



Technical Bulletin No.: 35

PINEAPPLE

**a profitable
fruit crop for** **Goa**

S. Priya Devi
M. Thangam
M. S. Ladaniya
N. P. Singh



ICAR RESEARCH COMPLEX FOR GOA

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

Old Goa - 403 402, Goa (India).

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FOREWORD

Goa is a small but important coastal state in India. In the state, mining and tourism are attractive enterprises, followed by agriculture. The state's income from horticulture is mainly due to plantation crops like cashew, coconut etc. Even potential fruit crops like banana and pineapple take back bench as enterprises. Pineapple is a fruit of ever-growing demand from domestic as well as tourism point of view. Presently, indescrpt 'Local' cultivar is grown disregarding quality of planting material and nutritional requirement. Plantation is also being continued for more than 5 to 6 ratoon crops or even more and fresh planting is not done for many years resulting in poor yields i.e. 8-10 tonnes per ha.

Although coconut is one of the important plantation crops cultivated in Goa in an area of 25, 160 ha, the inter-space is fallow in 90% of the fields. Availing this land for inter-cultivation of shade tolerant fruit crop like pineapple will not only serve as an additional income to farmers but also solve the problem of area expansion under horticulture in a small state like Goa. The current scenario of productivity of pineapple in Goa is well below the national average. This condition is due to ignorance and non-adoption of proven/ improved technologies of cultivation. Unsystematic orcharding and lack of scientific approach in farming are the current lacuna in Goan agricultural scenario. This technical bulletin throws light upon the prospects of scientific cultivation of pineapple as intercrop in coconut farms.

A handwritten signature in blue ink, appearing to read 'NP Singh', written over a horizontal line.

(Narendra Pratap Singh)

Director



PREFACE

The pineapple (*Ananas comosus*) is one of the most popular tropical fruits. The origin of the pineapple is the American continent, probably Brazil and Paraguay. It has spread throughout tropical and subtropical regions as a commercial fruit crop. The important pineapple growing countries of the world are the Hawaiian Islands, Philippines, Malaysia, Thailand, Brazil, Ghana, Kenya, Mexico, Taiwan, South Africa, Australia, Puerto Rico and India.

The juice has worldwide market. The fruit and juice have good industrial demand also. The fruit is a good source of vitamin A and B and rich in vitamin C and calcium. It also contains phosphorus and iron. India produces more than 8% of total world production of pineapple. The major pineapple producing states in India are Assam, West Bengal, Karnataka, Meghalaya, Manipur, Arunachal Pradesh, Kerala and Bihar.

Currently, India produces 1.53 million tonnes of pineapple with productivity of 15.3 t/ha. Although Goa is a potential state for cultivating pineapple, it has not been done commercially but for few farms. Utilisation of available inter space in coconut which is otherwise fallow by cultivating improved varieties of pineapples will fetch good profit to the farmers of Goa.

In this context a systematic evaluation study was undertaken in ICAR RC for Goa with three varieties of pineapple under the shade of adult coconut palms. The results were encouraging and the same has been published in this bulletin for the benefit of farmers. Besides, the package of cultural practices for commercial cultivation of pineapple has also been furnished in this bulletin. The authors are thankful to the organisation for all the support rendered.

We express our deep and sincere sense of gratitude to former Director V.S.Korikanthimath for his motivation and support since the initiation of this study. We also duly acknowledge the technical assistance rendered by Late. Mr. Ashok Dessai, Mr. Rahul M. Kulkarni and Mr M.M. Zalmi throughout the study period.

Authors





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1. Pineapple - A profitable fruit crop for Goa

1. INTRODUCTION

The pineapple [*Ananas comosus* (L.) Merr.] is one of the leading commercial fruit crops of the tropics. Pineapple is also a commercially important fruit crop of India with around 90,000 ha area under this crop, 15.27 lakh tonnes annual production and 15.3 tonnes /ha productivity (Anonymous, 2013). It is one of the choicest fruit all over the world because of its pleasant taste and flavour. Pineapple is a good source of vitamin A and B and fairly rich in vitamin C and minerals like calcium, magnesium, potassium and iron (Table 1). It is also a source of bromelin, a digestive enzyme. In addition to being eaten fresh, the fruit can also be canned and processed in to different forms.

