

# **PRODUCTION TECHNOLOGY OF GLADIOLUS IN GOA**



**ICAR RESEARCH COMPLEX FOR GOA**

**(Indian Council of Agricultural Research)**

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# **Production Technology of Gladiolus in Goa**

**K. RAMACHANDRUDU  
M. THANGAM**



**ICAR RESEARCH COMPLEX FOR GOA  
OLD GOA, GOA- 403 402, INDIA**



*Published by:*

**Dr.V.S.Korikanthimath**

Director

ICAR Research Complex for Goa

Ela, Old Goa – 403 402, Goa, India

Fax : 91-832 - 2285649  
Phone : 91-832 - 2284678, 2284679  
Email : director@icargoa.res.in  
Web site : <http://www.icargoa.res.in>

**Research, text preparation and compilation by:**

K. Ramachandrudu

M. Thangam

**Technical Assistance:**

Minanath M. Zalmi

Rahul M. Kulkarni

**Word processing:**

Sidharth K. Marathe

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Panandiker Chambers,  
M.L.Furtado Road, Margao, Goa-403 601  
Tel.: 0832-2731844 Fax: 0832-2706915  
E-mail: vpai@marpolind.com

## FOREWORD

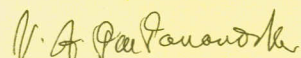
With an advent of WTO, floriculture has been experiencing rapid changes all over the world. Floriculture is given the status of sunrise industry and there is a significant growth in flower production, trade and consumption in our country. In fact, it is a viable diversification from the traditional agriculture. Flowers have occupied a special status in the life style of Goans. Now the people from all walks of life are showing great enthusiasm to take up floriculture as a commercial venture. Though Goa is lagging behind in floriculture, it is one of the leading flower markets in the country. Almost all the flowers, which are grown in India are sold in Goa. Annual flower business turn over in the state is about Rs.18 crores. Jasmine, marigold and crossandra are the traditional flowers of Goa. Jainchi Puja at Mardol and Lairaidevi jatara at Sirgao mark the significance of flowers in the state. Ratan aboli is a speciality of Goa. Modern flowers grown in the state are anthurium, orchids, gladiolus, gerbera, tubêrose, heliconia and ginger lily.

Gladiolus is one of the major cut flowers sold in Goa and daily 5000 spikes are consumed in the state. Of late, gladiolus production has gained popularity among growers owing to ease of cultivation and good profit. At present, it is mainly grown during winter season in the state. Its wide adaptability, huge demand and assured market definitely offer a great scope to growers for area expansion and regular production. In addition to spikes, corms also fetch good amount of income to farmers. I am sure that gladiolus being a high remunerative crop provides good opportunity especially to self help groups, unemployed youth and small and marginal farmers.

I am pleased to know that the ICAR Research Complex for Goa has played a pivotal role in popularization of gladiolus under Centrally Sponsored Scheme on Floriculture during 2001-02. Commendable work has been done on various aspects of gladiolus under agro-climatic conditions of Goa. Consequently lot of information particularly on agro-techniques and post harvest handling has been generated. This bulletin includes information on botany, suitable varieties, soil and climate, propagation, cultivation practices, post harvest management, plant protection, marketing and economics of the crop. This technical bulletin on production technology of gladiolus in Goa is an excellent compilation of the research work done at ICAR Research Complex for Goa, Ela, Old Goa.

I congratulate and complement **Dr.V.S.Korikanthimath**, Director of ICAR Research Complex for Goa for planning the contents and bringing out the bulletin. I extend my deep appreciation to the authors **Dr.K.Ramachandrudu** and **Dr.M.Thangam** for their sincere efforts in preparation of bulletin and presenting the information in a lucid manner.

I am confident that this publication will be useful to growers, department officials, researchers, academicians, policy makers and students.

  
**Dr. V. A. Pai Panandiker**



# PREFACE

Gladiolus is one of the most popular cut flowers in India and is available round the year because of its wide adaptability under various agro-climatic zones of the country. It is season bound in most of the places however, under moderate climatic conditions as in Bangalore, Karnataka, it is cultivated year round. Arrangement and opening pattern of flower buds on long spike make gladiolus the most fascinating flower. Spikes of gladiolus are mainly used in flower arrangement, bouquets, baskets and indoor decorations. It is cultivated commercially in an area of 1,500ha in the country. Though more than 50 per cent of total cultivable area is covered by horticultural crops, the area under floriculture is negligible in Goa. Loose flowers like jasmine, marigold and crossandra, cut flowers like gladiolus, orchids, gerbera, anthurium, heliconia and ginger lily are grown commercially in the state. Based on consumption, gladiolus ranks third next only to rose and China aster in Goa. Annual demand of gladiolus in the state is about 17 lakh spikes and monetary value of the same is Rs.1.3 crore. Hence, there is a tremendous potential for gladiolus production in the state.

Gladiolus has been identified as the most viable and successful crop under agro-climatic conditions of Goa. It was given the top priority under Centrally Sponsored Scheme (CSS) on Floriculture in 2001-02 and its cultivation was taken up by selected farmers in both the districts of Goa. Seeing the success, demand of flowers and profit, many farmers continued the production. Presently, gladiolus cultivation is just confined to winter season, though there is a great scope to expand the crop to other seasons as well. There was a need to develop a location specific package of practices for successful production of gladiolus since the crop is totally new to the farmers of Goa. Consequently, series of experiments were conducted to generate relevant technologies suitable to local conditions. Thus, keeping in mind the demand of the growers and amateurs, necessity was felt to compile the generated information and bring out the technical bulletin on “**Production Technology of Gladiolus in Goa**”. This technical bulletin is an outcome of research work carried out on various aspects of the crop during 1999-2006 at ICAR Research Complex for Goa, Ela, Old Goa.

It is a pleasure to express our deep sense of gratitude to **Dr.V.S.Korikanthimath**, Director of the ICAR Research Complex for Goa and also former Directors viz., **Dr.D.G.Dhandar** and **Dr.P.G.Adsule** for the active support, encouragement and inspiring guidance during the period of studies and bringing out this technical bulletin. Support and suggestions from fellow scientists and assistance from technical staff are sincerely acknowledged. It is hoped that this technical bulletin will serve as a useful reference to growers, amateurs, department officials, researchers, academicians, policy makers, students and others interested in gladiolus production.

July, 2009

**K. Ramachandrudu**  
**M. Thangam**

# ACKNOWLEDGEMENT

The technical bulletin 'Production Technology of Gladiolus in Goa' is an outcome of research work carried out during 1999 -2006 at ICAR Research Complex for Goa, Ela, Old Goa under the institute projects entitled "Collection and Evaluation of Flower Crops" and "Standardization of Agro-Techniques for Gladiolus". It is pleasure to express deep sense of gratitude to Dr.V.S.Korikanthimath, Director of ICAR Research Complex for Goa, and former directors *viz.*, Dr.D.G.Dhandar, Dr.P.G.Adsule and for the active support, encouragement and inspiring guidance during the studies and bringing out this technical bulletin.

We are thankful to Dr.S.Subramanian, In-charge Technical Cell, ICAR Research Complex for Goa, for facilitating the co-ordination of various aspects under the projects during the period.

We acknowledge the help and cooperation received from our colleagues *viz.*, Dr.A.R.Desai, Dr.S.C.Rana, Mrs.S.Priyadevi during our endeavour in accomplishment of projects. We wish to express our sincere thanks to fellow scientists for their moral support and help provided during the period of studies.

We wish to express special thanks to Mr.J.Ashok Kumar for his help in designing of experiments and statistical analysis and timely suggestions during the experimentation period.

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**K. Ramachandrudu**

**M. Thangam**

ICAR Research Complex for Goa,  
Ela Old Goa.



