

# Polyclonal Cultivation of Local Cultivars of Banana as Inter Crop in Coconut



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गोवा के लिए भा.कृ.अनु.प. का अनुसंधान परिसर  
(भारतीय कृषि अनुसंधान परिषद्)

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## FOREWORD

**G**oa is small but important coastal state in India. In the state, mining and tourism are attractive enterprises, followed far away 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. Unsystematic orcharding and lack of scientific approach in farming are the current lacuna in Goan agricultural scenario.

Cashew, coconut and arecanut are the important plantation crops cultivated in Goa. Banana is cultivated as a mixed crop in arecanut plantations in the form of traditional *Kulaghars* and to lesser tune in coconut plantations. Banana (*Musa spp*) is a potential fruit crop highly suitable for cultivation in interspaces of adult coconut palms . This will not only increase the state production but also the socio-economic status of the farmers. Effective utilization of land and the vertical space which other wise lie fallow is a prudent way of farming.

With regards to this, we are happy in publishing this technical bulletin entitled, "**Polyclonal cultivation of local cultivars of banana as inter crop in coconut**" for the benefit of the state. Systematic cultivation of choice local varieties in the interspaces of adult coconut plantations will prove economically beneficial as indicated in this publication. The brief description of the varieties like *amti*, *raspali*, *velchi*, *saldatti*, *savarboni*, *sugandi* and *myndoli* provides academic as well as practical information for cultivation. Besides, the package of cultivation practices for banana included in this publication will be very useful to the farmers of Goa.

(Narendra Pratap Singh)  
Director



## **PREFACE**

Globally, banana is fourth most important commodity after rice, wheat and corn, and is produced in tropical and sub tropical regions of developing economies. It is grown in more than 130 countries across the world with a total production of 97.38 million tonnes of banana and plantain. India is the largest producer of banana with production of 23.20 million tonnes from 0.65 million ha. India has remained the largest banana producer in the world for the past one decade. In India, banana is well adopted in the regions varying from humid tropics to humid sub tropics and semi arid sub tropics, and from the sea level up to an elevation of 2000 m above mean sea level. Among the horticultural crops, contribution of banana to Agricultural Gross Domestic Product (GDP) is the highest to the tune of 1.99 %.

In Goa, the area under banana cultivation has increased from 2000 ha (2000-01) to 2250 ha (2010-11), and production from 14745 t (2000-01) to 25006 (2010-2011). Though there is an increasing trend in the production and productivity of banana in the state of Goa, the current production is no where comparable with other states of the country.

In the state, different cultivars are grown in different taluks, with very few exceptions where farmers have opted for a complete polyclonal intercropping of banana under coconut. These are cultivated either as monocrop or intercropped in coconut or areca nut plantations in different places of Goa. Intercropping banana in coconut interspaces is a profitable venture recommended in many places in India. Therefore, this study was initiated to evaluate the performance of local cultivars of banana under coconut shade. It has resulted in identification of suitable banana cultivars for commercial cultivation under coconut shade.

I take this opportunity to sincerely thank ICAR, New Delhi for extending the facility required to carry out this study. I express my deep and sincere sense of gratitude to former Director V.S.Korikanthimath for his motivation and support since the initiation of this study. I 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.

I am also very grateful to Director Dr. N.P. Singh, Director, ICAR Research Complex for Goa, for his support in publishing this bulletin and also for his valuable foreword for this publication.

November 2013

**S. Priya Devi**



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**1****INTRODUCTION**

Goa is a small state admeasuring 3702 sq.km, in which more than 50% of the cultivated lands are covered with horticultural crops especially cashew, coconut and areca nut. Besides these plantation crops, fruit crops like mango, banana and pineapple are also cultivated in Goa. Banana cultivars of Goa are claimed to be local to Goa and the basic details about them like vernacular names, International names and their genome are as follows:

S.No	Vernacular name	International name	Ploidy
1	Amti	Mysore	AAB
2	Raspali	Silk	AAB
3	Velchi	Neypoovan	AB
4	Saldatti	Pachanadan	AAB
5	Savarboni	Bluggoe	ABB
6	Myndoli	Giant Plantain	AAB
7	Sugandi	Pisang Awak	AAB

These are cultivated either as monocrop or intercropped in coconut or areca nut plantations in different places of Goa. Intercropping banana in coconut interspaces is a profitable venture recommended in many places in India like Kerala (Rao *et al*, 2008), and in other countries like Srilanka (Liyanage *et al.*, 1985) and Philipines (Villanueva, 2008).

In Goa, different cultivars are grown in different taluks, with very few exceptions where farmers have opted for a complete polyclonal intercropping of banana under coconut. Polyclonal system of growing banana in India is predominant owing to the regional preferences. The best variety of one region may not be the best in other region. Nendran (AAB) banana is grown in Malabar region from time immemorial, which made to believe that it is indigenous to Malabar (Jacob, 1952).

However, in Goa, the performance of cultivars per se and the intercropping of banana under coconut have not been systematically studied. Therefore, this evaluation study was initiated with the objectives to find the cultivar suitability of banana under coconut and to study the performance of various cultivars systematically.

