Reciprocal Grafting of Normal and Dwarf Solo Papaya on Growth and Yield[1]

A. H. Lange
Weed Control Specialist, Agricultural Extension Service
University of California, Riverside, California

Abstract. Scions from 'Solo' papaya trees of normal size grafted on dwarf 'Solo' stocks resulted in trees with less vigor. Flowering and fruit production occured lower on the stem. The total quantity of fruit was smaller than on normal 'Solo' trees.

Dwarf 'Solo' scions grafted on normal 'Solo' stocks resulted in vigorous trees flowering and producing fruit higher on the stem; there was also more fruit, with less crowding, than on dwarf 'Solo'.

In the commercial field, grafting papaya is not undertaken (1,2,3,4,7) because the tree is short-lived and generally thought to be of insufficient value to warrant the cost. Although seedling papayas appear to produce fairly uniform crops of fruit, there is in fact considerable variation in quality and quantity throughout the year (5). The unproductive seasonal periods resulting from "sterile skipping" and un-normal roughening of the fruit, "carpelloidy", appear to be difficult to eliminate by breeding (8) and, at the same time, have proven to be expensive in papaya production. Although earlier workers (3) pointed out that a need for over 400 short-lived trees to the acre precludes the use of grafted papaya trees, the fact that 2 to 3 times this number must be seeded, transplanted to pots and, finally planted in the field as seedlings (the sex of which is indistinguishable) should be considered. The loss in growth, due to competition, and the added expense of growing 2 or 3 seedlings per location in the field, cannot be overlooked. With cost of production rising, the prospect of planting papaya groves with hermaphrodite trees capable of producing year-round heavy crops of uniform high quality fruit will become increasingly important (6). The object of this study was to determine how two forms of papaya, of considerably different growth habits, would respond to intergrafting; i.e., a normal 'Solo'–type papaya and a dwarf, low-growing 'Solo' papaya.

Following several prelimimary trials, two experiments were performed at the Manoa branch of the Hawaiian Agricultural Experiment Station.

First experiment. Teh papaya seedlings (5–weeks old) of Line 8 'Solo' (normal size) were approach-grafted with dwarf-type 'Solo' of the same age.[2] After one month, the appropriate stem or root was removed (Fig. 1D). At the age of seven months from seed, the grafted plants were transplanted into the field. After six months in the orchard age 12 months), the average height, circumference, and height to first fruit were recorded. Fruits were harvested for six months as they ripened and the number of fruits recorded. Insufficient data were produced to utilize statistics.

Second experiment. Two-month old seedling plants of Line 8 'Solo' were approache-grafted with seedlings of a dwarf 'Solo' papaya. All combinations of scion and rootstock were made in groups of ten. One month after approach-grafted, the grafts were completed by removing the appropriate top or root system. The plants were then transplanted to gallon cans and placed in the nursery for two months. At the age of five months from seed, the experimental plants were labeled individually, and randomly transplanted to the field. Three months later, at flowering (eight months of age), the height from ground level to the apical bud and the height to the first flower bud were measured. The circumference was measured below and above the graft in centimeters, and the number of nodes flowering at eight months of age was recorded. Four months later, when the first fruit was ripening (age 12 months) the height to first fruit, circumference above the graft, weight of marketable fruit, total fruit weight, number of fruit with carpelloidy (irregular development of carpels) and number misshapen due to crowding (fruit above 2 inches in diameter) were recorded.

The data from normal trees and dwarf trees were analyzed separately, because the data were from two separate populations, (i.e., normal and dwarf trees). The design used was a randomized block, each treatment replicated 10 times.

Experiment 1. The grafting of a normal 'Solo' on a dwarf 'Solo' papaya selection tended to reduce the total height and circumference, and the height to the first fruit (Table 1). The number of fruit harvested in 6 months was not greatly affected. When dwarf plants were grafted onto normal 'Solo' papaya, there appeared to be an increase in tree height over the ungrafted dwarf. A tendency for the number of fruits to increase on the dwarf plant, when grafted on to the more vigorous normal Line 8 'Solo' was also observed.

Experiment 2. The grafting of a normal size papaya on the lower-growing dwarf papaya resulted in a smaller-than-normal circumference when measured at 8 and 12 months, below and above the graft union (Table 2). The graft union appeared to have an effect on the circumference but not the height when normal was grafted on normal (Line 8).

Dwarf 'Solo', when grafted on normal 'Solo', showed no effect on circumference at the 8-month reading, but by 12 months there was a highly significant increase in the circumference just above the graft.

By 12 months, there was a decrease in height when the normal papaya was grafted on dwarf rootstock. When the reverse graft was made, there appeared to be an increase in height at 8 and 12 months of age, apparently due to the more vigorous rootstock of the larger, normal-sized Line 8 'Solo' trees.