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# PRODUCTION TECHNOLOGY OF GLADIOLUS IN GOA

## Introduction

All occasions celebrated by human beings are marked with flowers which occupy a prominent place in our life style. Floriculture is given the status of sunrise industry and it has immense potential for income generation, creation of employment opportunities and to earn precious foreign exchange earnings. The commercial production of cut flowers is in full swing in the country and accorded the top priority in states like Karnataka, Tamil Nadu and Maharashtra. In Goa, floriculture is yet to gear up and commercial production just comprises less than a percent as compared to other horticultural crops. Hi-tech floriculture is of recent origin in the state. Marigold, jasmine, crossandra, gladiolus, gerbera, tuberose, heliconia, ginger lily, orchids and anthurium are the crops grown on a small scale in Goa. Area under flower crops is hardly 30ha with a production of 45 tonnes in loose flowers and 16 lakh cut flowers per annum. There are 25 cost effective shadenet houses and poly houses spread in an area of 27,200sq.m. The warm and humid weather conditions of the state are ideal for commercial cultivation of marigold, jasmine, crossandra, tuberose, orchids, anthurium, heliconia, ginger lily and many greens/cut foliage. In fact, floriculture is a remunerative alternative to the existing farming practices in the state. Though there were some efforts made earlier, it was the year 2001 that marked the beginning of

commercial production of cut flowers such as orchids, anthurium and gladiolus in the state. The most recently introduced flowers are gerbera, heliconia and ginger lily. Now the people from all walks of life are coming forward with enthusiasm to take up floriculture as a commercial venture.

*Gladiolus*, popularly called sword lily, takes its name from the Latin word *Gladius* because of sword shaped leaves. It is one of the major cut flowers in national and international markets and it is grown commercially to an extent of 1,500 ha in India. It is mainly cultivated in Karnataka, West Bengal, Maharashtra, Punjab, Haryana, Uttar Pradesh, Tamil Nadu, Jammu and Kashmir, Uttarakhand, Delhi, Sikkim and Himachal Pradesh. It's elegant spikes with wide range of colours in various forms and size has won for it a place of pride in ornamental gardens and monetary value as a cut flower. It is widely used in flower arrangement, bouquets, bunches, baskets and indoor decorations.

Floriculture is still in infant stage in Goa, though it is one of the leading flower markets in India. At present, annual flower business turn over in the state is about Rs.18 crores. Gladiolus occupies the third position in flower trade and about 17 lakh spikes are consumed annually in the state. It has been found as a successful and viable crop under agro-climatic conditions of the state.



Of late, gladiolus production has gained popularity among farmers due to ease of cultivation and good profit. There is a tremendous scope for its production round the year as there is a huge demand for the flower. At present, growers are facing many problems and in need of location specific technical information about the crop. So, there is an urgent need for standardization of location specific agro-techniques for successful cultivation of gladiolus which is a newly introduced flower crop in Goa. Therefore, a series of experiments and observation trials were conducted during 1999 and 2006 to generate information on various aspects of gladiolus cultivation.

### Botany

Gladiolus is native of South Africa and was introduced into India during 19<sup>th</sup> century. There are 226 species in the genus *Gladiolus* and most of them are found in South and Tropical Africa. The basic chromosome number of gladiolus is  $n=15$ . South African species are mostly diploid, European species are tetraploid and those found in Russia and higher elevations are polyploids. The modern gladiolus varieties are developed through natural and manmade crosses involving about two dozen species.

Gladiolus, botanically known as *Gladiolus sps*, belongs to the family Iridaceae and sub family Ixoideae. It is a bulbous crop and mainly propagated by corms and cormels. Corm is a thickened underground perennating structure consisting of a short vertical stem having many ring like nodes with a bud in each node covered with leaf bases (tunics) all

around and disc like root zone at the base. Each bud has a potential to produce shoot and spike. In most of the varieties, buds on corm are arranged in linear fashion. Corm is more or less round in shape or often flattened from top to bottom. Among buds, the bud at the centre of the corm is the largest one and always sprouts first and grows vigorously compared to other buds. There is an emergence of root initials and sprouts when the dormancy of the corm is broken. Corm stores lot of food material which is utilized for growth and development of plant. Cormels/cormlets are miniature corms which develop in clusters between the old and new corms. Stolons develop from the base of new corm and tips of stolon swell and develop into cormels. They are small in size (0.5-2cm diameter) and round to oval or oblong in shape. Unlike corm, cormel is enclosed by hard shell which is less permeable for water. Root system is adventitious and shallow. It produces two types of roots namely filiform and contractile roots. Soon after planting, the mother corm produces filiform/feeder roots which are fibrous in nature. Contractile roots are developed from developing daughter corm and they are fleshy in nature. Then new corm continues to develop while the old corm gets shriveled and dries up.

Gladiolus plants grow vigorously and average height of plants in many commercial varieties ranged from 80 to 150 cm. It puts forth 8-12 sword shaped leaves arranged in opposite direction. Flower bud initiation begins at three leaf stage whereas the spike emerges out after 8 leaf stage. Leaf length and leaf width varied from 40



to 65cm and 2 to 3.5 cm, respectively. The inflorescence, botanically a spike, bears 8-22 florets arranged alternately on the axis of the spike. Florets are funnel shaped and open in acropetal succession i.e., from base to top of the spike. The size of florets varied from 7 to 12 cm. Each floret is enclosed by two green coloured bracts and contains 6 tepals, 3 stamens and a pistil. In gladiolus, sepals and petals look alike and are called tepals which are arranged in two whorls. The upper 3 tepals are large while the lower 3 tepals are small and often have blotches or markings on the throat to attract insects. The upper tepal of inner whorl is the largest one and arches forward to form a hood. Fruit is a capsule and each capsule contains 30-80 seeds.

### Site and soil

Gladiolus is a sun loving plant, so it prefers open field conditions for its commercial cultivation. Under shade, plants become lanky and produce poor quality spikes. It requires a minimum of 80% light for proper growth and flowering. Low light intensity leads to abortion of spikes or blind plants. However, it can be grown to some extent under partial shade of coconut gardens during summer season due to prevalence of high temperature and light intensity. A study was conducted with an intension of testing (Table 1a&1b) the performance of gladiolus cultivars under partial shady conditions (40% light intensity) of coconut garden. Relatively, the performance of all the cultivars was better under open conditions. Even then, there is a possibility of growing gladiolus as an inter crop in coconut garden particularly in summer. All cultivars except Nova Lux and Peter Pears performed well under shade.

So, it is basically a varietal character and capacity to tolerate shady situation. Seeing the performance in most of the characters, the cultivar Wigs Sensation is a better choice to take up in coconut gardens.

Gladiolus can be grown in a wide range of soils but the most preferred soil for its luxuriant growth and flowering is sandy loams. Soil having light texture, more organic matter and free drainage is ideal for its production. Though it can be grown more effectively between pH 5 and 7.5, the optimum level of pH is 5.5 to 6.5. Problematic soils namely alkaline, saline, acidic and water logged soils should be avoided as they affect growth and development of gladiolus. Lateritic and sandy loamy soils present in the state have been found suitable for gladiolus cultivation.