**2**

## Varietal description of local varieties of banana

### **2.1 AMTI**

**Vernacular name** : Amti

**Other names** : Lal velchi, Champa, Palayamkodan, Mysore, Poovan,

**International name** : Mysore

**Ploidy** : Triploid (AAB)

A very common and popular cultivar of banana cultivated throughout India, with fruits available throughout the year. When amti plants are grown under coconut shade, they grow to a height of around 290 cm and a plant girth of 42 cm before harvest of bunches. They produce 1-2 suckers per plant initially. Bunches of 12-13 kg can be harvested after 400 days of planting under coconut shade, whereas under open condition, it takes 3-4 weeks less duration. Each bunch has got 12-13 hands, with 14-16 fruits or fingers per hand. Each hand weighs an average of 1kg. Fruits are golden yellow in colour, of medium size weighing 65-70g, 12-14cm long and of 3.5-4cm diameter. Pulp is yellowish, juicy soft, tastes a blend of sweet and acidic and a unique flavor.(Fig 1a,1b and 1c)



Fig 1a.Bearing Amti plant



Fig 1b.Amti bunch



Fig 1c.Amti hand

## 2.2 RASPALI

Vernacular name : Raspali

Other names : Rasbale, Poobale, Sonkel, Malbhog kulpai, Poovan,

International name : Silk

Ploidy : Triploid (AAB)

This is a very, sweet and delicious variety always fetching premium price in the market. Raspali suckers when grown under coconut shade, grow to a height of around 275-285 cm and a plant girth of 50 cm before harvest of bunches. They produce 1-2 suckers per plant initially. Bunches of 12-13 kg can be harvested after 485 days of planting under coconut shade, whereas under open condition, it takes 7-8 weeks less duration. Each bunch has got 8-10 hands, with 12-14 fruits or fingers per hand. Each hand weighs 1.25 to 1.45 kg. Fruits are attractive yellow in colour, plumpy weighing 100-120g, 13-14cm long and of 3.5-4cm diameter. Pulp is creamish, firm and delicious (Fig 2a, 2b and 2c).



Fig 2a. Bearing Raspali plant



Fig 2b. Raspali bunch



Fig 2c. Raspali hand

### **2.3 SALDATTI**

Vernacular name	: Saldatti
Other names	: Kaali, Galibale, Ladan
International name	: Pachanadan
Ploidy	: Triploid (AAB)

This is also a very sweet and sought after variety fetching premium price in the market. When saldatti suckers are grown under coconut shade, they grow to a height of around 350-360 cm and a plant girth of 45-50 cm before harvest of bunches. They produce 1-2 suckers per plant initially. Bunches of 10-13 kg can be harvested after 400 days of planting under coconut shade, whereas under open condition, it takes 3-4 weeks less duration. Each bunch has got 7-8 hands, with 11-12 fruits or fingers per hand. Each hand weighs 1.50 to 1.60 kg. Fruits are greenish yellow in colour, with grey spots, weighing around 125g, 18-20cm long and of 3.5-4cm diameter. Pulp is whitish, firm and sweet with a typical flavour. The fruits detach easily from stalk; skin is thick and easily peelable.(Fig 3a,3b and 3c)



*Fig 3a. Bearing Saldatti plant*



*Fig 3b. Saldatti bunch*



*Fig 3c. Saldatti hand*

## 2.4 VELCHI

Vernacular name : Velchi/Elchi

Other names : Safed Velchi, Elakki bale, Chini Champa, Neypoovan

International name : Neypoovan

Ploidy : Diploid (AB)

Velchi or Elchi is a cultivar fondly consumed by all and available throughout the year. The fruits are suitable for feeding to infants due to its taste and pulp quality. Being a diploid, it is less vigorous, growing to a height and girth of 350cm and 48 cm respectively. They produce 3-4 suckers per plant initially. Bunches of 10-11 kg can be harvested after 400 days of planting under coconut shade, whereas under open condition, it takes 2-3 weeks less duration. Each bunch has got 11-13 hands, with 12-16 fruits or fingers per hand. Each hand weighs 0.75 to 0.85 kg. Fruits are small and yellow in colour, weighing around 60g, 10-11cm long and of 3.0-3.5cm diameter. Pulp is rather white, firm and sweet with a typical flavor. (Fig 4a,4b and 4c)



Fig 4a. Bearing Velchi plant



Fig 4b. Velchi bunch



Fig 4c. Velchi hand

## 2.5 MYNDOLI

<b>Vernacular name</b>	: Myndoli
<b>Other names</b>	: Moira
<b>International name</b>	: Giant Plantain
<b>Ploidy</b>	: Triploid (AAB)

Myndoli is a huge and tall growing banana cultivar found in Goa. The fruits are available at price always higher than other varieties, owing to its comparative rarity. The plants are vigorous growing to a height and girth of 450cm and 70 cm respectively. They produce hardly one sucker per plant initially. As the plants grow very tall, they are prone to lodging and need bamboo staking from 2-3 directions. Bunches of 15-17 kg can be harvested after 450 days of planting under coconut shade, whereas under open condition, it takes 2-3 weeks less duration. Each bunch has got 6-7 hands, with 12-14 fruits or fingers per hand. Each hand weighs 2.25 to 2.75 kg. Fruits are long and big, dark yellow in colour, weighing around 200g, 21-23 cm long and of 5.25-5.75cm diameter. Pulp is light orange, very firm and sweet with flavor similar to that of Nendran cultivar of Kerala. (Fig 5a, 5b and 5c)



Fig 5a. Bearing Myndoli plant



Fig 5b. Myndoli bunch



Fig 5c. Myndoli hand

## 2.6 SUGANDI

Vernacular name : Sugandi

Other names : Sukundi, Puttabale, Karpuravalli

International name : Pisang Awak

Ploidy : Triploid (AAB)

Sugandi produces very sweet fruits. The plants grow to a height of 300cm and girth of 50cm. They produce hardly 1-2 sucker per plant initially. Bunches of 10-12 kg can be harvested after 365 days of planting under coconut shade, whereas under open condition, it takes 3-4 weeks less duration. Each bunch has got 7-10 hands, with 14-16 fruits or fingers per hand. Each hand weighs 1.25 to 1.50 kg. Fruits are of medium size, yellow in colour, weighing 90-100g, 12-13cm long and of 3.0-3.3cm diameter. Pulp is creamish and very sweet. It has got a long shelf life. Even after the skin starts turning black, the pulp keeps good quality. (Fig 6a, 6b and 6c)