Table 1: Nutritional value of Pine apple (per 100 g)

Energy	48 kcal
Carbohydrates	12.63 g
Sugars	9.26 g
Dietary fiber	1.40 g
Fat	0.12 g
Protein	0.54 g
Thiamine (vit. B ₁)	0.079 mg
Riboflavin (vit. B ₂)	0.031 mg
Niacin (vit. B ₃)	0.489 mg
Pantothenic acid (B ₅)	0.205 mg
Vitamin B ₆	0.110 mg
Folate (vit. B ₉)	15.00 µg
Vitamin C	36.20 mg
Calcium	13.00 mg
Iron	0.28 mg
Magnesium	12.00 mg
Manganese	0.90 mg
Phosphorus	8.00 mg
Potassium	115.00 mg
Zinc	0.10 mg

Source: USDA Nutrient database



2. Classification of Pineapple

The horticultural classification of pineapple varieties of Hume and Miller (1904) is currently followed. They divided cultivated varieties of pineapple into 3 main groups *viz.*,

- i) Cayenne,
- ii) Queen and
- iii) Spanish.

Cayenne group is by far the most important group. Most of the varieties in India may be accommodated into anyone of the 3 groups. For example, Kew or Giant Kew, synonymous with Smooth Cayenne, grown most extensively in India, represents Cayenne group, and Queen another popular variety belongs to Queen group. Recently, Py *et.al.* (1987) classified cultivars grown throughout the world into 5 distinct groups, the additional two being 'Pernambkuco' and 'Mordilonus-Perolera- Maipure'.

The varieties of Cayenne and Spanish group are dual-purpose ones whereas varieties of Queen group are grown exclusively for fresh-fruit markets, as they are not suitable for canning; owing to deep eyes.

VARIETIES OF CAYENNE GROUP

Smooth Cayenne or Cayenne

Smooth Cayenne is extensively cultivated in Hawaii, Philippines, Australia, South Africa, Puerto Rico, Kenya, Mexico, Cuba and Formosa. It is the most popular canning variety.

The plant is stocky and robust; with tapering fleshy leaves up to 90 cm in length and about 6 cm in width. The upper surface of the leaves is dark green with brownish-red irregular mottling above (due to anthocyanin pigment in the epidermis) and silvery-grey mottling beneath with smooth straight margins, excepting near the tip and the base, where there are a few small spines. The flowers are light-purple with bright-red bracts and their number on a single spike ranges from 130 to 170. The fruit is cylindrical in shape and weighs between 2 and 3 kg; the fruitlets or eyes are typically broad and flat.

As the fruit ripens, it acquires a deep-yellow to coppery-yellow colour, which first appears at the base and progresses upwards to the shoulders. The flesh in firm, close-textured, juicy and with a pale-yellow to yellow colour at maturity.





Fruits of variety Giant Kew.

An average acid range lies between 0.5 and 1.0% and the total soluble solids (TSS) between 12° and 16° Brix. Crown is normally one, attached to fruit without a narrow neck and has loosely imbricate leaves above. Slips are on the peduncle ranging from 0 to 10, and suckers are in leaf axils ranging from 0 to 3 and reaching a length of 35-40 cm.

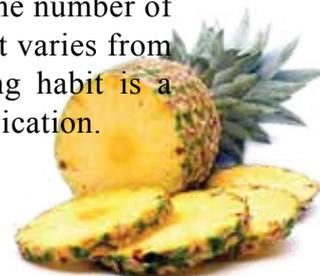
Kew

It is a late-maturing variety and is the leading commercial variety in India. Kew is valued particularly for its canning quality.

The plants are vigorous and leaves are long with straight margins. The upper surface is dark green with a superficial brownish-red mottling and the lower

surface is silvery-grey or ashy-grey in colour. Leaves often have a short sector of small spines at the tip and also at the base, near its attachment to the stem, where they are irregularly arranged.

Fruit weights 1.5-2.5 kg, and is oblong in shape, slightly tapering towards the crown. Eyes are broad and shallow; making fruits more suitable for canning. The fruit is yellow when fully ripe and flesh is light yellow, almost fibreless, and very juicy with 0.6-1.2% acid, and its total soluble solids content varies from 12° to 16° Brix. Normally fruit will have one crown but occasionally more are present. Slips arising on peduncle are 0 to 10 and the number of suckers produced per plant varies from 0 to 2. This shy-suckering habit is a disadvantage in its multiplication.



Giant Kew

This variety grown in certain regions of India is synonymous to Kew excepting in size of the plant and the fruit, which are larger than Kew as the name signifies.

Other varieties of Cayenne group

Hilo, Charlotte Rothschild, St. Michel and Baronne-de-Rothschild, Sarawak, Champaka, Typhones and various other Cayennes

VARIETIES OF QUEEN GROUP

Queen or Common Queen

This is an old cultivar and is grown mainly in Australia, India and South Africa, where it is preferred for trade of fresh fruit.