The height to the first flower and fruit of the Line 8 were decreased by the dwarf rootstock, whereas the height to first flower and fruit of the dwarf top was increased by the normal 'Solo' rootstock.

The fruit weight from normal 'Solo' tops (age 12 months) showed no apparent change resulting from the presence of a dwarf rootstock when compared with normal grafted on normal. The marketable fruit was not significantly reduced. However, when the dwarf was grafted on the normal, there was a significant increase in marketable fruit.

[1] Received for publication July 16, 1969.

[2] Dwarf Solo papaya was a selection made by Dr. H. Y. Nakasone (Hawaiian Agricultural Experiment Station) from a back-cross between 'Betty' and 'Solo'.

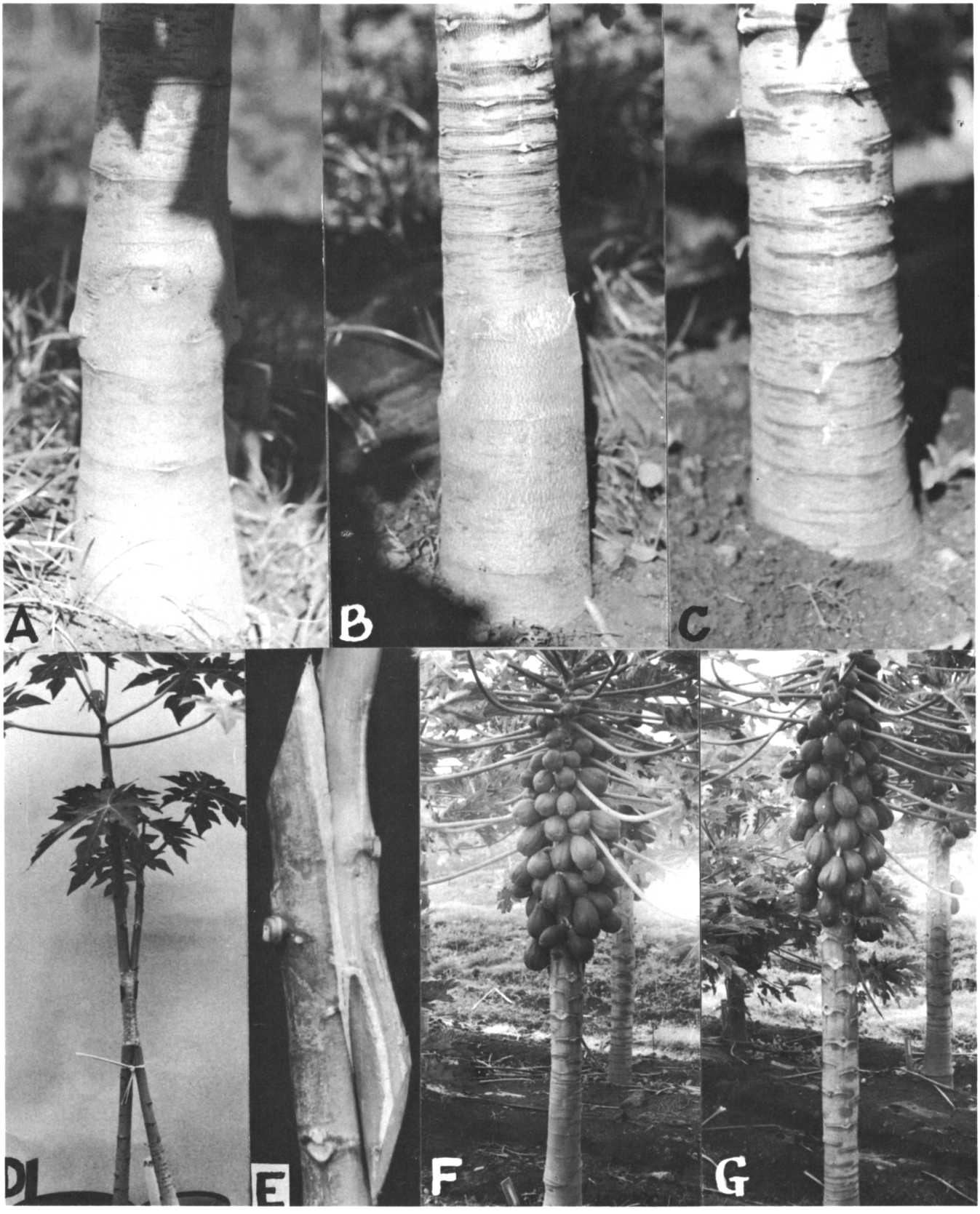

Fig. 1. (A) Comparison of Line 8 'Solo' papaya grafted on dwarf 'Solo'; (B) dwarf 'Solo' grafted on Line 8 'Solo'. Note smooth graft union of grafted trees; (C) Line 8 'Solo' ungrafted at 8 months of age; (D) approach grafting a 3-month-old Line 8 'Solo' seedling with dwarf 'Solo'; (E) graft union after removing respective tops and roots after removing plastic tape one month after grafting; (F) 18-month-old Line 'Solo' grafted on dwarf rootstock; (G) 18-month-old Line 8 ungrafted.