Fig 6a. Bearing Sugandi plant



Fig 6b. Sugandi bunch



Fig 6c. Sugandi hand

## 2.7 SAVARBONI

Vernacular name	: Savarboni
Other names	: Bankel, Monthan
International name	: Bluggoe
Ploidy	: Triploid (ABB)

Savarboni is a cooking type of banana. The well matured unripe banana fruits are used for culinary purposes. There is a variant of Savarboni with an ashy coating available in Goa. It is similar to Savarboni in all aspects except the ashy coating. The plants grow to a height of 400cm and girth of 65-70cm. They produce 1-2 side suckers per plant initially. Bunches of 12-13 kg can be harvested after 425 days of planting under coconut shade, whereas under open condition, it takes 3-4 weeks less duration. Each bunch has got 6-8 hands, with around 10 fruits or fingers per hand. Each hand weighs 1.75 to 2.00 kg. Fruits are of big size weighing 160-175g, 19-20cm long and of 3.7-4.0cm diameter. (Fig 7a, 7b and 7c)



Fig 7a. Bearing Savarboni plant



Fig 7b. Savarboni bunch



Fig 7c. Well matured hands of Ashy savarboni and Savarboni

**3**

## Performance of banana cultivars under coconut in Goa

The performance of these above mentioned cultivars per se and the intercropping of banana under coconut have not been systematically studied. Therefore, this evaluation study was initiated with the objectives to find the cultivar suitability of banana under coconut and to study the performance of various cultivars systematically.

### **3.1 MATERIALS AND METHODS**

Banana varieties like Amti, Velchi, Raspali, Saldatti, Savarboni, Myndoli, and Sugandi along with Grand Naine (AAA) as control were planted under coconut shade during August 2003. Sword suckers of these cultivars were collected from farmers' fields and Goa state Government farms. A field of adult coconut palms at a spacing 8 x 8 m was selected for taking up the trial at ICAR Research Complex for Goa. Banana suckers were planted at 2 x 2 m spacing as an intercrop to coconut, in randomized block design (RBD) with three replications. In an area of nearly 2100 sq.m, around 365 banana plants were accommodated in interspaces of 34 palms. Each cultivar had around 45 plants in the field. Regular package of practices like fertilizer application, irrigation, de-suckering, removal of old leaves, propping etc. were followed. Observations like, plant height at harvest, plant girth at one meter height from ground level during harvest, days taken for flowering,



*Banana as intercrop under coconut palm.*

days taken for harvest, bunch weight, number of hands per bunch, hand weight, number of fingers per hand, individual finger weight, finger length, finger girth were recorded. Fruit quality parameters such as pulp: peel ratio, total soluble solids (TSS) and total titrable acids were recorded (AOAC,1980). TSS and titrable acids in the fruit pulp were estimated during main crop only. During the course of study, the weight of all bunches harvested were weighed and then average drawn. The yield per unit area was calculated as the product of average bunch weight and banana plant population of 1764 plants per hectare under adult coconut palms of 8 x 8 m spacing. After harvest of main crop, first ratoon crop was taken and all the observations were recorded, following which, second ratoon crop was taken up. All data were statistically analysed using Web Agri Stat Package (WASP version 2.0), for interpretation and drawing conclusions.

### 3.2 RESULTS AND DISCUSSION

#### Main crop

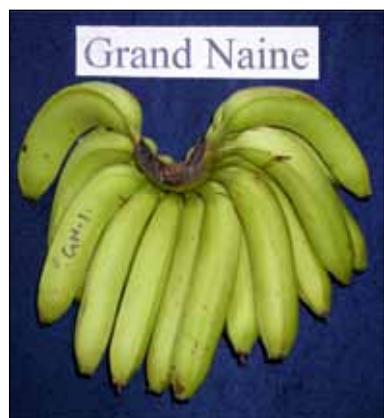
Among all cultivars evaluated, Velchi was the earliest to flower (299 days) after planting followed by Saldatti (309 days). Myndoli took the longest gestation period of 429 days. But by that time, cultivars like Grand Naine, Saldatti, Amti and Velchi, were ready for harvest of main crop bunches and time taken was 398, 402, 403 and 412 days respectively. The cultivars showed significant difference in time taken for flowering and harvest in main and following two ratoon crops. In a study conducted at Jalgaon, Bhalerao (2007) found that Grand Naine took 280 days to flower and 386 days for harvest of main crop. Rema *et al* (2002) reported that Myndoli recorded the longest crop cycle of 409 days under Kerala conditions. Medhi (1994) reported that Bharat Moni (Plantain) took a maximum of 491 days