### Climate

Basically, gladiolus is a winter annual and mainly cultivated during winter in plains and summer in hills under Indian conditions. However, it is grown round the year under mild climatic conditions like Bangalore, Karnataka. Extreme climatic conditions like very cold and hot are detrimental to the crop. It has spread length and breadth of the country as it has good adaptability in wide range of agro-climatic conditions. Goa, a part of Konkan region of the Western Ghats, has warm and humid climate with a distinct rainy season from June to September. Otherwise, state has moderate climate which has been found suitable for gladiolus production in all the seasons. Average annual temperature, relative humidity and rainfall of the state range from 22-33°C, 58-88 % and 2700-3000 mm, respectively. Among weather parameters,



**Table 1a. Effect of environment on vegetative and floral characters of gladiolus cultivars.**

Treatment	Leaf length (cm)			Leaf width (cm)			Days to opening of 1 <sup>st</sup> floret			Plant height/spike length (cm)			Rachis length (cm)		
	Shade	Open	Mean	Shade	Open	Mean	Shade	Open	Mean	Shade	Open	Mean	Shade	Open	Mean
Rose Supreme	82.23	63.40	72.81	2.70	2.63	2.66	74.33	71.33	72.83	116.73	106.80	111.76	40.26	41.90	41.08
White Prosperity	66.76	56.86	61.81	2.80	2.96	2.88	67.33	62.66	65.00	143.43	117.36	130.40	39.76	40.70	40.23
Peter Pears	63.20	47.13	55.16	2.43	2.76	2.60	61.00	67.00	64.00	111.56	103.56	107.56	36.36	39.23	37.80
Wigs Sensation	59.06	50.13	54.60	3.00	3.50	3.25	68.00	68.33	68.16	136.26	117.40	126.83	47.90	49.20	48.55
Darshan	59.66	47.90	53.78	2.40	2.50	2.45	81.00	82.66	81.83	106.43	96.80	101.61	34.50	39.56	37.03
Mean	66.18	53.08		2.66	2.87		70.33	70.40		122.88	108.38		39.76	42.12	
CD (P=0.05)															
Environment		2.10			0.13			NS			3.25			1.73	
Variety		3.33			0.21			1.19			5.15			2.74	
Variety x Environment		4.71			0.30			1.69			7.28			3.88	

**Table 1b. Effect of environment on floral and corm characters of gladiolus cultivars.**

Treatment	Florets/spike			Spike stalk diameter (cm)			Corm weight (g)			Corm size (cm)			Cormels/spike		
	Shade	Open	Mean	Shade	Open	Mean	Shade	Open	Mean	Shade	Open	Mean	Shade	Open	Mean
Rose Supreme	12.06	14.40	13.23	0.66	0.86	0.76	42.10	50.60	46.35	4.96	5.23	5.10	6.13	32.30	19.21
White Prosperity	10.96	12.50	11.73	0.67	0.76	0.71	35.90	40.26	38.08	5.03	5.53	5.28	9.73	18.90	14.31
Peter Pears	10.66	13.26	11.96	0.57	0.72	0.64	25.16	35.73	30.45	4.26	4.93	4.60	4.20	5.36	4.78
Wigs Sensation	12.63	16.06	14.35	0.71	0.92	0.81	81.63	87.90	84.76	5.93	6.00	5.96	7.60	5.96	6.78
Darshan	11.70	13.73	12.71	0.69	0.89	0.79	21.66	24.40	23.03	3.70	4.10	3.90	4.93	6.46	5.70
Mean	11.60	13.99		0.66	0.83		41.29	47.78		4.78	5.16		6.52	13.80	
CD (P=0.05)															
Environment		0.59			0.02			NS			0.24			3.56	
Variety		0.93			0.04			10.64			0.38			5.63	
Variety x Environment		1.31			0.06			15.05			0.54			7.96	

temperature and light play major role in success of gladiolus cultivation. Low light intensity coupled with low temperature is the main cause for failure of flowering in gladiolus. Crop at 4-6<sup>th</sup> leaf stage is most sensitive to light intensity and any reduction during this stage leads to blasting of plants. The number of days required for flowering is mainly influenced by temperature. It is rather more responsive to thermo periodicity than photo periodicity. Though gladiolus is coming up well in all the seasons, the best quality spikes are produced in winter.

Influence of seasons (Table 2a & 2b)) was conspicuous over the performance of varieties for most of the characters. With respect to the key parameters *viz.*, plant height, number of leaves/plant, days to harvest of spikes, spike length and number of florets/spike, the best performance of varieties was observed in winter season. Better results in winter may be due to exposure of plants to mild weather conditions particularly cool nights and optimum temperature favourable for luxuriant vegetative growth and flowering. It is worth noting that performance of all the varieties under intensive and high rainfall (2118 mm) conditions was encouraging. Further, the best corm size and weight were observed during rainy season in most of the varieties as compared to other seasons. Of all the varieties, Mascagni, Wigs Sensation, Rose Supreme and White Prosperity excelled in performance in all the seasons. Significant differences among the varieties for all the characters studied may be attributed to the genetic make up and their interaction (GxE) with seasons. Studies

have aptly indicated that gladiolus cultivation is possible round the year under prevailing agro-climatic situation in Goa.

Vegetables are widely cultivated on hill slopes and tops during rainy season in the state. With an intention of expanding gladiolus cultivation to hill slopes, observation trial on performance (Table 3) of popular varieties like White Prosperity and Nova Lux was conducted on up land and hill slope during rainy season. Performance of gladiolus except for corm characters was better on hill slope when compared to up land. Soil becomes porous and loose in rainy season due to continuous rains. So deep planting and earthing up can be practiced to give enough strength to plants to sustain its own weight and then avoid lodging. So, gladiolus can be grown on hill slopes as well as plateaus without any problem in *kharif* season.

### Varities

There is a wide range of variation in gladiolus. Species and varieties with different growth habits producing various types of flowers of different shape, size and colour are available. Some produce tall plants bearing large flowers while others medium and small bearing medium and miniature type of flowers. Based on the size of florets, gladiolus varieties are broadly classified into Grandifloras, Primulinus, Butterfly and Miniatures. Most of the present day hybrids belong to *Gladiolus grandifloras* and they are mainly developed by North America, Australia and New Zealand. There are more than 30,000 varieties in gladiolus all over the world and about 200 varieties are added every year



**Table 2a. Performance of gladiolus varieties for flowering characters during different seasons in Goa**

Varieties	Days to harvest				Spike length (cm)				Rachis length (cm)				Florets/spike				Floret size (cm)			
	S*	R <sup>#</sup>	W*	M*	S	R	W	M	S	R	W	M	S	R	W	M	S	R	W	M
Nova Lux	78.3	80.3	70.3	76.3	102.87	108.22	114.80	108.63	38.76	39.86	40.43	39.68	11.2	12.9	13.0	12.3	10.36	10.16	10.30	10.27
White Prosperity	64.3	61.3	58.6	61.4	119.39	121.54	121.94	120.95	43.84	43.24	41.34	42.80	12.4	11.7	13.1	12.4	10.63	10.63	10.69	10.65
Dhiraj	82.0	78.0	75.6	78.5	96.67	100.74	99.72	99.04	39.94	40.66	41.12	40.57	13.7	13.8	14.1	13.9	8.56	8.34	8.65	8.51
Plum Tart	60.3	61.0	59.3	60.2	102.45	106.35	109.91	106.23	38.73	41.15	40.30	40.06	10.2	10.1	10.4	10.2	9.81	9.72	10.04	9.86
Wigs Sensation	68.3	71.0	68.0	69.1	121.07	124.93	125.28	123.76	49.82	49.97	48.39	49.39	15.3	15.9	16.1	15.8	10.83	10.94	10.80	10.86
Rose Supreme	70.9	66.0	68.0	68.3	110.67	120.86	120.56	117.36	38.66	39.07	44.07	40.60	14.5	14.3	14.8	14.5	10.57	10.45	10.56	10.53
Mascagni	68.3	68.0	66.0	67.4	103.42	100.55	104.37	102.78	53.21	52.07	50.73	52.01	17.0	17.2	17.4	17.2	9.20	9.35	9.25	9.27
Peter Pears	67.3	69.0	68.0	68.1	109.57	112.66	116.15	112.79	40.89	39.55	41.38	40.61	13.0	13.1	13.2	13.1	9.81	10.02	9.79	9.87
Mean	70.0	69.3	66.7		108.26	111.98	114.09		42.98	43.20	43.47		13.4	13.6	14.0		9.97	9.95	10.01	
C.D. (P=0.05)																				
Variety				0.44				3.26				2.48				0.6				0.21
Season				0.27				2.01				NS				0.3				NS
Variety x Season				0.76				5.65				4.29				1.0				0.36
*S= Summer, <sup>#</sup> R= Rainy, *W= Winter, *M= Mean.																				

