
16 MAP	47.7	54.17	3.03	1.90	17.53	20.5
18 MAP	57.07	64.37	3.13	2.00	14.47	25.6
Mean	40.33	49.19**	2.51**	1.55	11.98	17.99**
Stages of harvest						
SEm ±	2.456		0.069		0.822	
CD (0.05)	0.21		2.49		7.45	
Stages of harvest *vs* Species						
SEm ±	3.184		0.119		1.770	
CD (0.05)	NS		NS		NS	

NS : Not Significant

Table 4. Influence of different stages of harvest on fresh and dry weight of root

Stages of harvest	Fresh weight of root (g/plant)		Dry weight of root (g/plant)		Fresh weight of root (t ha^{-1})		Dry weight of root (t ha^{-1})	
	P. rosea	*P.zeylanica*	*P. rosea*	*P.zeylanica*	*P. rosea*	*P.zeylanica*	*P. rosea*	*P.zeylanica*
6 MAP	21.63	26.56	5.27	9.70	2.06	2.52	0.50	0.92
8 MAP	32.43	29.23	8.13	17.87	3.08	2.78	0.77	1.69
10 MAP	36.03	39.63	8.43	21.90	3.42	3.77	0.80	2.08
12 MAP	60.70	50.53	10.00	20.83	5.77	4.80	0.95	1.98
14 MAP	69.87	66.77	13.80	29.83	6.64	6.34	1.31	2.83
16 MAP	79.43	70.83	17.70	33.67	7.55	6.73	1.68	3.19
18 MAP	88.63	77.26	22.73	41.73	8.42	7.34	2.16	3.97
Mean	55.53	51.55	12.29	25.08	5.28	4.89	1.17	2.38
Stages of harvest								
SEm ±	1.842		0.949		0.1673		0.087	
CD (0.05)	5.59		2.88		0.51		0.294	
Stages of harvest *vs.* Species								
SEm ±	3.561		1.828		0.338		0.174	
CD (0.05)	NS		5.55		NS		0.527	

MAP = Months after planting NS = Not Significant

Table 5. Influence of stages of harvest on fresh and dry weight of stem and leaf (g per plant)

Stages of harvest	Fresh weight of stem		Dry weight of stem		Fresh weight of leaf		Dry weight of leaf	
	P rosea	*P.zeylanica*	*P rosea*	*P.zeylanica*	*P.rosea*	*P.zeylanica*	*P.rosea*	*P.zeylanica*
6 MAP	3.77	22.50	1.87	9.77	3.06	15.83	1.43	2.93
8 MAP	6.20	26.10	2.50	14.27	4.90	12.50	2.07	6.47
10 MAP	7.10	34.27	2.87	18.73	2.93	8.57	1.17	5.47
12 MAP	10.70	79.90	3.33	26.93	6.67	64.10	1.90	15.10
14 MAP	18.63	91.43	5.87	42.40	13.87	30.00	3.60	9.20
16 MAP	24.37	98.50	7.63	45.40	16.83	33.00	4.90	11.13
18 MAP	34.20	108.17	12.13	56.26	12.50	11.50	5.03	5.17
Mean	14.99	65.84**	5.17	30.54**	8.68	25.12**	2.87	7.92**
Stages of harvest								
SEm ±	4.528		S		2.32		0.598	
CD (0.05)	13.73		6.07		1.735		1.814	
Stages of harvest *vs* Species								
SEm ±	7.332		S		2.835		0.890	
CD (0.05)	22.24		8.94		8.59		2.69	

MAP: Months after planting; ** Significant at 1 % level

In *P.rosea* the total leaf area per plant increased from 0.02 m^2 per plant at 6 MAP to 0.06 m^2 per plant at 8 MAP. Thereafter there was a decline in leaf area to 0.03 m^2 per plant at 10 MAP, which coincided with peak summer. With the onset of southwest monsoon, there was progressive increase in leaf area up to 16 MAP when it recorded the maximum area of 0.17 m^2 per plant. The leaf area declined thereafter.

The total leaf area per plant in *P. zeylanica* increased up to 12 MAP, and the highest value was noted at 12 MAP, i.e. after the commencement of south west monsoon. Then it showed slight decline at 14 MAP and thereafter increased up to 16 MAP in December. By 18 MAP, as dry season commenced, leaf area declined. In the case of *P. rosea,* the total leaf area increased up to 8 MAP and with the commencement of summer, a marked decline in leaf area was noticed. Later, with the onset of southwest monsoon, there was a progressive increase in leaf area up to 16 MAP and declined thereafter. Reduction in leaf area during dry season is a common observation in many crop plants. The present study also revealed that leaf area that contributes the major assimilatory surface of plant was influenced mainly by season. In *Rauvolfiatetraphylla,* it was found that the total foliage was markedly higher during rainy season and minimum during dry season (Granda, *et al.,* 1986). In *Holostemma annulare,* Meera (1994) also reported a progressive increase in leaf area up to 12 MAP and decline in leaf area thereafter.

The results on length, girth and number of roots per plant are furnished in Table 3. It was observed that *P. zeylanica* produced longer roots as compared to *P. rosea.* The interaction between stages of harvest and species was not significant. This indicated that both the species recorded similar pattern of growth in respect of root length at different stages of harvest. The root length of both the species showed a steady increase and significantly higher values were observed at 18 MAP.