The plants are characterized by dwarf, compact habit of growth. Foliage is bluish-green. The leaves are short, stiff, spiny along the margins, and thickly covered with a whitish bloom on both surfaces. The flowers are lilac in colour.

Fruit weighs 0.9-1.3 kg. Peduncle is short; fruitlets or eyes are small, prominent, deep set. When fully mature, the fruit is golden-yellow and internal flesh is deep golden-yellow. The flesh, although less juicy than Cayenne, is crisp (less fibrous), transparent with a pleasant aroma and flavour. The total soluble solids content varies from 15^o to 16^o brix and acidity between 0.6 and 0.8%. The slips are 0-4 and suckers are 0-3, and both are smaller in size than those of Cayenne.



Fruits of variety Mauritius.





Fruits of local variety.

Mauritius

It is grown in some parts of Meghalaya and Kerala in India. Fruits are of medium size and are of 2 types, deep yellow and red. Fruits of yellow variety are oblong, fibrous, and medium sweet compared to red type. Mauritius is exclusively grown for table purpose. Leaves are yellowish green, spiny throughout the margin. Crown also is spiny in both the types.

Other varieties of Queen group

Z. Queen, Ripley Queen, James Queen, Natal Queen, V.C. Queen, Alexandra, Mac Gregor, Common Rough, Comte de Paris, Victoria *etc.*

VARIETIES OF SPANISH GROUP

Red Spanish

It is extensively cultivated in West Indies, Cuba, Puerto Rico and Mexico, and is mainly used for trade of fresh fruits.

The plant and fruit size is intermediate between Cayenne and Queen. The leaves are long, about 1.2 m and spiny. Fruit is rather square in shape and weighs between 0.9 and 1.8 kg. Peduncle is long (20-25 cm) and slender and is often not able to support the fruit upright. Fruitlets are few, about 80, larger than cayenne; shell is tough and firm, and is orange-red. The eyes are located deep, as in Queen group. Flesh is pale yellow, fibrous with pleasant penetrating aroma and spicy acid flavour; quite different from that of Cayenne or Queen. Core is relatively large. Crown is 20-25 cm long, with long spiny recurved leaves. Slips are 2-8, and are borne very close to fruit. Suckers range from 1 to 3 per plant.

Other varieties of Spanish Group

Singapore Spanish, Masmerah, Espanola Roja, Cabezona, Pina de Cumana, Selengor Green, Nangka, Gandol, Betek, Castilla *etc.*



3. Pineapple cultivation in Goa

Pineapple is a hardy plant; requires very less water and hence suitable for most parts in coastal and inland of south India. Tropical climate of Goa is very much suitable for pineapple cultivation, both in open field conditions and under the shade of coconut. Goa receives an annual rainfall of 2800-3500 mm from June to October with equanimous weather (average annual minimum temperature of 20°C and maximum temperature of 30°C). The minimum temperature in winter ranges from 15° to 20°C with maximum temperatures 25° to 28°C. In summer (February-May) maximum and minimum temperatures

are 38° and 25°C, respectively. Climate is humid and hot in general.

Although coconut is one of the important plantation crops cultivated in Goa in an area of 25, 160 ha, the inter-space is fallow in 90% of the fields. Availing this land for inter-cultivation of a shade tolerant fruit crop like pineapple not only serves as an additional income to farmers but also solves the problem of area expansion under horticulture in a small state like Goa. Besides, pineapple is a fruit of ever-growing demand from domestic as well as tourism point of view. Presently, indescrpt



Cultivation of local variety under shade in Goa





Unproductive pineapple plantations.

‘Local’ cv. (Red Spanish group) is grown disregarding quality of planting material and nutritional requirement. Plantation is also being continued for more than 5 to 6 ratoon crops or even more and fresh planting is not done for many years resulting in poor yields i.e. 8-10 tonnes per ha. (Fig 1)

Therefore, performance of three varieties namely- ‘Giant Kew’, ‘Queen’

(‘Mauritius’) and ‘Local’ (similar to ‘Red Spanish’ group locally cultivated since long) was evaluated in the climatic conditions of Goa for the first time for flowering, fruiting, fruit quality and yield parameters during main crop (first crop) and two consecutive ratoon crops under the coconut shade.



