MARDI Res. J. 19(2) 1991: 191–195

Seedling age at transplanting and its relationship to growth and earliness in bearing of Eksotika papaya

(Umur benih betik Eksotika ketika mengubah dan hubungannya dengan pertumbuhan dan keawalan berbuah)

M. Masri*

Key words: seedling age, transplanting, first fruiting, papaya

Abstrak

Kesan umur benih betik (*Carica papaya* L.) var. Eksotika semasa mengubah terhadap pertumbuhan dan keawalan berbuah telah dikaji. Walaupun kelewatan mengubah 5 minggu selepas bercambah didapati mengurangkan kadar pertambahan tinggi pokok di ladang, keadaan ini tidak memberi kesan yang ketara terhadap kadar pertambahan garis pusat batang dan bilangan buku. Tempoh dari mengubah hingga berbunga dan berbuah didapati tidak dipengaruhi oleh umur benih ketika mengubah. Bunga dan buah yang pertama dihasilkan pada buku dan tinggi pokok yang lebih atas apabila benih diubah selepas 5 minggu selepas bercambah.

Abstract

The effects of seedling age at transplanting on the growth and earliness in fruit bearing of Eksotika papaya (*Carica papaya* L.) were studied. Though delayed transplanting after 5 weeks after the appearance of hypocotyl (WAAH) decreased height increment rate, it had no significant effects on stem diameter and node number increment rates. The time from transplanting to first flowering and fruiting was independent of seedling age at transplanting. However, node number and height of first flowering and fruiting were significantly higher up on the main stem when seedlings were transplanted after 5 WAAH.

Introduction

Optimum stage for transplanting papaya (*Carica papaya* L.) seedlings is often crucial. Seedlings transplanted too early may not be hardy and competitive enough for better growth and development in the field. Delayed transplanting, however, may cause severe shock which subsequently retards plant growth and development.

The ideal stage for transplanting papaya seedlings is at the 8 to 12-leaf stage or 6–8 weeks after sowing (Lim 1989; Masri 1989; Raveendranathan 1989). Seedlings transferred at this stage suffered the least transplanting shock due to their optimal plant size (Raveendranathan 1989). However, unfavourable weather conditions or incomplete land preparation may force the grower to delay transplanting. As such, the seedlings have to be transplanted to the field at stages later than optimal.

Raveendranathan (1989) reported that delayed transplanting of seedlings caused fruit being borne much higher up than normal along the main stem. However, information regarding the effects of seedling

*Fruits Research Division, MARDI Fruit Research Centre, Bukit Tangga, 06050 Bukit Kayu Hitam, Malaysia
Author's full name: Masri Muhamad

age at transplanting on subsequent plant growth in the field as well as the bearing ability of papaya plants is relatively scarce. This study was conducted to ascertain the effects of seedling age at transplanting on the growth and earliness in bearing of Eksotika papaya.

Materials and methods

Eksotika seeds were sown on different dates in 15 cm x 23 cm polyethelene bags filled with a mixture of soil, cow dung and sand (3:2:1). In this study, seed germination is defined as when the hypocotyl appeared from the potting media mixture. At each sowing date, only seedlings that showed the hypocotyl appearance on the 10th day after sowing were selected. Seedling age was regarded as the number of weeks after the appearance of hypocotyl (WAAH). The staggered sowing of seeds had resulted in the availability of seedlings of different stages as required by the treatments *(Table 1)*.

All seedlings were transplanted to the field at MARDI Bertam in a randomized complete block design with four replications and 8 plants/ plot. Each plot measured 16.4 m^2. The planting distance was 1.8 m within rows and 2.7 m between rows. Single row of plants were planted as guard rows between plots. Prior to transplanting, 200 g of triple superphosphate (45% P_2O_5) was added to each planting hole. All plants were drip irrigated throughout the experimental period. Subsequent fertilization and other agronomic practices were carried out as recommended by Raveendranathan (1989).

Table 1. Treatments of various seedling stages as obtained by staggered sowing of seeds

Treatment	Seedling age (WAAH)	No. of leaves
T1	3	<8
T2	5	9–12
T3	7	13–15
T4	9	16–19
T5	11	20–23
T6	13	>24

WAAH = weeks after appearance of hypocotyl

Monthly measurements of plant height, stem diameter and node number were taken to characterise plant growth and development. Plant height was measured from the collar at the base of the trunk to the tip of the shoot. Stem diameter at 15 cm above the collar was determined using vernier calipers. Chan and Toh (1984) reported that the linear phase of plant growth coincides with the 15 to 31-week period from seed sowing. Linear regression analyses during this rapid stage of growth were performed and the slopes of the regression lines were regarded as monthly increment rates of height, stem diameter and node number. Analysis of variance (ANOVA) was conducted on these slopes to differentiate treatment differences. Subsequently, parameters such as days to first flowering and fruiting, node number and height of first flowering and fruiting were taken. ANOVA was performed on these parameters to differentiate treatment means.