*Fig 8a.  
Bearing Grand Naine plant*



*Fig 8b.  
Grand Naine bunch*

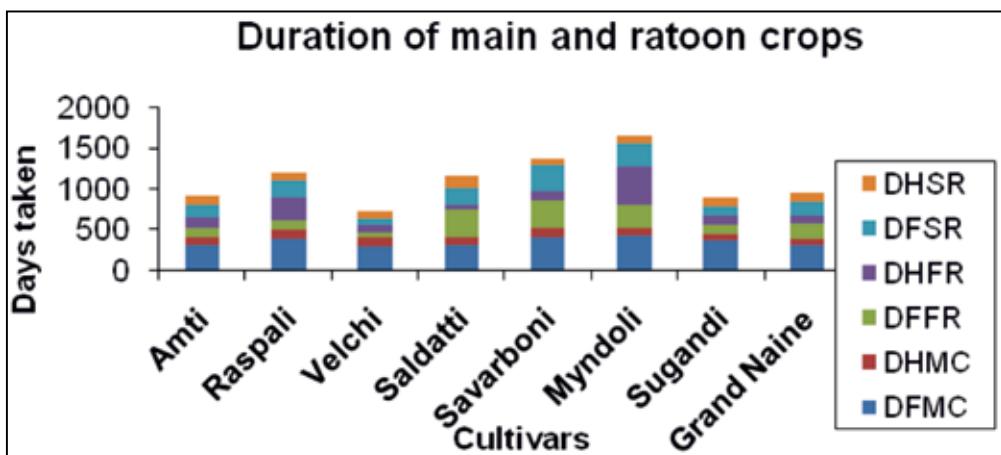


*Fig 8c.  
Ripe hand of Grand Naine*

to harvest bunches. Baruah *et al.*, (2007) found that Dwarf Cavendish (Fig 8a, 8b and 8c) was found to be most precocious (275 days for shooting) and Kachkal (Cooking type) took maximum time of 391 days for shooting, whereas Champa (Mysore) took 376 days and Malbhog (Silk) took 351 days. Though the findings of present study are in line with the crop duration recorded in other places, it is evident that the time taken to shoot out inflorescence as well as harvest of bunches is higher by an average of one month because of the partial shade under which the cultivars were tried.

In first ratoon crop, Velchi was the earliest to shoot inflorescence (473 days), followed by Amti (528 days). Velchi came to harvest in 568 days after planting; Amti in 661 days; Sugandi and Grand Naine in 673 and 675 days respectively. Dinesh Kumar *et al.*, (2008) found that Rasthali took 295 days to flower and 401 days to harvest during main crop. However during first ratoon, it took 248 days to flower and 349 days to harvest at Orissa condition. Babu Ratan *et al.*, (2008) also found that Grand Naine took 220 days to flower and 324 days to harvest during main crop whereas it took 146 days to flower and 263 days to harvest during first ratoon, thereby taking 543 days for completion of main + one ratoon cycle under open climatic conditions of Andhra Pradesh.

In the same trend, in present study, Velchi took a very short duration of 95 days between of harvest of first ratoon and flowering of second ratoon i.e., after 630 days of planting. But, cultivars like Savarboni and Raspali took almost double the



**Fig 9. Duration taken for different cultivars of banana to flower and fruit during main and ratoon crops**

- DFMC- Days taken for flowering in main crop
- DHMC- Days taken for harvest of main crop
- DFFR- Days taken for flowering in first ratoon
- DHFR- Days taken for harvest of first ratoon
- DFSR- Days taken for flowering in second ratoon
- DHSR- Days taken for harvest of second ratoon

duration i.e., 1188 and 1185 days respectively, to flower in the second ratoon crop. The second ratoon crop of Velchi was harvested at the earliest (720 days) followed by Sugandi (891 days), Amti (912 days) and Grand Naine (945 days). Raspali took the longest duration (1295 days) to harvest, followed by Savarboni (1268 days) and Myndoli (1250 days). (Fig. 9)

### **3.2.1.1 Performance of banana cultivars with respect to vegetative characters**

The vegetative growth and stature of all the cultivars evaluated were fairly normal. A significant varietal difference was noticed in the plant stature traits of cultivars evaluated (Table 2). During main crop, Grand Naine was shortest in height with 162.5 cm, whereas, Myndoli was observed to be the tallest of all (450.70 cm), followed by Savarboni (400.50 cm). Similarly, Myndoli also recorded the maximum plant girth (70.88 cm), followed by Savarboni (69.74 cm). Amti recorded the minimum girth (40.90 cm), followed by Saldatti (42.53 cm) and Grand Naine (43.58 cm).

Likewise, during the first ratoon also, Grand Naine was observed to be the dwarfest (170.03 cm), followed by Raspali (281.67 cm) and Amti (285.23 cm). Myndoli was the tallest cultivar (448.30 cm), followed by Savarboni (406.63 cm). Similarly, during second ratoon also, the same trend was noticed with Grand Naine recording the lowest plant height of 168.55 cm and Myndoli the maximum of 451.15 cm. Amti recorded the minimum plant girth of 41.25 cm, whereas, Myndoli recorded the maximum of 70.56 cm. Bhalerao (2007) also observed that plant height and stem girth of Grand Naine were 191.50 cm and 74.40 cm respectively. Medhi (1994) found during an evaluation trial at Assam, Chenichampa (Neypoovan) 253 cm and 49.35 cm; Bharat Moni (Giant / Horn Plantain) 230 and 46.67 cm; Malbhog (Silk) 228 cm and 48.50 cm and Kachkal (Cooking type) 278 and 51.17 cm respectively for plant height and plant girth. In another evaluation study conducted at Assam by Baruah *et al.* (2007), it was found that, the highest psuedostem height (272.25 cm) was found in Champa (Mysore), followed by Kachkal (cooking type; 271.25 cm). In the present study, the findings are in similar line, except that, the plant height is more, due to intercropping under coconut shade. There was noticed a phenomenon of competence for sunlight with the adult coconut palms. Consequently, Myndoli and Savarboni required support of bamboo stakes due to their tall stature.

Suckering habit of cultivars was observed before desuckering. Myndoli had a very shy suckering habit (0.5), whereas Velchi showed a profound suckering habit with 1.94 suckers per mat (Table 2). Velchi, being a diploid and of comparatively shorter duration, with additional advantage of high suckering tendency, therefore, produced more number of bunches in a short duration, when compared to others. Considering these factors, Velchi also being a choice cultivar in market, can be recommended as a suitable intercrop under coconut plantation in Goa.