4. Evaluation of pineapple cultivars

4.1 Varieties evaluated

Three varieties namely 'Giant Kew', 'Queen' ('Mauritius') and 'Local' ('Red Spanish' group) were planted under the coconut (cv. Benaulim) shade during September- 2003. The soil was red laterite as observed in coastal western ghats of India. The planting distance between the coconut palms was 8 m (row to row and plant to plant). The palms were about 20 years old. Twenty pineapple suckers were planted in 30 cm deep trenches at the distance of 30 cm (plant to plant) in double row system. The trench width was about 90 cm and length 3 m. The space between two rows of pineapple plant was 60cm. There were 12 trenches of each variety.

The planting was done during second week of September 2003. Suckers were drenched with Fytolon (0.2%) two weeks after planting and normal cultivation practices were followed for weeding and fertilizer application.

Fertilizers such as Urea, Single super phosphate and Muriate of Potash were applied on the basis of the per hectare (10,000sq m) rate of 600 kg N, 600kg phosphorus and 600 kg potash. The split doses of fertilizers were applied after 2, 4, 6, 8, 10, 12 and 14 months. For ratoon crops fertilizers were applied twice i.e. before flowering and during fruit growth (8th and 10th month,



Plantation of pineapple as intercrop in coconut





Giant Kew fruiting in field

respectively, after harvest of earlier crop).

In all the three varieties studied, observations were recorded for crown weight, fruit length, girth, weight, juice content, TSS and titratable acidity. Fruit yield was recorded in all the plants during harvests and average individual fruit weight was drawn. Expected pineapple yield in one hectare of coconut plantation was further calculated.

4.2 Span of flowering and fruiting:

Harvesting started from November-December 2004, *i.e.* 13 to 14 months after planting. Fruits of 'Mauritius' matured first while maturity and harvesting in 'Giant Kew' started one month later. The peak harvesting of

main crop was carried out in April and May 2005 *i.e.* after 17-18th month from planting which is the normal duration for main crop of pineapple. Most plants flowered 10-12 months after planting and fruits matured after 5 months and thus it took 16-17 months for harvesting of main crop. Maximum crop of all the three cultivars was harvested during this period. 'Local' cultivar was a shy bearer, late and produced least crop as compared to 'Giant Kew' and 'Mauritius' (Table 2). Mauritius was the earliest to flower and to fruit and was closely followed by Giant Kew. Overall highest yields were recorded in Giant Kew. In Mauritius and 'Giant Kew' 10-15% plants did not flower in main and ratoon crops while in 'Local' percentage of such plants was 15-20%.

The first ratoon crop matured in April





Queen variety fruiting in field

–May 2006 i.e.12-13 months after harvesting of main crop. Harvesting of first ratoon crop was started with Mauritius, the first to flower and produce mature fruit closely followed by Giant Kew with the difference of 2 weeks. Harvesting of first ratoon was completed in 2 years and 9 months from date of planting. Harvesting of second ratoon crop was started about 12 months after first ratoon crop and got completed 44 months after planting. ‘Mauritius’ as well as ‘Giant Kew’ matured simultaneously. ‘Local’ cultivar recorded flowering and fruiting very late. It also produced minimum yield as a main crop but yield increased slightly in first ratoon and then declined in second ratoon crop.

Results indicated that there was no adverse effect of coconut shade (coconut planting at 8 m distance) on

duration of fruit maturity and yields in pineapple. Duration of crop maturity in main and ratoon crops grown under open field conditions was recorded to be similar (Samson, 1984).

4.3 Main crop:

4.3.1 Fruit length, girth and weight: In the main crop, length of ‘Mauritius’ fruit was the highest (15.95 cm) followed by ‘Giant Kew’ (15.84 cm) while in ‘Local’, fruit length was 14.73 cm with insignificant difference between these cultivars (Table 2). Fruit girth was maximum (39.81 cm) in ‘Giant Kew’ followed by local (32.44 cm). Fruits of ‘Mauritius’ have recorded least girth. The difference was highly significant (at 1%) between fruit girth of ‘Giant Kew’ and ‘Mauritius’ (Table 2). Fruit weight (without crown) was maximum in Giant Kew (2.16 kg)



followed by Mauritius (1.01kg) with highly significant difference between these two. Fruit weight was least in local cultivars (0.99 kg) and was significantly less as compared to Giant Kew. Difference was non-significant in fruit weight of Mauritius and local. Higher length and girth of Giant Kew was reflected in fruit weight.

4.3.2 Crown weight: Local cultivar produced heaviest crown (0.197 g/ fruit) followed by Giant Kew (0.138 g/ fruit). The smallest crown was produced by Mauritius. Findings indicated that crown of the 'Mauritius' were significantly smaller (at 5%) than local and Giant Kew. The crown weight was 16.10% out of average fruit weight of 'Local' cultivars while in case of 'Giant Kew' crown weight constituted 5.67% of the fruit weight.