Results and discussion

In the analysis of variance, plant height increment was significantly affected by seedling age at transplanting. However, there were no significant ($p < 0.05$) effects on stem diameter and node number increments, *(Table 2)*. As for the reproductive parameters, first flowering and fruiting were significant ($p < 0.05$) among treatments. These suggest that some form of significant relationship existed between age of papaya seedling at transplanting and the subsequent growth as well as the first bearing ability of papaya plants.

Plant growth

Vigorous vegetative growth is required by most plants in preparation for the reproductive stage. Normally, vigorously grown plants have the potential to produce better yield than those retarded ones. In this study, it was found that stem diameter and

Table 2. ANOVA of the various parameters as affected by the treatments

Source	df	Mean squares								
		1st flowering			1st fruiting			Monthly increment		
		Height	Node	DAT	Height	Node	DAT	Height	Node	Girth
Block	3	40.16ns	2.08ns	5.16ns	15.98ns	6.05ns	19.04ns	2.57ns	0.26ns	0.02ns
Treatment	5	431.96**	95.86**	19.73ns	395.81**	89.01**	74.75ns	14.45**	0.66ns	0.05ns
Error	15	23.84	6.18	26.01	24.57	3.58	33.76	1.99	0.37	0.04
Total	23									

**highly significant at $p < 0.05$
ns = not significant at $p < 0.05$
DAT = days after transplanting

Table 3. Growth and reproductive parameters of papaya seedlings transplanted at different ages

Seedling age (WAAH)	Monthly increment rate			Days after transplanting	
	Height (cm)	Girth (cm)	Node	1st flowering	1st fruiting
3	18.28a	1.04a	10.40a	86.57a	157.83a
5	18.17a	1.12a	10.51a	82.88a	150.63a
7	18.76a	1.19a	10.77a	89.16a	153.75a
9	17.22a	1.10a	10.16a	87.53a	156.95a
11	16.57b	0.88a	9.62a	88.19a	159.10a
13	16.13b	1.02a	10.02a	84.63a	163.10a

WAAH = weeks after appearance of hypocotyl
Means in each column with the same letter are not significantly different at $p < 0.05$ using DMRT

node number increments were not affected by age of seedlings at transplanting. In all treatments, stem diameter increment was not significant ($p < 0.05$), averaging about 1.1 cm/month. Similarly, node number increment was not significant among treatments ranging from 9.6 to 10.8 nodes/month *(Table 3)*.

Plant height increment was found to be affected by seedling age at transplanting *(Table 3)*. Delayed transplanting at ages of 11–13 WAAH resulted in significantly ($p < 0.05$) slower height increment as compared with seedlings transplanted earlier. Seedlings transplanted at 3–9 WAAH showed no significant difference ($p < 0.05$) in height increments. Despite the inherent difference in node and height of the initial seedlings, the subsequent vegetative growth was not much affected except for the slight effect on height increment in the seedlings of 11–13 WAAH.

Days to first flowering and fruiting

One of the important aspects of early fruit bearing is the shorter time taken to first flowering and fruiting i.e. dates when first flower bud and fruitlet were observed. Days to first flowering were not significant ($p < 0.05$) among treatments *(Table 3)*, indicating that the time taken to first flowering did not depend on the seedling age at transplanting. In all treatments, first flowering was observed between 83 and 89 days after transplanting.

Similar results were observed in the appearance of the first fruitlet. The time taken for first fruitlet to appear on the main stem was not significantly different ($p < 0.05$) among treatments averaging 151–163 days after transplanting *(Table 3)*.

Although there were inherent differences in node number and height of the initial seedlings before transplanting, results showed that these differences did not

influence the time taken to flower and fruit. This may signify the fact that papaya plants require a certain amount of node and height development in the field before responding to flowering and fruiting.

Node and height of first flowering and fruiting

Under optimum conditions, each node on the main papaya stem produces one flower which will develop into fruit (Chan 1986). With respect to early harvest and ease of later harvesting, it is therefore advantageous to have the papaya plants start fruiting at the lowest possible node along the main stem.

Transplanting papaya seedlings at different ages had significant effects on the node number and height of first flowering and fruiting *(Table 4)*. Both node number and height of first flowering of seedlings transferred 3–5 WAAH were significantly lower than those transplanted later. The lowest flowering node (38th) was attained by seedlings transferred at 3 WAAH while the highest (58th) by those transferred at 13 WAAH. Similar trend was observed for the height of first flowering. The lowest height of first flowering (81–82 cm above the ground) was observed when seedlings were tranferred at 3–5 WAAH.