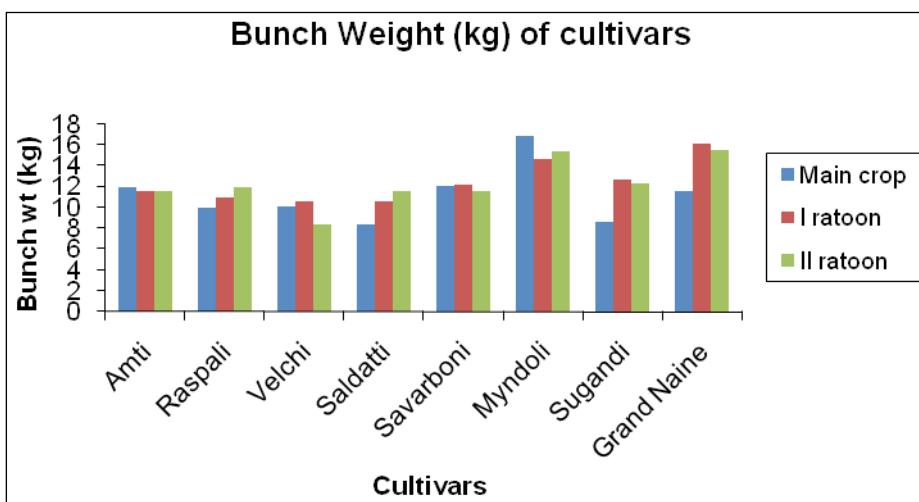
In a similar performance evaluation study, Hipparagi (2002) has recommended Elakkibale (Velchi) as the best profitable cultivar for Southern Karnataka. Bharuah *et al.*, (2007) reported a significant difference in suckering habit at 5 % level. He observed a range of 3.25 in Lacaton to 10.00 in Kachkal and Bhutmanohar.

**Table 2: Vegetative characters of cultivars evaluated**

Varieties	Plant height at harvest (cm)			Plant girth at harvest (cm)			No. of suckers per mat
	Main crop	I ratoon	II ratoon	Main crop	I ratoon	II ratoon	
Amtri	290.40	285.23	287.56	40.90	41.90	41.25	1.30
Raspali	275.50	281.67	285.87	46.07	47.47	49.98	1.28
Velchi	350.40	359.03	345.64	48.10	47.00	46.89	1.94
Saldatti	347.20	358.60	367.88	42.53	45.60	49.74	1.23
Savarboni	400.50	406.63	400.45	69.74	65.61	65.26	1.72
Myndoli	450.70	448.30	451.15	70.88	70.90	70.56	0.51
Sugandi	290.50	300.60	300.17	46.58	49.45	50.05	1.23
Grand Naine	162.50	170.03	168.55	43.58	43.67	43.61	1.20
CD (P=0.01)	12.28	14.54	1.63	5.07	4.50	3.71	0.24

### 3.2.1.2 Performance of banana cultivars with respect to yield characters

The cultivars evaluated showed a great variation in bunch weight and were significantly different from each other. Other than Velchi, rest was triploids (Figure 10 and Table 3). Myndoli recorded the highest bunch weight (16.80 kg), followed by cooking type Savarboni (12.04 kg). In Kerala, Rema *et al* (2002) recorded 25 kg of bunch weight for Myndoli whereas, under Orissa conditions, Lenka *et al.*, (2002) evaluated different types of cooking bananas and found that a minimum of 16 kg was recorded per bunch in type Gaja Bantal (similar to Savarboni), whose cooking quality and market acceptability was the highest among all. Medhi (1994) recorded bunch weights of 13.37 kg, 14.19 kg and 15.35 kg in cultivars Bharat Moni (Plantain type), Malbhog (Silk) and Kachkal (Cooking type) respectively. Baruah *et al.*, (2007) reocrded bunch weights of 12.50 kg, 10.01 kg, 12.00 kg and 11.89 kg in Champa (Mysore), Kachkal (cooking type), Bhutmanohar (similar to Sugandi) and Malbhog (Silk). These findings corroborate with those of present study. In the present study, Saldatti recorded the least bunch weight (8.30 kg) followed by Sugandi (8.58 kg). In terms of yield per unit area, Myndoli recorded the highest yield of 29.64 t /ha, followed by Savarboni (21.24 t / ha). Saldatti recorded the minimum yield of 14.64 t/ ha.



Although, Myndoli and Savarboni recorded less number of hands per bunch (6.12 and 5.56 respectively), the greater hand weight (2.68 kg and 2.10 kg per hand for Myndoli and Savarboni respectively) contributed towards the higher bunch weight (Table 3). Amti recorded the highest number of hands per bunch (12.32), followed by Velchi (11.67). Saldatti produced appreciable hands weighing on an average 1.603 kg and Velchi recorded the lowest hand weight of 0.781 kg. Significant difference in yield was mainly due to the inherent yielding ability of the cultivars. Similar reports were given by Ray and Yadav (2002). Also Bhalerao (2007) observed that Grand Naine produced 8.77 hands per bunch and 152 fingers per bunch. Medhi (1994) observed 7.23 and 7.82 hands per bunch in cooking type and Raspali type of Assam. In the present study, Grand Naine produced on an average, 8.6 hand per bunch and 123 fingers per bunch under Goa conditions.

Sugandi recorded the highest number of fingers per hand (15.65) followed by Velchi (14.57) and Amti (14.46). Myndoli recorded the highest individual fruit weight (226.54 g) followed by Savarboni (145.53 g) (Table 4). Similarly Myndoli and Savarboni bore long fruits (21.71 cm and 20.30 cm respectively), followed by Saldatti (19.32 cm). Highest fruit diameter (5.30 cm) was also observed in Myndoli followed by Savarboni (4.55 cm) and Raspali (4.00 cm). Appreciable pulp: peel ratio (4.69: 1) was noticed in Velchi, followed by Raspali (3.92: 1). Savarboni being a thick-skinned cooking banana recorded the least pulp: peel ratio of 1.75: 1 (Table 5). Baruah *et al.*, (2007) found that finger length ranged from 11.43 cm in Chenali to 23.15 cm in Garomaina (Plantain type), finger girth varied from 9.65 cm in Lacaton to 12.30 cm in Krishnasagar, finger weight ranged from a minimum of 47.20 cm in Chenali to a maximum of 254.60 cm in Kachkal (starchy cooking type). He has also reported a minimum of 5.50 hands per bunch in Asomiya Malbhog (probably a natural mutant of Silk at Assam) and a maximum of 10.75 in Simolumanohar.