4.3.2 Fruit yield: Giant Kew was profuse and regular in bearing while local variety produced smaller fruits after late flowering resulting in lower yield. An average individual fruit weight of 2.16 kg in Giant Kew translated to yield of 49.27 t/ha per hectare. Per hectare yield of local cultivar would be less (22.58 t / ha) as compared to Mauritius (23.04 t / ha) and Giant Kew (49.27 t / ha). In monocrop or single crop cultivation, pineapple yield was estimated to be more than 65 t for plant density of 53300 in hot humid areas (Chadha, 4). The highest fruit weight with crown (2.41 kg) and the highest yield (84.57 t/ha) were recorded with a chelated commercial formulation 'Polymax super' compared with 1.38 kg and 29.26 t/ha respectively in the control, in Giant Kew under Assam condition



Local variety fruiting in field.



Table 2 . Performance of Pineapple cvs. during main crop

Cultivar	Fruit length (cm)	Fruit girth (cm)	Fruit weight without crown (kg)	Crown weight (kg)	Expected yield /ha (tonnes) under coconut shade	TSS* (%)	Titration acidity* (%)	TSS: acidity Ratio*
Giant Kew	15.84	39.81	2.16	0.13	49.76	12.75	0.79	16.13
Mauritius	15.95	31.87	1.01	0.07	23.04	12.17	0.66	18.43
Local	14.73	32.44	0.99	0.19	22.58	14.34	0.74	19.37
CD 1%	N.S.	2.73	0.34	0.06				
CD 5%	N.S.	2.01	0.25	0.04				

* Average of five fruits from different trenches

Note: Average fruit weight of 2.16 kg in 'Giant Kew / plant means 43 kg from one trench with 20 plants. There can be around 1152 trenches in one hectare of coconut plantation with the plant density of around 23040 per ha. The average fruit weight / plant have been extrapolated to yield per ha yield of 49.76 tonnes from 23040 plant density. However, under field conditions, as all plants may not flower or due to some climatic or nutritional factors, yield would be 44.79 tonnes / ha or less in Giant Kew after deducting 10% population towards irregular flowering.. Similar status applies for other cultivars also.

(Bhattacharyya and Bhattacharyya, 1992). For the plant density of around 29,000 per ha (one inter-space between four coconut palms accommodating 8 trenches of 3 m length, with 20 plants per trench accounting to around 1152 trenches in one ha), yield as per present results would be a maximum of 49.77 t (calculated from actual average fruit weight). In present experiment, natural flowering and fruiting was evaluated. Growth regulators such as ethrel were not used for flower regulation, but with which, even higher yields could have been realized.

4.3.4 Fruit quality: The TSS content was highest (14.34 %) in 'Local' cv. followed by Mauritius (12.17%). The titratable acidity was 0.74% in 'Local' resulting in TSS: acid ratio (17.56). In Giant Kew, TSS: acidity ratio was 13.92 which was also palatable.

4.4 First ratoon crop:

4.4.1 Fruit length, girth and weight:- Fruit length (16.36 cm) and girth (38.89 cm) in 'Giant Kew' were highest followed by 'Local' cultivar (Table 3). Fruits of Mauritius were smallest in size and recorded weight of 0.766 kg which was significantly lower



than Giant Kew. Lower fruit length and girth of 'Mauritius' reflected in fruit weight. Fruits of Giant Kew were largest with 1.61 kg weight. There was a decrease in fruit weight of Giant Kew and 'Mauritius' in first ratoon crop as compared to main crop while there was no drop in weight of local cultivar.

4.4.2 Crown weight:- Crown weight was maximum in Giant Kew (0.303 kg) closely followed by 'Local' (0.298 kg) with insignificant difference between the two. The crown of Mauritius was significantly smaller (at 1% level of significance) than that of Giant Kew and Local. In first ratoon crop, crown weight increased as compared to plant crop. Crown contributed 22.48% of the total fruit weight in local cv. while in Giant Kew, crown weight was 15.70% (of the fruit weight with crown). The

percentage of crown weight increased the total fruit weight of Mauritius also. In case of Giant Kew and Mauritius fruit weight (without crown) decreased while crown weight increased.

