Chui', 'Wubentou', 'Waiwei', 'Pasi', 'Fwang Tung', and 'Golden Star' as having thin ribs.

Industry evaluation—overall impression. Survey participants were asked to give their overall impression of the 14 cultivars evaluated (Table 7). This overall impression is important for researchers as a guide to the direction and attributes most desired by the industry. A majority of the participants rated 'Kary', 'Arkin', 'B-10', 'Sri Kembangan', and 'Lara' as good to very good. In contrast, most participants rated 'Erlin', 'Cheng Chui', 'Wubentou', and 'Pasi' as poor. Most people rated 'Kajang' and 'Waiwei' as fair. 'Fwang Tung', 'Miss', and 'Golden Star' were rated by most participants as fair to poor.

Summary. Fruit from young trees of 13 to 14 cultivars of carambola were evaluated during 1997. The °Brix did not change substantially among fruit picked during July and November but was higher for 'B-10', 'Fwang Tung', 'Lara', 'Kary', and 'Waiwei' compared to 'Erlin', 'Wubentou', 'Cheng Chui', and 'Pasi'. The °Brix for 'Arkin', 'Sri Kembangan', 'Kajang', and 'Miss' was intermediate. Participants in an informal taste test rated the overall performance of 'Kary', 'B-10', 'Arkin', 'Sri Kembangan', and 'Lara' fruit as good to very good. Many others such as 'Erlin', 'Cheng Chui', 'Wubentou', and 'Pasi' were rated as poor.

These results must be considered as only preliminary because many other attributes such as tree vigor, crop yield, season of production, disease and insect resistance, and postharvest handling characteristics need to be evaluated. In addition, some attributes such as fruit size and quality and season of production may change as trees mature.

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NEW JACKFRUIT CULTIVARS FOR COMMERCIAL AND HOME GARDEN USE IN FLORIDA

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Additional index words. Artocarpus heterophyllus, tropical fruit, cultivar selections.

Abstract. The jackfruit (Artocarpus heterophyllus Lam.) has remained an oddity in Florida since its introduction over a century ago. However, recent advances in cold protection, new cultivars, production techniques, increased ethnic diversity and a lucrative commercial market have heightened interest in this crop. Twenty-five cultivars, predominantly of Asian origin, are under evaluation at Fairchild Tropical Garden in Miami, Florida. Current data are presented on the characteristics of specific cultivars and how these cultivars are grouped in terms of the general aspects of production. Based on these fruit and tree data, 'Black Gold', 'Golden Nugget', 'Cheena', 'Dang Rasi-mi', 'Honey Gold', 'J-30', 'J-31', 'NS-1' and 'Tabouey' are recommended for commercial and home garden use. Evaluations continue and the recommended cultivars will be modified as additional data become available.

The jackfruit is native to the lowland rainforests of Southeast Asia, where it is widely grown commercially and in the home garden (Acedo, 1992; Samaddar, 1985). The highly versatile fruit is used green as a cooked vegetable, eaten fresh when ripe, and included in many regional cuisines. The large, starchy seeds are also cooked and eaten, and the fibrous rind of the fruit is fed to livestock. In the Western Hemisphere the jackfruit is much less known or appreciated. Although it was introduced to many countries in this hemisphere over a century ago, it has never been more than a curiosity except for Brazil and parts of the West Indies. Certainly the large size of the fruit, weighing 25 kg or more, and its unusual appearance and strong aroma contribute to its slow acceptance. As a result, few cultivar selections have been made and commercial production is limited.

Today we are entering a new era with the jackfruit in the Western Hemisphere (Campbell et al., 1998). Superior selections are now available, modern growing techniques have been developed, and there are emerging ethnic and mainstream markets for the fruit. The objective of this paper is to present current data on jackfruit cultivars introduced to South Florida in the past 15 years, with consideration of their suitability as commercial and home garden crops.

General Description of the Tree

The jackfruit is adapted to the warm, wet lowland forests of Southeast Asia (Acedo, 1992; Samaddar, 1985). Unpruned,
Jackfruit are monoecious, with male and female inflorescences produced on short shoots on the trunk and major limbs. The male inflorescences have a strong, sweet aroma that attracts beetles and other insects, which assist in pollination. The fruit generally ripen during the warm season, 150 to 180 days after flowering. Fruit weigh from 2 to 25 kg and have a green skin covered with fleshy spines. The aromatic, sweet flesh surrounds each of the 30 to 200 seeds within the single fruit. The flesh and seeds are embedded within the fibrous unpolinated flowers (rag) which contain a sticky, white latex.