**Table 2b. Performance of gladiolus varieties for corm production and corm parameters during different seasons in Goa**

Varieties	Corms/plant				Cormels/plant				Corm size (cm)				Corm weight (g)			
	Summer	Rainy	Winter	Mean	Summer	Rainy	Winter	Mean	Summer	Rainy	Winter	Mean	Summer	Rainy	Winter	Mean
Nova Lux	1.0	1.0	1.0	1.0	3.46	4.40	13.40	7.08	4.44	5.34	4.86	4.88	36.23	52.74	40.25	43.07
White Prosperity	1.0	1.0	1.0	1.0	18.56	4.63	21.16	14.78	4.38	5.15	4.77	4.77	30.99	39.18	34.15	34.77
Dhiraj	1.2	1.8	1.6	1.5	6.46	4.90	6.80	6.05	4.25	4.88	4.19	4.44	24.93	28.95	22.61	25.50
Plum Tart	1.1	1.1	1.0	1.1	21.66	18.03	26.76	22.15	4.16	4.20	5.31	4.55	31.35	28.63	44.03	34.67
Wigs Sensation	1.0	1.0	1.1	1.0	6.13	5.53	7.50	6.38	6.05	6.98	6.78	6.60	87.91	99.29	100.42	95.87
Rose Supreme	1.0	1.0	1.0	1.0	22.96	32.63	40.90	32.16	4.98	5.14	4.83	4.98	48.17	50.38	36.86	45.13
Mascagni	1.0	1.0	1.0	1.0	3.00	6.83	6.46	5.43	4.39	5.41	4.97	4.92	30.75	52.36	42.07	41.73
Peter Pears	1.0	1.0	1.0	1.0	4.13	6.76	6.90	5.93	4.94	5.32	5.01	5.09	35.84	35.17	38.38	36.46
Mean	1.0	1.1	1.1		10.80	10.46	16.24		4.70	5.30	5.09		39.36	48.34	44.85	
C.D. (P=0.05)																
Variety				0.1				1.97				0.24				2.9
Season				NS				1.21				0.15				1.78
Variety x Season				0.2				3.42				0.42				5.03

**Table 3. Effect of locations on performance of gladiolus during rainy season.**

Character	White Prosperity		Nova Lux	
	Up land	Hill slope	Up land	Hill slope
Plant height (cm)	123.65	159.25	112.45	140.32
Number of leaves/plant	10.9	11.3	10.6	12.0
Leaf length (cm)	60.34	68.52	49.16	51.5
Leaf width (cm)	3.36	4.06	2.99	5.2
Days to harvest of spikes	61.5	56.0	68.8	59.0
Spike length (cm)	98.62	128.64	88.26	115.45
Rachis length (cm)	44.21	63.86	42.32	62.5
Number of florets/spike	13.42	15.86	14.25	16.84
Spike stalk girth (cm)	2.95	3.48	3.11	3.52
Corm size (cm)	4.69	4.82	5.29	5.22
Corm weight (g)	37.22	39.82	53.84	52.92

and the same number is dropped because of degeneration. India also developed more than 100 varieties mainly by Indian Agricultural Research Institute (IARI), New Delhi, Indian Institute of Horticultural Research (IIHR), Bangalore, National Botanical Research Institute (NBRI), Lucknow and State Agricultural Universities (SAU's). Exotic varieties have become more popular than indigenous varieties in the country. Based on the crop duration, varieties in gladiolus are grouped into early, medium and late. The duration of crop normally varied from 5 to 7 months. Most of the commercial varieties complete the life cycle in five months under climatic conditions of Goa.

Performance of gladiolus varieties is not uniform under different agro-climatic conditions of India. There are some varieties which perform well in all locations

and in all the seasons of particular location. So, location specific selection is very important aspect before going for commercial cultivation. There is a wide range of colours in gladiolus varieties. Colour and length of spike play a major role in gladiolus trade in Goa. The preferred colours are white, red, orange, pink, yellow and purple. American Beauty, Friendship, Her Majesty, Jester, Nova Lux, Royal Gold, Oscar, Morning Kiss, Day Dream, Priscilla, White Prosperity, White Friendship, Rose Supreme, Wigs Sensation, Eurovision, Mascagni, Blue Sky, Peter Pears, Rose Delight, Christian Jane, Sancerre, Yellow Stone, Trader Horn, Apollo, and Jack's Gold are some of the varieties grown commercially in India. Twenty five varieties consisting of both Indian and exotic origin were evaluated under climatic and edaphic conditions of Goa. With respect to key parameters like spike length and number of



florets/spike, the best performance of varieties was observed in winter season as compared to other seasons. Better results in winter may be due to exposure of plants to mild weather conditions especially cool nights and optimum temperature. In most of the varieties, the best corm size and weight were recorded in rainy season. Of all the varieties, Mascagni, Wigs Sensation, Rose Supreme and White Prosperity emerged as promising ones in all seasons. Wigs Sensation, Mascagni, Rose Supreme, White Prosperity, Peter Pears, Dhiraj, Nova Lux, Friendship and Trader Horn are recommended for commercial production in Goa. Planting material can be procured through Goa State Horticulture Development Corporation and Directorate of Agriculture.

### **Propagation**

Gladiolus is multiplied by corms, cormels, seed and tissue culture but the common method of propagation is through corms and cormels. Based on the size, corms are graded into large, medium and small. Large sized corms are subdivided into Jumbo (>5.1 cm) and No.1 (3.8-5.1 cm). Medium sized corms have two categories i.e., No.2 (3.2-3.8 cm) and No.3 (2.5-3.2 cm) while the small sized corms (cormels) are grouped into three categories i.e., No.4 (1.9-2.5 cm), No.5 (1.3-1.9 cm) and No.6 (1.0-1.3 cm). Only the large and medium size corms are used for production of flowers whereas small size corms are used as planting stock for the production of flower grade corms for subsequent planting

seasons. When there is a shortage of corms, it is better to divide large size corms into two or three pieces and each division should have a bud along with a portion of root zone. Large and jumbo size corms can be cut based on the number of buds, a week prior to planting. Split corms must be treated with Sulphur dust or charcoal powder or 0.2% Bavistin or 0.2% Dithane M-45 and dried under shade and planted. This avoids the infection of soil borne pathogens after planting. Size of the corm (Table 6) significantly influences the growth and yield of gladiolus. There is a positive relation between the size of corm and prominent characters like days to flowering, florets/spike and spike length.

Due to lack of awareness, most of the farmers in Goa are not using the cormels for propagation. Cormels produce (Table 4) small to medium size corms in a single season without much care and maintenance. In most of the varieties, large size cormels also produce spikes which should be cut immediately after emergence. Cormels having thick shell tend to escape diseases even if parent corm is infected. Cormels should be soaked for 24-48 hours; the diseased ones which normally float on the water surface be discarded and planted then at a closer spacing of 5-10cm at a shallow depth of 2.5 cm. Shallow planting and removal of spikes at early stage improve size of corms. Adequate moisture and nutrition promotes growth and corm production.



Wigs Sensation      Rose Supreme      Peter Pears      Nova Lux      Dhiraj

Promising varieties of gladiolus



Gladiolus grown on hill slope during rainy season



To know the growth and development of cormels of gladiolus, an observation trail was taken up with 12 varieties (Table 4) under agro-climatic conditions of Goa. Flowering grade corms and also cormels were observed in all the varieties. Flowering

also was noticed in Dhiraj, Dr.Flemming and Mutant No.1. Size of the corm ranged from 1.8 cm in Spic and Span to 3.6 cm in Wigs Sensation. Farmers can obtain small to medium size corms in 6 month duration.