**Table 3: Bunch characters and yield of cultivars evaluated**

Varieties	No. of hands /bunch			Av hand weight (kg)			No. of fingers / hand		
	Main crop	I ratoon	II ratoon	Main crop	I ratoon	II ratoon	Main crop	I ratoon	II ratoon
Amti	12.32	13.53	12.25	1.036	0.925	0.995	14.46	14.45	15.02
Raspali	8.53	8.67	7.75	1.162	1.243	1.428	10.70	10.78	13.30
Velchi	11.67	12.90	11.50	0.781	0.810	0.710	14.57	15.23	13.62
Saldatti	6.55	7.67	7.75	1.603	1.350	1.500	11.03	11.41	12.17
Savarboni	5.56	7.70	6.50	2.100	1.580	1.820	9.47	9.65	9.50
Myndoli	6.12	6.30	6.20	2.68	2.310	2.300	11.83	13.85	12.50
Sugandi	6.51	8.07	9.50	1.270	1.450	1.180	15.65	13.66	13.97
Grand Naine	7.70	11.23	7.25	1.746	1.440	2.010	14.00	14.70	13.86
CD (P=0.01)	1.484	1.757	1.580	0.224	0.301	NS	0.999	1.348	NS

**Fig 10. Bunch weight of banana cultivars evaluated during main and ratoon crops**

### 3.2.2 First ratoon crop

There was no much difference in plant height and plant girth between main crop and first ratoon crop. (Table 2). Myndoli recorded the maximum plant height (448.30 cm) and plant girth (70.90 cm), followed by Savarboni (406.63 cm and 65.61 cm). Grand Naine recorded the maximum bunch weight (16.05 kg), followed by Myndoli (14.58 kg). Minimum bunch weight (10.50 kg) was recorded by Velchi and Saldatti, followed by Raspali (10.86 kg) (Figure 10). There was a general increase in yield in all cultivars except Myndoli, which recorded 25.72 t/ha. But, Grand Naine recorded the maximum of 28.31 t/ha. A minimum of 18.52 t/ha was observed in cultivars Velchi and Saldatti. The difference in performance of cultivars was statistically significant. In a management trial on Raspali at Orissa, Dinesh Kumar *et al.*, (2008) found that, in a population of 2500 plants per ha (similar to present study) plants recorded psuedostem height of 276.10 cm in main crop and 262.30 cm in first ratoon; pseudo stem girth of 65.10 cm and 60.20 cm in main and ratoon crop respectively; 5.72 and 6.12 hands per bunch; 8.2 and 7.6 kg bunch weight and an estimated yield of 20.6 and 19.0 t/ha respectively for main and first ratoon crops. In an evaluation trial, Grand Naine recorded a maximum bunch weight of (14.95 kg) (Deshmukh and Badgujar, 2002). In another trial by Kanamadi *et al.*, (2002), a bunch weight of 10.55 kg /plant (25.27 t/ha) and 12.76 kg / plant (32.56 t /ha) was recorded in cv. Rajapuri . In general, triploid cultivars particularly those in commercial plantations are generally superior to diploids in terms of vigour, productivity and acceptability (Shepherd *et al*, 1986)

Amti recorded the maximum number of hands per bunch (13.53), followed by Velchi (12.90 kg) with average hand weights of 0.925 kg and 0.814 kg respectively for cultivars Amti and Velchi (Table 3). Cultivar Myndoli recorded the least number

of hands per bunch (6.30). Though Velchi recorded the minimum hand weight of 0.81 kg, it recorded the maximum number of fingers per hand (15.23). This was followed by Grand Naine (14.70), Amti (14.45) and Myndoli (13.85) (Table 3). Similar to main crop, Myndoli recorded the highest individual fruit weight of 168.5 g, followed by Savarboni (166.08 g) (Table 4). Similarly Myndoli produced the longest fruits (23.31 cm) with highest fruit diameter (5.45 cm). Velchi produced the fruits of minimum length of 10.58 cm, followed by Raspali (12.92 cm) and Sugandi (12.07 cm).

**Table 4: Fruit characters of cultivars evaluated**

Varieties	Finger wt (g)			Fruit length (cm)			Fruit diameter (cm)		
	Main crop	I ratoon	II ratoon	Main crop	I ratoon	II ratoon	Main crop	I ratoon	II ratoon
Amti	71.85	65.15	65.32	11.23	11.20	12.60	3.32	3.34	3.26
Raspali	120.15	115.23	102.77	12.97	12.92	14.11	4.00	4.00	3.86
Velchi	60.70	54.47	59.23	10.19	10.58	11.00	3.03	3.09	3.63
Saldatti	131.09	118.32	115.59	19.32	19.46	17.438	3.52	3.62	3.97
Savarboni	145.53	166.08	158.85	20.30	19.75	19.50	4.55	4.73	4.63
Myndoli	226.54	168.50	170.35	21.71	23.31	21.00	5.30	5.45	5.25
Sugandi	86.37	106.50	82.63	12.03	12.07	13.25	3.17	3.07	3.30
Grand Naine	120.76	106.33	115.07	16.32	16.50	14.52	3.36	3.38	3.11
CD (P=0.01)	9.487	15.045	22.230	1.561	1.657	3.360	0.313	0.554	0.870

### 3.2.3 Second ratoon crop

Yield characters of crop was recorded and furnished in tables 3 and 4. Maximum bunch weight of 15.45 kg was recorded in Grand Naine, followed by Myndoli (15.25 kg). Velchi being a diploid again recorded a minimum bunch weight of 8.38 kg (Figure 10). Velchi recorded a minimum yield of 14.78 t/ha, whereas, Grand Naine recorded a maximum of 27.25 t/ha, followed by Myndoli (26.90 t/ha). The cultivars showed significant difference in growth and bunch characters except average hand weight and number of fingers per hand.