**Flesh type.** Jackfruit are grouped into soft-fleshed and firm-fleshed types. Soft-fleshed jackfruit include ‘Golden Nugget’, ‘Black Gold’ and ‘Cheena’. The firm-fleshed types include ‘Dang Rasimi’, ‘Cochin’, ‘NS1’, ‘Tabouey’, ‘Honey Gold’, ‘Lemon Gold’, ‘J-30’ and ‘J-31’. If used green as a vegetable, the entire fruit is consumed at one to two months of age, and there are no strong cultivar preferences.

**Cultivar Descriptions**

Cultivar descriptions are limited to those recommended for use in Florida. Complete descriptions of additional cultivars are reported elsewhere (Campbell et al., 1998).

‘Golden Nugget’ was selected in Queensland, Australia. The tree is vigorous, with a distinctive dark green, rounded leaf. It forms a dense, spreading canopy which is easily maintained at a height and spread of 2 to 2.5 m. The fruit are small, green and rounded, with sharp, fleshy spines on the skin. The spines flatten and change to a golden-yellow color upon ripening. Average fruit weight is 3.2 kg, with an edible flesh percentage of 41%. There are on average 79 seeds per fruit, which constitute 13% of the total fruit weight. The deep orange flesh is soft to medium-firm depending on ripeness. The flavor is excellent, with no fiber. ‘Golden Nugget’ fruit often split on the tree prior to ripening when there are heavy rains. Yields can be maintained at 60 to 80 kg per tree per year. The fruit should be thinned to 20 to 25 per tree to avoid tree damage due to over-production.

‘Black Gold’ was selected in Queensland, Australia. The tree has medium vigor, with a spreading and highly manageable canopy. With annual pruning it is easily maintained at a height and spread of 2 to 2.5 m, with consistent, heavy fruit production of 55 to 90 kg per tree. The fruit average 6.7 kg, with an edible flesh percentage of 35%. There are 192 seeds per fruit, which constitute 17% of the total fruit weight. The exterior of the fruit is dark green and has sharp, fleshy spines. The spines do not flatten upon maturity, making it difficult to judge the proper harvest time and causing difficulty in handling after harvest. The deep orange flesh is soft to medium firm, with a strong, sweet flavor and aroma. The flesh is more easily separated from the “rag” compared with other cultivars.

‘Dang Rasimi’ originated in Thailand. The tree is open, spreading and fast growing. It must be pruned to maintain a height and spread of 3 to 3.5 m. The trees are highly productive, yielding 75 to 125 kg per tree, while maintaining vigorous growth. The fruit are green to pale yellow and uniform in shape if thinned to one fruit per fruiting shoot. The skin has sharp spines that do not flatten or “open” with maturity. Fruit are medium to large, averaging 5.7 kg, with 32% edible flesh percentage. There are 137 seeds per fruit, which constitute 12% of the total weight. The flesh is deep orange and firm. It has a mild, sweet flavor and a pleasant aroma. ‘Dang Rasimi’ is well suited to less than ideal conditions due to its vigorous habit, which also allows it to remain healthy while fruiting heavily.

‘Cheena’ is a hybrid between jackfruit and champedak (Artocarpaceae minimae) originating in Malaysia (Soepadmo, 1991). The tree has an open, low and spreading growth habit and can be maintained at a height and spread of 2.5 m with annual pruning. ‘Cheena’ consistently produces 50 to 70 kg per tree. The fruit are long, narrow and uniform in size and shape. The skin is green, with blunt spines that yellow and open slightly upon maturity. Fruit are small, weighing on av-

**Cultivar Selection**

Jackfruit are often grown from seed because of a lack of cultivar availability and difficulty in clonal propagation. The introduction of superior cultivars into this hemisphere in the last 15 years has provided an infusion of genetic diversity. Seedling trees in South Florida are precocious and produce variable, yet excellent quality fruit within two to three years of planting. Their growth habit is more upright than grafted trees, and they respond well to pruning and shaping. At present, commercial jackfruit production relies on seedling trees, but as the market becomes more sophisticated, uniform cultivars will be desirable.

Limited information is available on clonally-propagated jackfruit cultivars (Acedo, 1992; Campbell and McNaughton, 1994; Samaddar, 1985). There have been successful selection efforts in India, Indonesia, Malaysia, the Philippines and Thailand to produce clonally-propagated cultivars. These cultivars differ in yield, fruiting season, fruit weight, aroma, flesh color, fiber content, taste, edible flesh percentage and seed number. Over the past six years, Fairchild Tropical Garden has maintained and evaluated a collection of 25 jackfruit cultivars (Campbell and McNaughton, 1994). General production characteristics of these cultivars, as well as specific cultivar descriptions are presented.