Similar results were obtained with respect to node and height when the first fruitlet was observed. Seedlings transplanted at 3–5 WAAH had produced their first fruitlet at the 52nd node. This corresponded to heights of 104–106 cm above the ground. Even a 2-week delay in transplanting (from 5 to 7 WAAH) had resulted in fruit being borne on nodes significantly higher ($p < 0.05$) up the main stem. Although there are certain differences in terms of absolute values of these parameters as compared with Eksotika papaya planted elsewhere, the trend did show that older seedlings (more than 5 WAAH) flowered and fruited on higher nodes and height as compared with seedlings transplanted earlier.

Since the node number on which the first fruitlet was observed may indicate the earliness and potential yield of a papaya plant, a regression analysis was conducted to relate this first fruiting node with seedling age at transplanting *(Figure1)*. There was a significant positive correlation between seedling age at transplanting and first fruiting node. The linear relationship is described by the equation $y = 47.64 + 1.24x$ ($r^2 = 0.83^{**}$) where y is the estimated first fruiting node and x is the seedling age at transplanting. Seedlings transplanted soon after germination produced their first fruit at lower nodes along the main stem as compared with those transplanted later. The slope of the regression line indicated that after 3 WAAH, a delay of 1.2 weeks (8 days) in transplanting led to fruit being borne one node higher up the main stem.

Table 4. Effects of transplanting papaya seedlings at different ages on node number and height of first flowering and fruiting

Seedling age (WAAH)	1st flowering		1st fruiting	
	Node	Height (cm)	Node	Height (cm)
3	37.9d	80.6c	52.3d	105.9d
5	42.3c	82.1c	52.2d	104.3d
7	45.9b	89.1b	57.1c	110.3cd
9	46.7b	92.9b	58.4bc	116.2bc
11	48.6ab	95.8b	61.1b	119.7b
13	57.9a	109.0a	64.0a	130.9a

WAAH = weeks after appearance of hypocotyl
Means in each column with same letter are not significantly different at $p < 0.05$ using DMRT

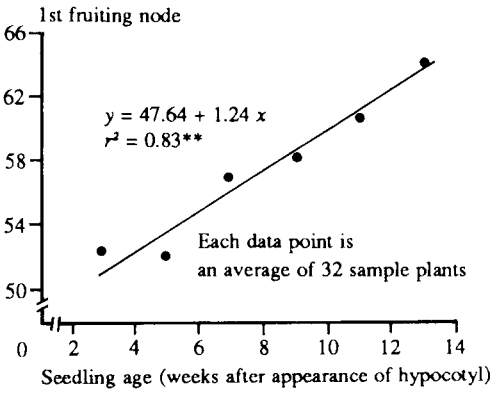

Figure 1. Relationship between seedling age at transplanting and first fruiting node

Conclusion

Seedling age at transplanting had significant effects on the node number and height of first flowering and fruiting. The subsequent plant growth as shown by height increment was also affected by seedling age. However, there were no significant differences in stem diameter and node number increments regardless of seedling age at transplanting. There was a positive correlation between seedling age at transplanting and node number of first fruiting. A delay of 1.2 weeks in transplanting the seedlings after 5 WAAH resulted in fruit being borne significantly higher up the main stem.As such, transplanting papaya seedlings after 5 WAAH will result in fruit bearing too high up the main stem which may reduce the number of fruit and cause inconvenience in later harvesting.

Acknowledgements

The author wishes to thank Mr Ahmad Hj Doon and Mr Ali Sulaiman for their technical assistance.

References

Chan, Y. K.(1986). Comparative performance of female and hermaphrodite trees in four gynodioecious varieties of papaya. *Teknol. Buah-buahan, MARDI 2:* 25–31

Chan, Y. K. and Toh, W. K.(1984). Growth studies on some vegetative characters of papaya (*Carica papaya* L.). *MARDI Res. Bull. 12(1)*: 46–54

Lim, C. H.(1989). Commercial cultivation of Eksotika papaya. A case study. *Proc. MARDI-MAPPS Sem. Eksotika Papaya* 7–8 March 1989, Johor Bharu, p. 69–88. Serdang: MARDI-MAPPS

Masri, M.(1989). Cultivation of Eksotika papaya in northern states of Peninsular Malaysia (in Bahasa Malaysia). Paper presented in seminar on development of fruit industry in Penang. 25–26 Jul. 1989, Penang. Organizer: Penang State Government

Raveendranathan, P.(1989). Agronomy of Eksotika, p. 19–28. *See* Lim (1989)

Accepted for publication on 12 July 1991