Amti had maximum (12.25) hands per bunch, followed by Velchi (11.50). The same trend was noticed in previous crops also. Myndoli showed minimum number of hands (6.20) that weighed higher than all others (2.30 kg). Minimum hand weight of 0.71 kg was seen in Velchi, followed by Amti (0.995 kg). Maximum number of fingers per hand (15.02) was noticed in Amti, followed by Sugandi (13.97). Among the cultivars evaluated, Myndoli recorded the maximum finger weight (170.35 g), followed by Savarboni (158.85 g), whereas, the minimum finger weight (59.23 g) was exhibited by Velchi. Myndoli recorded the maximum fruit length (21.00 cm) and fruit diameter (5.25 cm), whereas Velchi recorded minimum fruit length (11.00 cm) and Grand Naine, the minimum fruit diameter (3.11 cm). Similar evaluation

trials were taken up with different cultivars of banana under both East and West coast conditions. Cultivars like Poovan, Thenkadali, Monthan, Robusta and Peyan performed well; Rasthali, Kolikodu, Neypoovan, Saba and Karpuravalli performed moderately, whereas, Red banana, Matti, Anaikomban and Nendran were poor performers. (Shakila and Ruban, 2007)

### 3.3 FRUIT QUALITY

In main and first ratoon crops, Velchi recorded the highest pulp: peel ratio of 4.69: 1 and 4.88: 1 indicating thin skin. The minimum ratio was noticed in Savarboni, it being a cooking type (1.75: 1, 1.74: 1 and 1.74: 1 during main, first and second ratoon crops). Saldatti, which means banana with thick skin in Konkani (regional language of Goa) also, had low pulp: peel ratio (1.81: 1). Similarly, Ramkumar and Rajan (2007) reported that pulp percentage was maximum (85.9%) in Neypoovan and that pulp: peel ratio varied from 1.16 to 6.13 and it was higher in Neypoovan and minimum in Malaikali. Rekha and Prasad (2002) also have reported high significant variations among cultivars evaluated for fruit weight, pulp weight and peel weight. In the present study, among the cultivars evaluated, Myndoli was the sweetest (30.85 % TSS), followed by Velchi (25.88 %) and Raspali (25.38 %), whereas Grand Naine recorded minimum TSS of 21.68 %. Medhi (1994) also reported Malbhog (Silk) had the highest TSS (24.22%) among the cultivars evaluated. Amti was the sourest cultivar with 0.62 % of titrable acidity whereas Sugandi recorded the least acidity of 0.26%. Total soluble solids constitute mainly of sugars in banana pulp and thus more TSS content indicates more sweetness.

**Table 5: Quality characters of banana cultivars evaluated**

Varieties	Pulp: peel ratio			TSS (%)	Titrable acidity (%)
	Main crop	I ratoon	II ratoon		
Amti	3.1: 1	3.06: 1	4.39: 1	23.58	0.62
Raspali	3.92: 1	3.87: 1	4.50: 1	25.38	0.48
Velchi	4.69: 1	4.88: 1	4.21: 1	25.88	0.55
Saldatti	1.81: 1	1.81: 1	2.60: 1	24.76	0.49
Savarboni	1.75: 1	1.74: 1	1.74: 1	--	--
Myndoli	2.02: 1	2.04: 1	2.05: 1	30.85	0.31
Sugandi	2.52: 1	2.48: 1	2.68: 1	23.600	0.26
Grand Naine	1.91: 1	1.94: 1	3.15: 1	21.68	0.40
CD (P=0.01)	0.267	0.256	0.950	2.680	0.220



*Saldatti a potential Banana Cultivar.*

### 3.4 COST ECONOMICS

Working out cost economics for one main and two ratoons, it was found that Raspali (1: 2.21), Savarboni (1: 2.31), Myndoli (1: 2.4 7) and Grand Naine (1: 2.48) showed higher cost benefit ratios followed by Amti (1: 1.95), Saldatti (1:1.85), Velchi (1: 1.67) and Sugandi (1:1.15). In a similar case, Marimuthu *et al* (2007) reported that banana cv. Monthan (Savarboni) could be profitably grown as intercrop in adult coconut garden to get more return from the unit area.

**4**

## Conclusion and Future thrust

### Conclusion with recommendations

Under Goa condition, owing to shorter duration and sustained market, cultivars like Velchi, Amti and Saldatti will fetch good returns. High cost incurred in propping of Myndoli plants, breakage losses and long duration are few important criteria that go against this cultivar despite the higher returns due to their high prices. Therefore, polyclonal culture i.e., cultivation of two or more chosen cultivars from the above group ie., Myndoli + Grand Naine+ Velchi (or)

Savarboni + Amti + Velchi (or)

Raspali + Amti + Velchi (or)

Saldatti + Amti + Velchi (or)

cultivation of Grand Naine + Velchi along with any other local variety of regional preference under coconut shade will be highly remunerative to the farmers. It has been proved that banana and coconut are companion /mixed crops synergistic in growth and sharing the inputs. Banana forms a major / essential component either in homestead farming, small land holding or mixed cropping with other perennials as well as multi-storied, multi-species cropping systems and mixed farming system in Asian and Pacific Countries. Being a partial shade tolerant crop, growing banana in coconut provides a favourable micro-climate to plantations and also increases the yield of coconut due to the sharing of inputs as well as addition of biomass to plantations, which add nutrition on recycling (Rethinam, 2002).