**Table 4. Growth and development of cormels in different varieties of gladiolus.**

Variety	Plant height (cm)	Leaves/plant	Corm size (cm)	Cormels/plant
Sindhur	50.7	4.9	2.3	3.0
Spic and Span	43.9	2.7	1.8	7.1
Dhiraj	54.1	4.8	3.1	4.0
Nova Lux	53.1	3.3	2.7	3.3
Rose Supreme	57.5	4.1	2.7	3.1
White Prosperity	49.2	3.6	2.7	6.1
Dr. Flemming	50.8	4.6	2.6	9.0
Mutant No.1	55.3	5.0	2.7	6.7
CPG-6	43.5	4.8	2.2	5.7
Raffling Water	45.9	3.1	2.0	16.6
Red Star	42.0	2.5	1.9	2.1
Wigs Sensation	40.9	5.2	3.6	3.6

### Preparation of land

Gladiolus requires good soil preparation for its better growth and yield. Land should be ploughed thoroughly at least a fortnight prior to planting of corms. Exposure of soil to the sun is required to kill weeds and insects. Ploughing, harrowing and leveling of land can be done with an interval of 7 days. Apply the recommended dose of manure prior to ploughing of soil. Open the furrows and ridges as per the spacing and make irrigation channels a day prior to the planting. Gladiolus does not need deep cultivation as it is a shallow rooted crop so the ploughing to a depth of 30 cm is sufficient.

### Planting

In India, gladiolus production is seasonal and mostly grown during winter in plains and

summer in hills. It comes up well under varied climatic conditions of temperate, sub-tropical and tropical regions. It is grown throughout the year in places like Bangalore. Results of evaluation studies under agro-climatic conditions of Goa indicated that gladiolus cultivation is possible round the year since the weather prevailing in the state is moderate. Currently, gladiolus production in the state is just confined to winter season. There is a great scope to expand the crop to other seasons as there is a regular demand for flowers. There are views that crop can not come up well in rainy season. Crop growth and yield have been found better in rainy season compared to summer grown crop. Staggered planting with a gap of 10-15 days interval can be taken up for regular supply of flowers to florists. Planting of different grade corms of the same

variety and early, medium and late varieties together also extends flowering period.

Open furrows up to 15cm depth, plant corms in furrows and cover with soil to avoid an exposure to the sunlight. Care should be taken not to plant corms upside down. Planting can be done in furrows in all seasons. However, planting on ridges is better for water logged or ill drained areas because plants can not tolerate water stagnation. Normally corms are planted at 15-25cm apart in a row and rows are spaced at 30-45 cm apart. Accordingly, the density of planting varied from 1-1.5 lakh plants per hectare. There should be enough space between rows to facilitate intercultural operations. Among the various characters studied, only the plant height, leaf length, corm size and corm weight were found significant among the treatments (Table 5). Plant height and leaf length were more at closer spacing. This may be due to the fact that plants tend to grow vertically when they are crowded owing to shadowing effect

of plants on one another. Maximum corm size and corm weight were recorded at wider spacing whereas the minimum at closer spacing. More competition for nutrients and space among the plants at closer spacings might be responsible for less corm size and weight. And also shadowing effect of plants with one another might have affected photosynthesis and ultimately, accumulation of dry matter in plants. The convenient and optimum spacing for Goa is 40 x 20/45x20 cm which can accommodate 1.25lakh plants/hectare. Depth of planting is mostly dependant on the size of corms, soil type and season. There is a direct relation between the corm size and depth of planting. The higher the corm size the more is the depth of planting. Planting depth must be more in light soils as compared to heavy soils. Optimum depth of planting for small, medium and large size corms is 5cm, 7cm and 10cm, respectively. In sandy soils corms can be planted 2.5 cm more deeper in each grade. It is better to avoid very deep as well as very shallow planting.

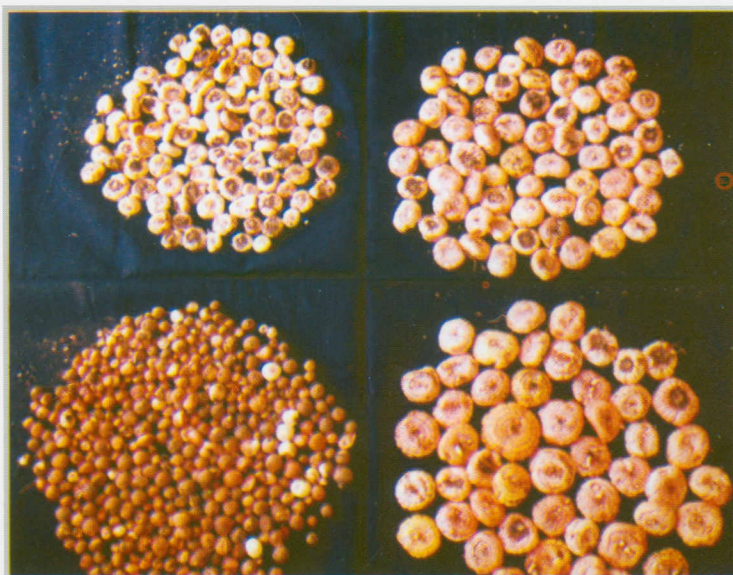
**Table 5. Effect of spacing on vegetative, flowering and corm characters of gladiolus cv. White Prosperity**

Spacing (cm)	Plant height (cm)	Leaf length (cm)	Days to harvest of spikes	Florets/s pike	Spike stalk girth (cm)	Spike length (cm)	Rachis length (cm)	Corm size (cm)	Corm weight (g)
45x20	56.83	45.60	59.00	11.93	2.83	116.83	44.06	4.57	30.40
45x15	61.83	46.60	59.33	11.70	2.83	118.90	44.96	4.33	25.83
40x20	61.33	46.90	58.67	11.53	2.83	118.30	43.60	4.51	27.37
35x25	60.50	46.83	59.33	12.00	2.83	119.20	44.20	4.27	25.03
30x20	63.10	45.63	60.00	11.86	2.87	117.56	44.57	4.19	24.77
30x10	66.10	48.03	58.67	11.93	2.63	118.13	43.50	4.19	24.20
30x15	64.63	47.83	58.33	12.30	2.77	118.16	43.93	4.34	23.07
25x20	62.40	45.60	58.33	12.13	2.73	118.03	43.63	4.21	22.80
CD(P=0.05)	2.05	1.06	NS	NS	NS	NS	NS	0.22	2.07





Corms of different varieties produced from cormels



Different grades of gladiolus corms



Plants produced from cormels

There is a positive correlation between corm size and vegetative growth, flowering and corm production (Table 6). Relatively, improved growth and flowering and corm size and weight were observed in plants raised from large sized corms. This may be attributed to presence of more food reserves and hormones like gibberellic acid (GA) in big size corms. The performance of cut corms obtained from Jumbo (6-7cm) size corms was found better in some of the

characters like days to flowering, number of florets/spike and corm size as compared to grade No.3 corms. This may be attributed to bigger size of cut corm rather compared to whole corm of grade No.3. Though plants raised from Jumbo grade corms had shown better performance in flowering parameters over other grades, it is suggested to use cut corms of the same since the shoot or corm production of Jumbo corms was just 1.17 per plant.

**Table 6. Effect of corm size on flowering and yield of gladiolus cv. Wigs Sensation.**

Treatment (Diameter of corm)	Days to flowering	Plant height /Spike length (cm)	Rachis length (cm)	Spike stalk girth (cm)	No of florets/ spike	No of corms/ plant	Corm size (cm)	Corm weight (gm)
No.3(>2.5-3.2)	69.75	117.72	49.22	3.35	15.82	1.00	7.12	150.00
No.2(>3.2-3.8)	69.50	121.87	47.50	3.80	17.50	1.00	7.57	151.20
No.1(>3.8-5.1)	69.25	125.05	46.85	3.80	17.45	1.00	8.00	176.17
Jumbo(>5.1)	64.25	126.67	49.57	3.85	17.60	1.17	8.75	208.07
Cut corms	67.25	118.80	46.37	3.40	16.17	1.00	8.02	152.87
CD(P=0.05)	0.74	2.81	NS	0.11	0.79	0.09	0.38	21.04

### Double/Multiple shoots and branching in spike:

Though all the buds in gladiolus corms are capable of producing shoots as well as spikes practically it is not proportionate to the number of buds on the corms. There is a direct relation between number of shoots and spikes. The production of shoots is a varietal character and the number of shoots produced/plant is different in varieties. Large size (3.5-5.1cm) corms of seven varieties were used for making observations (Table 7) on the production of shoots and spikes. The variety Dhiraj produced the highest number of shoots/plant while the

lowest number of shoots was recorded in Rose Supreme. Double or multiple shoots are seen mainly in medium and large size corms and it ranged from 1-3 shoots/plant. Spikes produced from multiple shoots are relatively shorter (10-20cm less) in length and contained 1 or 2 buds lesser as compared to the spike produced from the single shoot. It has been observed in many of the varieties that the number of florets and spike length are more or less the same particularly in double shoots. If there are multiple shoots, it is better to retain only two good shoots and cut the rest at the initial stage. To obtain the best grade spike, retain



the strong bud possibly the centre one and remove all the sprouts.