**Cultivar Production Characteristics**

**Tree vigor.** A healthy, vigorous tree is more tolerant of cold temperatures, root disease and excessive fruit loads than a weak tree. The most vigorous cultivars are 'Black Gold', 'Dang Rasimi' and 'Golden Nugget'. Medium vigor cultivars include 'NS1', 'Tabouey', 'J-30', 'Galaxy' and 'Lemon Gold'. The least vigorous cultivars are 'Honey Gold', 'J-31' and 'Cochin'.

**Fruiting season.** Fruiting season varies with the timing of cool, dry weather and the health of the tree. In general, the early season cultivars are 'J-31', 'NS1' and 'Golden Nugget'. Middle season cultivars are 'Cochin', 'Dang Rasimi', 'Galaxy', 'Honey Gold', 'J-30', 'Lemon Gold' and 'Tabouey', and the late cultivar is 'Black Gold'. Many cultivars have off-season production if properly managed or if there are significant dry periods during the season.

**Yield potential.** The yield potential of the jackfruit is highly dependent on the cultivar and the weather conditions during bloom and fruit development. Yields over the past six years ranged from 75 to 125 kg per tree for the most productive cultivars, and averaged 40 kg for the less productive cultivars.
average 2.4 kg and they have an edible flesh percentage of 33%. There are 38 seeds per fruit, which constitute 11% of the fruit weight. The flesh is deep orange, soft and fibrous, with an excellent flavor. The fruit have an intense aroma. 'Cheena' usually produces one fruit per shoot without thinning and heavy fruiting does not damage the tree. The flesh is easily separated from the rag, requiring less than 10 min to prepare a fruit for consumption. There is little problem with the latex in ripe fruit.

'NS1' was selected in Malaysia and was one of the first superior jackfruit cultivars imported into the Western Hemisphere. The tree has medium vigor, forming a dense, upright canopy which can be maintained at a height and spread of 2.5 to 3 m with moderate annual pruning. Annual yields are 90 kg or more per tree. The fruit are blocky and dark green in color, with blunt spines on the skin. Average fruit weight is 4.2 kg, with a flesh percentage of 34%. There are 63 seeds per fruit, constituting 5% of the total fruit weight. The blunt spines flatten and open as the fruit ripen. The flesh is dark orange and firm, and the flavor is rich and sweet.

'Tabouey' was selected in Indonesia. The tree has rounded, dark green leaves and forms an open, rounded canopy. The tree can be maintained with a size and spread of 3 m with annual pruning. The fruit are long, thin and tapered at the stem-end. They are often misshapen, with a bright yellow color and irregular, blunt spines. The flesh is firm, pale yellow and has almost no aroma. Its flavor is mild and pleasant. The tree consistently produces moderate crops of 50 to 70 kg per tree.

'Honey Gold' was selected in Queensland, Australia. The tree has a slow to moderate growth rate, forming a small, open and spreading canopy. The tree can be maintained at a height and spread of 2.5 m with annual pruning and will produce 35 to 50 kg per tree. Fruit thinning is necessary to maintain healthy growth. The blocky, dark green fruit have small, sharp spines that open and turn a golden yellow upon maturity. The fruit weigh on average 4.5 kg, with an edible flesh percentage of 36%. There are 42 seeds per fruit, which constitute 5% of the total fruit weight. The flesh is dark yellow to orange and firm, with a sweet, rich flavor. The fruit have a strong, sweet aroma.

'J-31' was selected in Malaysia. The tree forms a small, spreading, open canopy and can be maintained at a height and spread of 2 to 2.5 m. Trees of this size can produce 42 to 60 kg per tree, and require fruit thinning. Fruit average 12 kg and are irregular in shape with prominent, blunt spines and an edible flesh percentage of 36%. There are 180 seeds per fruit, constituting 18% of the total weight. The flesh is thick-walled, deep yellow and firm. The flavor is sweet and rich with a strong, earthy aroma. 'J-31' will often produce off-season fruit during the fall and winter.

'J-30' was selected in Malaysia. The tree is vigorous, forming an open, conical canopy. The tree can be maintained at a height and spread of 3 m with annual pruning. The production is moderate 50 to 60 kg per year. Fruit are uniform and hang singly on the major limbs. The fruit are dark green and blocky, with blunt spines on the skin. The fruit average 5.6 kg, with an edible flesh percentage of 27%. There are 166 seeds per fruit, which constitute 9% of the total fruit weight. The flesh is deep orange and firm, although the walls of the flesh are thin. The flavor is rich and sweet with only a slight aroma to the flesh and fruit.

Conclusions

With our present data, the cultivars 'Black Gold', 'Golden Nugget', 'Cheena', 'Dang Rasimi', 'Honey Gold', 'J-30', 'J-31', 'NS-1', and 'Tabouey' appear well suited for commercial and home garden use in South Florida. As evaluations proceed, new cultivars will be identified for use in South Florida.

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