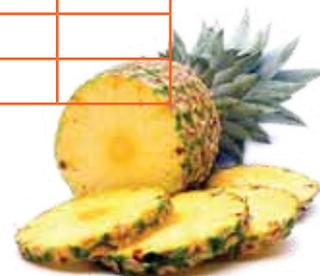
4.4.3 Fruit yield: The average individual fruit weight was 1.62 kg in 'Giant Kew', which was highest among all the cultivars. This yield translated in to 36.84 tons /ha *i.e.*, 25.22 % less than main crop. With yield of 0.766 kg per plant, average yield per ha in case of Mauritius would be 17.47 t (24.17 % less than main crop), whereas in 'Local', it would be 22.97 t (almost as main crop).

4.4.4 Fruit quality: The TSS content was highest (18.21%) in Giant Kew followed by 'Local' and Mauritius. The acidity content was higher in Giant

Table 3. Physico-chemical attributes and yield of pineapple cvs. in first ratoon crop.

Cultivar	Fruit length (cm)	Fruit girth (cm)	Fruit weight without crown (kg)	Crown weight (kg)	Expected yield/ha (tonnes) under coconut shade	TSS* (%)	Titrateable acidity* (%)	TSS: acidity Ratio*
Giant Kew	16.36	38.89	1.615	0.303	36.84	18.21	0.70	26.01
Mauritius	14.69	32.49	0.766	0.120	17.47	12.75	0.43	29.65
Local	14.79	34.72	1.007	0.298	22.97	13.15	0.60	21.91
CD 1%	--	2.63	0.34	0.07		--	--	
CD 5%	1.21	1.94	0.25	0.05		--	--	

* Average of five fruits from different trenches



Kew than other cultivars but the fruits were very palatable and tasty. The TSS: acidity ratio was highest in Mauritius due to lower acid content (Table 3). The pulp was creamy white in Giant Kew while it was yellowish in local. External colour of fruit was also reddish orange in case of Local cultivar. Mauritius fruit appeared to be of cylindrical shape which is desirable for canning.

4.5 Second ratoon crop:

4.5.1 Fruit length, girth and weight:- Fruit size decreased in Giant Kew and Mauritius during second ratoon crop as the fruit length and girth decreased (Table 4). In Giant Kew, fruit length was 12.75 cm which was 3.09cm lower than main crop, while the girth of 33.16 cm was 6.665 cm lower than main crop. The trend was similar in Mauritius. In case of local cv., there was a slight decrease in fruit length, but girth was higher and weight was less in second ratoon crop as compared



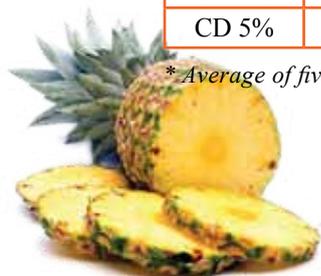
First ratoon crop of variety Mauritius.

to main crop and first ratoon crop. Fruit length, girth and weight were higher in 'Local' cultivar than Giant Kew and Mauritius. Fruit weight was lowest in second ratoon crop among the three

Table 4. Physico - chemical quality and yield of pine apple cultivars in second ratoon crop

Cultivar	Fruit length (cm)	Fruit girth (cm)	Fruit weight without crown (kg)	Crown weight (kg)	Expected yield/ha (tonnes) under coconut shade	TSS* (%)	Titrateable acidity* (%)	Juice* (%)	TSS: acidity Ratio*
Giant Kew	12.756	33.16	0.74	0.128	16.88	18.12	1.10	42.58	16.47
Mauritius	12.177	30.02	0.57	0.071	13.00	18.23	0.76	43.93	23.98
Local	14.348	35.93	0.87	0.197	19.84	12.73	0.87	38.32	14.63
CD 1%	--	4.31	--	--		--	-	--	
CD 5%	1.58	3.17	0.21	0.04		-	-	---	

* Average of five fruits from different trenches





First ratoon crop of variety Giant Kew.



First ratoon crop of local variety.



crops (main + two ratoon) studied. Py *et al.* (1987) reported that reduction up to 20% in yield of smooth Cayenne (Kew and Giant Kew) varieties is common in ratooning. Experiments conducted at the Indian Institute of Horticultural Research, Bangalore, on ratooning have revealed that average fruit weight in the first and second ratoon was 88% and 79% of the plant crop, and the plant stand also reduced leading to reduction in fruit yield by 49.3% and 46.2% in the first and second ratoon crops (Chadha *et al.*, 1977). In present study, fruit weight dropped by 25% and 24% in first ratoon as compared to main crop in case of 'Giant Kew' and 'Mauritius', respectively. Rao *et al.* (1977) reported that reduction in fruit yield in ratoon crops could not be prevented by increasing irrigation and nitrogen doses.

4.5.2 Crown weight:- The crown weight was highest (0.197 g) in local followed by Giant Kew (0.128 g) which indicated that local variety produced more biomass as compared to Giant Kew. Mauritius produced smallest crown with smallest fruit.