**Table 7. Production of shoots and spikes in different varieties of gladiolus.**

Variety	Shoots/plant	Spikes/plant
Dhiraj	2.8	2.8
Nova lux	2.5	2.5
Dr.Flemming	2.2	2.2
White Prosperity	1.7	1.7
Spic and Span	1.6	1.6
Rose Supreme	1.0	1.0
Peter Pears	1.1	1.1

Branching in spike is common in some varieties and the number of branches ranged from 1-5. The number of florets in each branch varied from 2-8. The highest number of branches has been noticed in the cultivar Dr. Flemming. Remove the branches at the initial stage itself since the branching in spike is not a preferred character in gladiolus.

### Irrigation

Gladiolus is a water loving plant and needs sufficient moisture in the soil till the harvesting of spikes. Flower bud initiation and spike elongation are the most critical stages in gladiolus. Moisture stress during these stages results in a considerable damage to growth and yield. Water requirement and frequency of irrigation depend on the soil type, weather conditions and stage of the crop. Lateritic soils need more number of irrigations compared to sandy loam soils. Irrigation is not required in rainy season unless there is a dry spell. In lateritic soils, irrigation should be given once in a week during winter and twice in

a week during summer whereas in sandy loam soils once in a week during summer and once in a week or 10 days during winter. Normally, irrigation can be cut down after the harvest of spikes and withheld completely once leaves start yellowing. If the soil is hard, a light irrigation may be given to facilitate the lifting of corms from the soil. Irrigate the crop once in 10 days when it is grown under partial shade of coconut gardens during summer season. It can tolerate high summer temperature and come up well if sufficient moisture is maintained in the soil during the crop period. So, the success of the crop in summer is mainly dependant on the irrigation.

### Weeding

Weeds compete with crops for water and nutrients and also host insect pests. Gladiolus is a shallow rooted crop which can easily succumb to weeds. If the weeding is delayed or neglected, weeds take over the crop and pose serious problem for growth and yield of gladiolus. Warm and humid conditions prevalent in the state encourage weed growth. Therefore, field must be kept weed free till the flowering/harvesting of spikes and the frequency of weeding mainly depends on the intensity of weed growth. Normally two or three weedings with a gap of 20-30 days are required during the crop period. Weeding can be done either manually using *kurphi*/hand hoe or by using herbicides. If there is a labour problem, herbicides like glyphosate/grammoxone @ 0.6 lt/1000 sq.m. can be applied to the soil prior to the planting of corms. Application of herbicides can not be taken up in standing crop as they injure plants and cause abnormalities in growth.

### **Earthing up**

*Gladiolus* is a shallow rooted crop and needs earthing up to prevent lodging of plants due to heavy wind, rain and weight of spikes. After emergence, spikes become gradually heavier and tend to bend down due to gravitational force. Hence, earthing up is an important practice in *gladiolus* cultivation and normally done once or twice during the crop period. Plants are earthed up to a height of 10-15 cm after a month of planting. It provides good anchorage or support to plants to sustain its own weight and avoid lodging. In addition, it checks weed growth and conserves moisture. Field operations like weeding, fertilizer application and earthing up have to be done at a time. Staking of plants with bamboo/ wooden sticks for avoiding lodging of plants is a recommended practice in *gladiolus* and practiced in some states. However, earthing up is a better and cost effective practice than staking which is a cumbersome practice and increases the cost of cultivation. Deep planting ensures vertical and straight growth of shoots and prevents their lodging. Deep planting is a good alternative in high density planting where earthing up is not possible. Corms of all the categories can be planted 2.5cm deep than the recommended depth of planting to avoid the lodging of plants.

### **Mulching**

Mulching helps in conservation of moisture and suppression of weeds during the crop period. This practice cuts down the expenditure and provides comfortable environment to plants. It is a good option for water scarcity areas and when the crop is grown during summer months. Farmers

can reduce the frequency of irrigation, weeding, save sizeable amount of money and get higher yield. It should be kept in mind that mulching can be done only after earthing up operation. Farmers are advised to use dry grass available in and around the fields or else freely available materials like coir dust. Effect of mulching depends on the type and depth of mulch. Mulching must be at least 7.5 cm thick so that it does not allow any weed growth.

### **Nutrition**

*Gladiolus* responds well to externally applied organic manures and inorganic fertilizers. Application of chemical fertilizers should be as per the requirement which can be known only through analysis of soil. Nutrient requirement depends on the nature of soil, weather conditions and corm size. Judicious and balanced application of manures and fertilizers is most important and crucial practice in *gladiolus* production. Plants produced from large corms need lesser quantity of fertilizers than plants from small size corms. Farm yard manure @ 3t/ 1000sq.m can be applied at the time of land preparation. Application of overdose of manures should be avoided as it tends to produce tall and slender spikes which may lead to lodging of plants.

Growth and yield of *gladiolus* were found better when manure was applied in furrows rather than whole area. When the field is ready for planting, open the furrows to a depth of 15 cm, apply mixture of fertilizers and manure in furrows and mix them with soil. So, cattle manure/ FYM @ 2t/1000 sq.m can be applied in furrows along with fertilizers at the time of planting





Double and multiple shoots of gladiolus

Earthing up of gladiolus plants



Corms and cornels of gladiolus

rather than applying prior to ploughing of the land. It saves lot of manure and provides ideal environment to plants in the rhizosphere. This practice increases the spike length, number of florets/spike, corm weight, corm size and cormel production as compared to broadcasting. But care should be taken to use the well decomposed manure.

A field experiment was carried out to find out the effect of various organic manures (Table 8) over growth and yield of gladiolus variety White Prosperity. Results revealed that significant variation was noticed among the treatments for major yield attributes like spike length, rachis length and no of florets/spike. The maximum spike length and highest number of florets/spike were observed in goat and pig manure as compared to control. In addition to farm yard manure, farmers can use locally available pig manure, vermi compost, poultry and goat manure.

NPK in the form of urea, single super phosphate and muriate of potash can be

used. The quantity of fertilizers required for 1000 m<sup>2</sup> is 25kg urea, 90kg single super phosphate (SSP) and 25kg muriate of potash (MOP). Full dose of phosphorus and potassium and 1/3<sup>rd</sup> of nitrogen can be applied as a basal dose at the time of planting of corms. Remaining dose of nitrogen can be applied 30 days after planting of corms. In late varieties, it is better to apply nitrogen in three equal splits-basal, 30 and 60 days after planting. Cattle urine being rich in nutrients and growth hormones like auxins has been found as good substitute for chemical fertilizers (Table 9) in gladiolus. It enhances the plant height, spike length, number of florets/spike. Liquid manure prepared with water did not show much impact as compared to liquid manure prepared with cattle urine. Cattle urine 100% fermented for a week can be applied twice (3-4lt/sq.m) to the soil. First dose can be given at the time of planting and second dose after a month of planting. Significant improvement in corm size and corm weight was noticed with application of fertilizers.