The species differed significantly in girth of roots. A significantly higher girth was noticed in *P. rosea* (2.51 cm) compared to in *P. zeylanica* (1.55 cm). The interaction between the species and stages of harvest was not significant. The girth of roots increased with increase in age of crop in both species and the maximum value was noticed at 18 MAP. However, the root girths at 16 and 18 MAP were on par. The rate of root production was significantly higher in *P. zeylanica* (17.99) as

compared to *P. rosea* (11.98). The interaction between stages of harvest and species was not significant. In both the species, the number of roots increased steadily up to 18 MAP. However, these were statistically on par with that observed at 16 MAP in both the species.

P. zeylanica produced comparatively longer and higher number of roots. But the girth of roots was comparatively smaller than *P.rosea.* In both the species, number of roots and girth of roots increased with age up to 16 MAP and thereafter the values were on par. However, in respect of length of root, the observations showed that, the roots continue to grow up to 18 MAP. Meera (1994) reported similar results in *Holostemma annualare* where in all root characters increased progressively with age. Similar results were reported in *Costus speciosus* also (Joseph, 1983).

The data on fresh and dry weights of roots per plant and per hectare are given in Table 4. With respect to fresh weight of roots per plant, there was no significant difference between the two species at 1 per cent level. However, *P. rosea* recorded a higher fresh weight of root of 55.53 g per plant as compared to *P. zeylanica.* The fresh weight of root progressively increased with age. Interaction between the species and the stage of harvest was also not significant. However, *P. rosea* recorded 7.78 per cent higher yield than *P. zeylanica* at 18 months after planting. The fresh root yield per hectare also showed similar pattern.

There was significant difference in dry weight of roots of both the species. *P. zeylanica* recorded the higher value of 25.08 g per plant as against 12.29 g per plant in *P. rosea.* The percentage increase in yield over *P. rosea* was 83.5. It was observed that retaining the crop in the field up to 18 months increased the dry root yield by 2.27 times in *P. rosea* and 2.01 times in *P. zeylanica* as compared to harvesting after 12 months. The interaction between the species and stages of harvest was significant. The results showed that dry weight of root of *P. zeylanica* was the maximum during 18 MAP. In *P. rosea* also maximum dry weight was observed at 18 MAP. This was on par with the dry weight of root at 16 MAP. Similar results were also noticed in terms of per hectare yield. In respect of fresh weight of roots, the two species did not differ significantly. However, the dry root weight was significantly higher in *P zeylanica,* which is due to the higher dry recovery. Fresh and dry weights of root increased progressively with age of the crop and maximum values were observed at 18MAP. Meera (1994) observed progressive increase in fresh and dry weights of root in *Holostemma annulare.* But it could be noticed that in *P. rosea,* dry weights at 16 and 18 MAP were on par. This showed that *P. rosea* could be harvested at 16 and 18 MAP as the yields did not vary significantly. In *P. zeylanica,* further studies are required to arrive at the optimum stage of harvest, as the root yield continued to increase with age of plant up to 18 MAP. Most of the earlier studies in this crop suggested the suitability of growing this crop as annual (Subha, 1990). In the present study, it was found that the rate of growth in respect of economic characters showed a linear trend with age. The comparison of fresh and dry yields at 12 and 18 MAP stressed the usefulness of retaining the crop up to 18 months to realize higher yield. Such a practice increased dry root yield by 2.27 times in *P. rosea* and 2.01 times in *P.zeylanica.*

The data on fresh and dry weights of stem and roots are given in Table 5. Fresh weight of stem was significantly higher in *P. zeylanica* as compared to that of *P. rosea.* The interaction between different stages of harvest and species was also significant. The values showed a progressive increase with advance in stages of harvest in both the species. The fresh weight of shoot at 18 MAP was on par with that at 14 and 16 MAP.

Dry weight of stem was also significantly higher in *P. zeylanica.* The dry weight recorded by *P. rosea* was only 5.17 g per plant (Table 5). The interaction was also significant. As in the case of fresh weight, the increase in dry weight was steady up to 18 MAP and significantly higher values were observed at 18 MAP in both the species.

The data furnished in Table 5 suggested that fresh weight of leaf was significantly higher in *P. zeylanica.* The value recorded by *P. rosea* was only 8.68 g per plant. The interaction between the species and stages of harvest was also significant. The fresh weight of leaf was

significantly high at 12 MAP in *P. zeylanica* and thereafter the fresh weight tended to decline. In *P. rosea*, there was a progressive increase up to 14 MAP. The fresh weights at 14, 16 and 18 MAP were on par. As in the case of fresh weight, dry weight of leaf was significantly higher in P. *zeylanica* as compared to *P. rosea* (Table 5). The interaction was also significant. Significantly higher dry weight of leaf was observed at 12 MAP in *P. zeylanica.* In *P. rosea*, there was a steady increase in dry weight of leaf up to 14 MAP and there after there was no significant difference.

P.zeylanica recorded significantly higher fresh and dry weight of stem. In both species, the values showed a progressive increase with age. In respect of fresh weight of shoot, significant difference was noticed up to 14 MAP and after that the values were on par. The significant increase in fresh weight up to 14 MAP is attributed to favourable environmental conditions that prevailed during the period. After 14 MAP, the values were not significantly different, which might be due to the high metabolic rate during dry season. However, the increase in dry weight was significant up to 18 MAP and this is due to the high dry recovery. *P. zeylanica* showed vigorous growth as compared to *P. rosea.* The fresh weight of leaf was significantly higher in *P. zeylanica.* During different stages of harvest, the values showed the similar trend as that of total leaf area per plant. The influence of wet and dry seasons on leaf area was reflected in fresh and dry weights of leaf also.

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