### Future thrust/Envisaged research:

Commercial cultivation of banana is being adopted by farmers of Goa as intercrop in plantation crops like arecanut and coconut. However, systematic orcharding is not currently followed. Therefore, Precision Farming of banana is advocated with the following features:

- ◆ Planting material of Tissue culture banana for genetic uniformity and disease free farming
- ◆ High density planting ie planting of 2-3 suckers per pit to increase the productivity of unit land area
- ◆ Minimizing the inputs like water and fertilizers to precise levels by adopting fertigation
- ◆ Use of bunch sleeves for uniform, blemishless bunches
- ◆ Furnishing a supply chain to market the harvested good quality bunches.

**5**

## Package of practices for banana

### **Introduction:**

Banana is one of the important fruits commercially cultivated in Goa under open as well as coconut plantation. In Goa, it is cultivated in an area of 2,342 hectares with total production of 23,420 tonnes/year. Banana can be cultivated in sandy loam to clay soil. Banana is well suited for cultivation under humid, tropical high rainfall zone.

### **Land preparation:**

The land should be ploughed well and pits of 60 m<sup>3</sup> should be dug out. In Goa, it is cultivated in all type of soils. Sword suckers with well developed rhizomes weighing 500 to 750g are used for planting.

### **Varieties:**

Amtri (Mysore), Raspali (Silk), Velchi (Ney poovan), Saldatti (Saba), Savarboni (Bluggoe), Myndoli (Horn Plantain) and Sugandi (Pisang awak) are the cultivars commercially cultivated in Goa besides Cavendish varieties like Grand Naine, Dwarf Cavendish and Robusta.

### **Planting method:**

Conventional suckers or tissue culture plants should be planted at a spacing of 2x2m. Before planting, rhizome or sucker should be dipped in Bavistin (0.1%) solution. Around 10kg of FYM along with 5 g of Furadon granules should be applied per pit before planting.

**High Density Planting:** Planting three suckers per pit at a spacing of 2x3m yield up to 80t/ha in Grand Naine. This aids in over all mat or hill management rather than individual plant management. The individual bunch weight gets reduced; however, the total yield per hectare increases more than double fold, due to higher plant population. A high density banana plantation needs to be maintained by fertigation system to realize higher profit.

### **Manures and fertilizer:**

A fertilizer dose of NPK @ 400:200:400g/plant/year applied in three split doses during 3rd, 5th and 7th months after planting is recommended for effective vegetative growth, timely flower initiation and appreciable yield. Micronutrient like Zinc @ 40g/plant along with Borax @ 10g/plant induces early flowering and higher bunch weight.

### **Inter cultivation:**

Desuckering once in 45 days is a common practice to be followed. The suckers should be removed along with rhizomes without damaging the mother plant. Mulching helps to conserve soil moisture and is beneficial for root growth. As the plants grow, dried lower leaves are to be removed periodically. For maximum yield, a minimum of 13 functional leaves are required to be retained on the mother plant. To avoid lodging of plant, propping should be done with bamboo poles immediately after bunch emergence. Removal of male bud after completion of female phase referred as "Denavelling" has to be done. Bunch covering with dried leaves or polythene sleeves is practiced to get attractive appearance and increase in the yield up to 15% in Cavendish group.

### **Harvest and yield:**

When banana is cultivated under coconut shade, the days taken for flowering as well as harvest gets prolonged by an average of one month. The bunches can be harvested after 3-4 months of flower emergence. The average bunch weight of different cultivars under Goa condition is furnished below:

Cultivar	Average bunch weight (Kg)
Amti	14
Raspali	13
Velchi	11
Saldatti	9
Savarboni	15
Myndoli	16
Sugandi	9
Grand Naine	15-20
Robusta	20-25
Dwarf Cavendish	20-25

### **Processing and value addition:**

Banana fruits are used for culinary as well as dessert purpose. Value added products like custard, chips, halwa, cake, milk shake, cutlet, pan cake etc can be prepared.



## COMPARE AND CONTRAST BETWEEN NORMAL AND HIGH DENSITY PLANTING OF BANANA

### Normal cropping of banana under coconut shade

#### Features

- Adult coconut palms as main crop
- Coconut spacing: 7 x 7 or 8 x 8 m
- Banana as intercrop
- Spacing: 2 x 2m
- Square planting accommodating 16 plants in the inter-space of four coconut palms
- Flood irrigation
- Soil application of fertilizers

**Advantages:** Utilization of inter-space both horizontal and vertical

Additional income from banana

**Disadvantages:** Non-judicious use of resources like water and fertilizers



*Normal cropping of Banana under coconut shade*

### High density cropping of banana under coconut shade

#### Features

- Adult coconut palms as main crop
- Coconut spacing: 7 x 7 or 8 x 8 m
- Banana as intercrop
- Double row system of planting wherein row to row spacing is 1.8 to 2.0 m and plant to plant spacing is 1.2 m
- Accommodates 4000-4500 plants per ha depending on coconut spacing / population.
- Full dose of P2O5 at planting, 3 splits of N and K are recommended.

- Application of one-fourth N and one-third K<sub>2</sub>O at reproductive phase is also found beneficial.
- Drip irrigation is becoming increasingly important and it has resulted in increasing the productivity. Fertigation increases yield in Robusta and Grand Naine cultivars significantly.

### Advantages

High density planting along with fertigation enables phenomenal yield increase in banana varieties like Cavendish, Robusta, Nendran etc without adverse effect on finger size and shape.



*High density planting fertigation line*

This method increases the productivity by 50% and reduces the cost of production by saving 25% fertilizers and 30-40% water.

It has been clearly established that leaching and run-off of nutrients is checked since small quantities of fertilizers are applied at frequent intervals.

### Future thrust

Though the HDP system has proved to be economical for banana, further studies at institute aim at assessing the responsiveness of commercial varieties like Amti, Velchi, Saldatti to High Density Planting and intensive cultivation.



*High density planting of Banana*

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