**Table 8. Effect of manures on flowering and yield parameters of gladiolus cv.White Prosperity**

Treatment	Plant height (cm)	Spike length (cm)	Stalk girth (cm)	Florets/s pike	Shelf life of spikes (days)	Corm size (cm)	Corm weight (g)	Cormels/plant
Pig manure	129.83	108.50	2.51	12.03	10.06	4.37	23.20	69.16
Poultry manure	124.40	103.30	2.65	12.00	10.83	4.17	20.40	95.36
Vermi compost	122.06	102.40	2.61	11.80	10.33	4.33	22.96	81.13
Goat manure	130.46	111.16	2.64	12.16	10.66	4.27	20.53	89.83
Cattle manure	119.86	100.06	2.56	11.40	10.53	4.34	23.10	73.53
Mixture*	123.60	103.40	2.80	12.00	10.76	4.16	20.90	84.33
Control	107.26	86.43	2.37	9.80	9.66	4.25	22.53	51.63
NPK	118.60	100.93	2.84	12.20	9.90	4.57	28.83	80.50
CD (P=0.05)	3.95	2.70	0.09	0.83	0.60	0.18	2.83	7.27

\* Mixture: Cattle manure+goat manure+vermi compost+poultry manure (1:1:1:1)



**Table 9. Effect of cattle urine, liquid manure and fertilizers on growth and yield parameters of gladiolus cv. White Prosperity**

Treatment	Plant height (cm)	Spike length (cm)	Florets /spike	Flower size (cm)	Spike stalk girth (cm)	Corm diameter (cm)	Corm weight (g)	Cormels/ plant
Cattle urine	124.82	102.32	12.50	11.65	2.68	4.12	21.72	69.87
Liquid manure-1*	114.12	93.10	11.82	11.40	2.72	3.74	17.47	84.25
Liquid manure-2**	125.15	104.15	12.67	11.22	2.80	4.16	20.30	89.82
NPK	117.85	98.90	12.15	11.35	2.86	4.56	28.60	77.27
Control	107.35	85.55	9.65	10.65	2.35	4.20	23.02	52.70
CD (P=0.05)	4.09	4.34	0.68	0.30	0.18	0.26	3.35	9.79

\*Liquid manure-1: Prepared with water; \*\*Liquid manure-2: Prepared with cattle urine.

### Growth regulators

In addition to genetic constitution of variety, environment, nutrition and soil moisture, growth regulators influence the growth and flowering of gladiolus. Plant hormones play a vital role in influencing the physiology of plant, which in turn puts forth many changes in plant growth, flowering and yield. At present, many synthetic growth substances are used in crop production for various benefits starting from germination to post harvest life. Plant growth regulators are expensive chemicals which require solvents for dissolution and distilled water for application, so it is really a tough job for farmers. Therefore, there is a need to look for some alternatives having similar growth promoting with ease of application at farmers' level. Tender coconut water contains a variety of substances such as cytokinins, auxins, gibberellins, amino acids and nucleic acids. Similarly, cattle urine is known for the presence of auxins like indole acetic acid (IAA). And both are available abundantly in the state.

An attempt was made to ascertain the effect of coconut water and cattle urine

along with synthetic growth regulators on growth, flowering and yield of gladiolus. Results of the study (Table 10) indicated that cattle urine and coconut water were found better as compared to synthetic growth regulators in important characters like number of florets/spike, spike length, stalk girth, corm weight and diameter and cormels production. Interaction between cattle urine and growth regulators was also found compatible and there was no sign of antagonism between them. In fact, more number of florets/spike was recorded with combination rather than growth regulators alone. Therefore, cattle urine at 10% and coconut water at 50% are recommended for commercial application in gladiolus. Similarly, experiment was carried out to find out the response of cormels to growth regulators. Cormels were soaked for 24 hours in growth regulators solutions and tender coconut water and cow urine and planted in the field. Of all the treatments, significant results (Table 11) in respect of plant height, number of leaves/plant, corm weight and corm size were obtained with tender coconut water and GA75ppm. Hence, tender coconut water can be used for getting good size of corms from cormels.

**Table10. Effect of growth regulators, tender coconut water and cow urine on flowering and yield parameters of gladiolus cv. White Prosperity**

Treatment	Days to flowering	Spike length (cm)	Spike stalk girth (cm)	No of florets/spike	Flowering duration (days)	Corm weight(g)	Corm diameter (cm)	Cormels/ plant
Control	60.50	102.00	2.35	9.10	11.00	24.00	4.25	55.60
GA <sub>3</sub> 100ppm	57.50	104.30	2.45	9.95	13.50	26.40	4.37	57.00
GA <sub>3</sub> 150ppm	57.00	111.40	2.50	10.15	15.50	25.20	4.35	61.50
Kinetin50ppm	63.50	101.90	2.45	9.20	11.50	28.60	4.52	59.00
Kinetin100ppm	64.00	101.70	2.40	8.50	10.00	23.80	4.20	66.80
NAA100ppm	67.00	102.70	2.45	9.30	12.50	27.20	4.46	69.45
NAA200ppm	67.50	100.10	2.35	9.80	25.00	24.00	4.23	55.00
CW*25%	58.50	110.20	2.50	10.90	12.00	29.40	4.60	53.10
CW50%	58.50	112.25	2.55	11.30	10.00	29.70	4.75	48.80
CW100%	59.00	106.90	2.50	11.00	11.00	25.80	4.54	47.80
CU**10%	58.00	111.40	2.60	12.15	10.50	27.60	4.57	54.20
CU20%	59.50	107.25	2.60	11.30	9.50	22.10	4.17	72.50
CU50%	60.50	103.05	2.45	10.70	9.50	22.60	4.30	75.70
CU100%	60.00	102.00	2.45	10.90	9.50	24.20	4.29	78.90
CU20%+GA <sub>3</sub> 100ppm	57.50	109.90	2.60	11.20	12.50	26.80	4.52	64.10
CU20%+Kinetin50ppm	60.50	104.35	2.45	10.30	9.00	31.70	4.73	54.80
CU20%+NAA100ppm	62.50	109.45	2.45	10.35	8.00	25.80	4.45	53.40
CD (P=0.05)	2.33	5.28	0.11	1.04	2.01	3.58	0.31	7.65

\*CW: Coconut water, \*\*CU: Cattle urine



Some varieties of gladiolus produce jumbo grade corms but they hardly produce 1 or 2 shoots. For example, the variety Wigs Sensation produces 1.6shoots/plant which indicates the scope for more number of shoots. Each corm should produce at least 2shoots/plant when jumbo or large size corms are used for commercial cultivation. A preliminary study was conducted on the

effect of GA, tender coconut water and cow urine on production of shoots in gladiolus. Among the treatments, GA150ppm and cow urine 25% produced (Table12) more number of shoots/plant. So, farmers can soak the corms either in GA150ppm or cow urine 25% for 24 hours and plant the corms to improve the shoot production.

**Table 11. Effect of growth regulators, tender coconut water and cow urine on growth and yield of cormels in gladiolus cv. Wigs Sensation**

Treatment	Plant height (cm)	No. of leaves/plant	Leaf length (cm)	Leaf width (cm)	Corm size (cm)	Corm weight (g)
GA-75ppm	47.62	6.30	34.76	1.81	4.16	29.13
NAA-50ppm	44.60	5.82	34.54	1.75	3.94	24.62
Kinetin 50ppm	43.04	5.55	34.27	1.65	3.91	23.56
Cow urine 100%	43.15	5.95	32.29	1.83	3.90	26.57
Coconut water100%	47.91	6.45	35.05	2.09	4.26	32.61
Water	39.05	5.15	32.61	1.59	3.65	18.58
C.D (P=0.05)	2.06	0.29	NS	0.12	0.17	2.23

**Table 12. Effect of GA, tender coconut water and cow urine on production of shoots in gladiolus cv. Wigs Sensation**

Treatment	No. of shoots/plant
Water	2.75
Coconut water 100%	2.87
Cow urine 25%	3.11
GA200ppm	2.51
GA150ppm	3.67
GA100ppm	2.55
GA50ppm	3.02

### Harvesting and post harvest handling of spikes

Spikes of gladiolus are harvested when the first 5-6 flower buds show the colour and the first flower bud is ready to open the next day. Poor opening of flower buds was observed in some varieties when they were harvested at very tight bud stage. Harvesting at bud stage eases transport of spikes without damage to buds. While harvesting spikes, at least four leaves should be retained on the plant to ensure proper development of corms and cormels. Spikes should be harvested with the help of sharp knife or secateur during cool hours of the day to avoid exposure of spikes to hot conditions which accelerates water loss and depletion of stored food due to more respiration. The period of harvesting is different in different varieties and in general it varied from 10 to 15 days. Staggered planting with a gap of 10-15 days and planting of different grade corms of a single variety extend the flowering period. Care should be taken not to crush the stalk of spike at the time of harvesting because the crushed portion releases exudates which promote microbial growth in vase solution. If there is any delay in delivery, spikes should be placed in buckets containing water till they are sent to markets.