4.5.3 Fruit yield:- The average individual fruit weight in 'Giant Kew' was 0.74 kg (54.18% less than first ratoon crop). However, an average fruit yield of 16.88 t/ha could be achieved. Similarly, 'Mauritius' showed a decreasing trend of 13 t/ha (as compared to 17.47 t/ha in first ratoon which was 25.56 % less) and local type recorded an average individual fruit weight of 0.87 kg, extrapolating to 19.84 t/ha (with 13.58 % reduction from 22.97 t/ha in first ratoon)



Profuse slip formation in local variety



4.5.4 Fruit quality:- Giant Kew fruit recorded 18.12% TSS, 1.10% titrable acidity and 42.58% juice content. The TSS: acidity ratio was 16.47 which resulted in very palatable fruit. Fruits of Mauritius recorded similar composition (Table 4) with slightly lower acidity and sweeter taste. In 'Local' cv., TSS content was quite low (12.73%) with lower juice content (38.32%). The flavour of local cv. was not as good as Giant Kew and Mauritius.

Ratoon crops are obtained by leaving the suckers to develop on the mother plant after the first has been harvested. In ratoon crop, the crop cycle is short, cost is less although fewer suckers are produced. The crowns can be used if ratoon crops

are taken and results are good (Py *et al.*, 1987). The reduction in yields in ratoon crop can be compensated by reduced cost. In Smooth Cayenne (Kew) group it is justified. However in Hawaii under optimum and favourable climate conditions yield reduction has not occurred. In Queen and Spanish group cultivars there is no reduction in yield (Py *et al.*, 1987). In present study, the average fruit weight of Giant Kew was 25% less in first ratoon as compared to the main crop. Generally there is a recommendation of two ratoon crops. Cultivation cost appeared to be very less in ratoon and moreover no insect-pest or disease incidence was observed in present study. Pesticides sprays were also not applied as there was no need.



Local, Giant Kew and Mauritius fruits





Pineapple in flowering

4.6 Estimated income from pineapple intercrop:

The estimated income from main crop of 'Giant Kew' variety grown in coconut plantation would be around Rs. 3 to 4 lakhs from 49.27 tonnes yield from one ha (Rs. 8/- per kg average wholesale price for pineapple during 2013; NHB). In first and second ratoon crops, income would be Rs. 2-3 lakhs and Rs. 1 lakhs/- from 36.84 and 16.88 tonnes /ha yield, respectively. This is an additional income besides regular income from coconut. The additional side suckers and slips produced also fetch margin to the farmers. The cost of suckers varies

from Rs 2 to Rs 4 per sucker. Pineapple biomass like leaves and crowns can be utilized for composting and recycling nutrients thus reducing fertilizer costs. If possible, pineapple biomass can be a better and easier material to extract bio-ethanol than from other sources like algae and fish biomass (Abu Osman et al, 2008).

In present study, pineapple cultivar 'Giant Kew' was found to be most suitable for cultivation under coconut shade in climatic conditions of Goa considering higher yields, good fruit quality and relatively higher crown or





Uniform fruiting in variety Giant Kew.

biomass production than 'Mauritius'. 'Local' cultivar was not a high yielder; a shy flowering type coinciding harvests with monsoon. The smaller sized fruits and loss of crop stand bring down the yield levels in ratoon crops. Nevertheless pineapple cultivation will

be remunerative due to good market prices and also due to very less disease and pest incidence under agro-climatic conditions of Goa. Fresh plantation is recommended after second ratoon crop.



5. Package of practices for Pineapple

5.1 INTRODUCTION

Pineapple (*Ananas comosus*) is one of the commercial fruit crops of Goa. It originated in Brazil and then spread to other tropical parts of the world. The cultivation of Pineapple is confined to high rainfall and humid coastal regions in the peninsular India and hilly areas of north-eastern regions of the country. In Goa, it is cultivated in an area of 336 hectares with an annual production of 5,040 tonnes. Pineapple grows well in humid tropical condition, in coastal belts as well as inlands. Optimum temperature requirement is 22 to 32°C.

It can be grown up to 1100m above mean sea level, if frost free. An optimum rainfall of 100-150 cm is required, but still pineapple performs well under high rainfall zone and also under dry zones with supplementary protective irrigations during dry spell. The plants can come up well in any type of soil except heavy clay. Sandy loam is ideal for pine apple. Soil of 45-60 cm depth without hard pan or stones and with pH of 5.0-6.0 is highly preferred.