Table 1. The effect of scion and rootstock on the average growth and yield of normal (Line 8 'Solo') and dwarf (#23) 'Solo' type papaya.

Graft	Circumference (cm)	Height at 1 year (cm)	Height of first fruit (cm)	Fruit/tree for 6 months (no.)
Normal	48	220	146	52
Normal/dwarf	44	186	110	62
Dwarf	34	102	53	40
Dwarf/normal	42	165	66	46

Table 2. The effect of scion and rootstock on the average growth, flowering and yield of normal (Line 8) and dwarf (#23) Solo types of papaya.

	Circumference			Height						Unmarketable fruits by type	
	Below graft	Above graft		Apical meristem		First flower	First fruit	Fruit weight at 12 months		Misshapen from	
	8 mo (cm)	8 mo (cm)	12 mo (cm)	8 mo (cm)	12 mo (cm)	8 mo (cm)	12 mo (cm)	Marketable (lb.)	Total (lb.)	overcrowding (No./tree)	Carpelloid (No./tree)
Normal	30	30	50	135	252	131	152	55	61	0	7
Normal/Normal	31	27	49	134	234	134	136	45	54	0	9
Normal/Dwarf	27	22	44	118	201	111	121	40	48	2	6
LSD											
05	2.9	2.5	3.9	ns	21.3	18.9	20.1	ns	12.3	ns	ns
01	4.0	3.4	ns	ns	32.7	ns	28.7	ns	ns	ns	ns
Dwarf	26	26	36	78	123	49	56	32	46	14	6
Dwarf/Dwarf	28	22	31	74	121	49	51	34	49	13	6
Dwarf/Normal	29	24	43	85	159	54	65	46	54	6	2
LSD											
05	2.0	2.5	5.5	8.6	14.6	4.3	10.3	10.2	ns	ns	ns
01	2.2	3.5	6.7	ns	ns	20.4	ns	ns	ns	ns	ns

No effect was noted on misshapen fruit or carpelloid fruit resulting from the use of either rootstock; however, the coefficient of variation for these two types of fruit measurement were excessively high—a larger sample or more uniform plant material would be required in order to resolve this point. There appeared to be a tendency toward reduction of misshapen fruit, due to crowding, when dwarf scions were grafted on the more vigorous normal rootstock. The number of nodes to flowering showed no significant difference so the data were excluded from the tables.

Most of the differences occured after the 8-month measurement of tree circumference. The dominant effect of the rootstock appeared to be on the tops in both normal and dwarf type rootstocks.

The results of the second experiment substantiated the trends indicated in the first experiment, with the exception that the dwarf rootstock appeared to increase the average number of fruits of the normal-sized Line 8 'Solo' in Experiment 1. However, the number of trees involved were too limited to analyze the data so that this difference may not have been significant. On the other hand, in Experiment 2, there was a significant decrease in total amount of fruit resulting from grafting Line 8 'Solo' on dwarf rootstock.

The effect of rootstock on top growth and the inverse have been studied in orchard crops, but have not been reported for papaya. Papaya trees respond in a manner similar to other grafted tree crops. Since the Papaya has a short life cycle (fast growing and produces heavily), it could serve as a useful plant material for studying stock-scion interactions.

Literature Cited

1. Chandler, W. H. 1950. Evergreen orchards. Lea & Febiger, Philadelphia. p. 239.
2. Feilden, G. St. Clair, and R. J. Garner. 1936. Vegetative propagation of tropical and sub-tropical fruits. *Imperial Bur. Fruit Prod. Tech. Comm.* No. 7.
3. Hancock, W. G. 1940. Grafting male papaya trees. *Queensland Agr. J,.* 54: 337-339.
4. Jones W. W., and W. B. Storey. 1941. Propagation and culture of the papaya. Part 2-Papaya production of the Hawaiian Islands. *Hawaiian Agr. Exp. Sta. Bul.* 87:21-23.
5. Lange, A. H. 1961. Factors affecting sex changes in the flowers of *Carica papaya L. Proc. Amer. Soc. Hort. Sci.* 77:252-264.
6. Peters, C. W. 1953. Marketing fresh Hawaiian papayas and pineapple on the mainland. *U. of Hawaii. Agr. Econ. Bull.* 6.
7. Pope, W. T. Papaya culture in Hawaii. 1930. *Hawaiian Agr. Exp. Sta. Bul.* 61.
8. Storey, W. B. 1953. Genetics of the papaya. *J. Heredity.* 64:70-78.