5.2 Land preparation

The field should be well-ploughed and



Mulched trenches of pineapple



made to fine tilth. The ideal time of planting would be April-May or August to October in order to avoid harvests during rainy seasons.

5.3 Planting method:

The propagation materials used are suckers and slips. Uniform sized slips weighing around 350g are used for planting. Suckers and slips are usually preferred for planting since they flower comparatively earlier than crown. The suckers are planted in trenches with a spacing of 90x60x30 cm to accommodate 43,500plants/hectare as a sole or main crop (see Fig). In Goa, the local variety is planted as intercrop in slopes under partial shade of cashew and other wild trees, accommodating around 20,000 plants / hectare.

5.4 Manures and fertilizers:

Pineapple is shallow feeder with high N and K requirement. A dose of N, P₂O₅

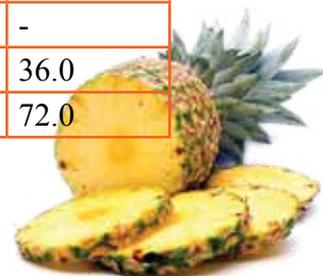
and K₂O at 12, 4 and 12g/plant/year respectively is optimum. Application of fertilizer under rain fed conditions should be done when moisture is available i.e. during monsoon season. (Table 5).

5.5 Inter cultivation:

Earthing up is an essential operation which will result in good anchorage. It is more important in ratoon crop. Mulching is essential to conserve soil moisture as well to check weed growth. Spraying Glyphosate @ 4-5 ml/L or Diuron 2 4 ml/ l is recommended to control the weeds. Fruit weight increases with increasing number of suckers per plant, while more number of slips delays fruit maturity. Hence desuckering can be delayed as much as possible, while slips are recommended for removal as soon as they attain the size required for planting.

Table 5: Fertilizer schedule for soil application in pineapple

Months after planting	N	Urea	P ₂ O ₅	Rock Phosphate	K ₂ O	MOP
	g/plant/year		g/plant/year		g/plant/year	
0	-	-	4	13.5	-	-
2	2	4.4	-	-	-	-
4	2	4.4	-	-	-	-
6	2	4.4	-	-	6	36.0
8	2	4.4	-	-	-	-
10	2	4.4	-	-	-	-
12	2	4.4	-	-	6	36.0
Total	12	26.40	4	13.5	12	72.0





Mauritius



Local type



Giant Kew



Table 6: Flower regulation for staggered harvests

Month of Planting (I year)	Month of application of growth regulators in the II year	Months taken for flower induction	Harvesting month
April	March-April	1-2	October-November
May	April-May	1-2	November-December
August	July-August	1-2	February-March
September	August-September	1-2	March-April
October	September-October	1-2	April-May
November	October-November	1-2	May-June

5.6 Flower regulation using growth regulators:

Normally, pine apple flowers 10-12 months after planting and fruits are ready for harvest after 5-6 months of flowering. Besides time of planting, flower induction practices with certain chemicals or growth regulators influence the season of harvest. Ethrel @ 0.025 ml/l + 2 % urea + 0.04 % Sodium carbonate induce more than 90 % flowering, as urea helps in better absorption and sodium carbonate increases release of ethylene. Therefore for 1000 plants, 50 litres of solution has to be prepared by dissolving 1.25 ml of ethrel + 1 kg of urea + 20 g of sodium carbonate. Around 50 ml of this solution has to be poured in the crown. Similarly, 95 percent of flowering within

56 days could be induced by applying 50ml of solution containing calcium carbide (1%) and urea (2%) at the age of 12 months. In ratoon crop of Giant Kew, calcium carbide (1%) and urea (2%) applied in the whorl of plants in September-October induced flowering within one month and the fruits were ready for harvesting in first week of March to end of May. The planting and flower induction schedule can be planned as follows so as to accomplish staggered harvest and unbroken market availability through out the season i.e. from October to May. (Table 6).

Although, growth regulators or chemicals can induce flowering at any stage of the plant growth, forcing the plants to produce flowers at an early

Table 7: Yield potential of pineapple varieties evaluated

Variety/Yield	Main crop (t/ha)	Ratoon crop (t/ha)
Giant Kew	90-100	60-65
Queen	75-80	50-60
Local	50-60	40-45





Harvested fruits

stage reduces fruit size. Therefore, when plants of optimum size (35-40 fully grown and active leaves) are induced to flower, better fruit size is obtained without any adverse effects on the ratoon crop

Harvesting and yield:

Pineapple plants flower 10-12 months after planting and fruits become ready 15-18 months after planting. (Table 7).



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