Spikes can be bundled in units of 10 or 12, wrapped with news paper and loosely tied with rubber band to avoid the bruising. They must be carried in vertical position to prevent geotropic bending which is quite common in gladiolus. Pinching of topmost 3 or 4 flower buds reduces stalk curvature and also helps in proper opening of upper flower buds. Perforated card board boxes

having 1.2 m length, 60cm width and 30cm height are convenient for safe handling of spikes to destination. Give a slant cut at bottom of the stalk and keep spikes immediately in buckets containing water. Spikes lose lot of water during transit and sometimes show the symptoms of wilting. On reaching the destination, they can be immediately kept in warm water which helps in reconditioning or rehydration of spikes. And also it improves turgidity and facilitates opening of flower buds.

Based on the spike length and number of flower buds/spike, spikes are grouped into four grades and specifications of the same are given in the following table .

**Table 13. Different grades in Gladiolus**

Grade	Spike length(cm)	No. florets/spike
Fancy	>107	16
Special	96-107	15
Standard	81-96	12
Utility	<81	10

In India the above grades are referred as A, B, C and D, respectively.

### Vase Life of Spikes

Shelf life of gladiolus is mainly influenced by cultivar, cultural practices, harvesting stage, weather conditions and vase solution. In general, spikes kept in plain water last for 9-11 days under room temperature. Flower buds in the spike open from bottom to top. Varieties have definite pattern of flower bud opening in gladiolus, 1 or 2 buds open daily and each floret lasts for 2 or 3 days. In most of the varieties only a single bud opens in first 1 or 2 days and then two buds for 3 or 4 days and finally a single bud for 2 or 3 days. Normally, all





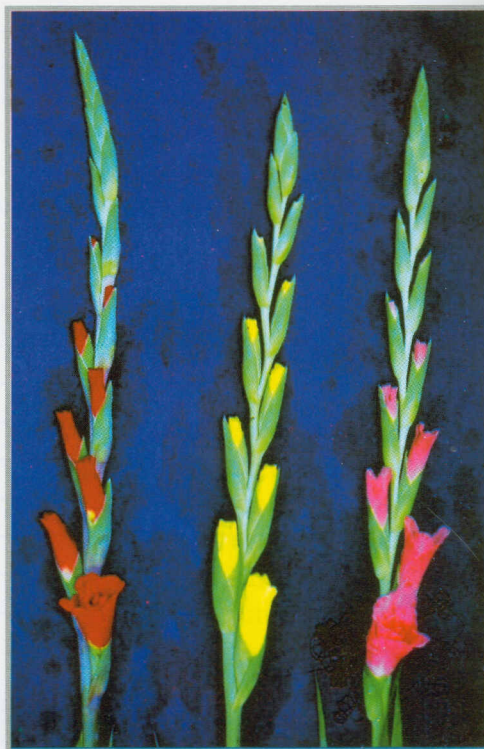
Spike with curvature and bending



Spike without bending



Spikes produced from control and pig manure



Right stage of harvesting of spikes in gladiolus

the flower buds open in most of the varieties provided when the spikes are harvested at the right stage. Life of the first floret is most important in gladiolus and mostly, it lasts for 2 days in vase and 3 days on the plant in the field. It has been found that organic manures improve shelf life of spikes for one or two days more as compared to chemical fertilizers. Care should be taken to change water daily or at least every alternate day, clean the container and cut stalk to enhance the vase life. Also, remove the faded flowers regularly to avoid the ugly appearance.

Normally, two types of preservatives i.e., food providers and biocides are used for enhancing the shelf life of cut flowers. Sugar provides food to spike and keeps stalk in turbid condition whereas biocide checks microbial growth at the cut surface and in vase solution. Sucrose as food source and chemicals like citric acid, 8-hydroxyquinoline sulphate, (8-HQS), 8-hydroxyquinoline citrate (8-HQC), aluminium sulphate, silver thiosulphate and sodium hypochlorite as biocides are commonly used in gladiolus. So, the preservative solution used for gladiolus should contain both sugar and biocide. Of the vase solutions, sucrose (4%) + 8-HQC (250ppm) has been found as the best at improving the post harvest life and quality of gladiolus spikes. Shelf life of gladiolus spikes during winter months is slightly more as compared to other seasons.

**Geotropic bending of spikes:** The tips of gladiolus spikes have the tendency to curve or bend down against the gravity if they are placed horizontally in transport.

Bending happens due to lateral downward movement of auxin (IAA) and its accumulation on the lower portion of the spike. IAA causes asymmetrical elongation of cells in the region and thereby causing the upward bending of spike tips. In some varieties, bent portion hangs down which in turn affects the vase life by restricting an upward movement of water. This is a common post harvest problem in gladiolus and some times it reduces marketable value considerably. The point of bending in spike varied from variety to variety and it is not uniform even within a variety. Pinching of topmost 3 or 4 buds and keeping of spikes in vertical position during transport and storage container can prevent the spike bending.

### **Lifting of corms and cormels and post harvest handling**

Corms and cormels become matured when retained leaves on the plant starts yellowing. The time gap between harvesting of spikes and corms varied from 6 to 8 weeks. Harvesting of corms should be done at the right stage of maturity for obtaining quality planting material. Premature harvesting sometimes leads to loss of viability of corms. However, delayed harvesting of corms produces lengthy spikes and more number of florets/spike. Harvesting can be done manually using pick axe or spade. If the soil is hard, a light irrigation is to be given to facilitate the easy lifting of corms. Care should be taken to prevent damage to corms at the time of lifting and dressing and damaged corms must be treated with fungicides to avoid the fungal infection.



Immediately after lifting, separate old mother corm and cormels from new corm. A delay in separation of old mother corms makes it difficult as they become dry and hard and finally injure the new corms. Adhered soil and leafy portion of new corms should also be removed. Infected corms and cormels can be discarded at the time of dressing. Handle the varieties separately to maintain the identity. Keep dressed corms and cormels under shade for drying in free ventilated place for a month for proper curing. Then store them keeping in trays or net type bags under aerated conditions. Do not store them under air tight conditions as there is a risk of rotting of corms. There should be a provision for free passage of air through storage structures to avoid the fungal infection and keep them healthy. Drying of corms under the sun should be avoided as corms become spongy and will not be useful.

Owing to high humidity and continuous rain during rainy season, storage of corms has become a major problem in Goa. Corms can be dried under fan for a month and stored under room conditions. If they are kept open there are chances for rotting of corms due to more humidity. Otherwise corms can be stored in cold rooms at 4-7°C for three months. A study on the storage of corms was taken up during June – December 2003 to find out suitable and low cost method by using locally available resources. Corms were stored in four types of environment (Table 14): 1. Corms were kept in plastic basins covered with dry soil, sand, saw dust and coir dust up to 5cm height. 2. Steel cupboard/air tight place. 3. Cold storage. 4. Plastic trays at room

condition. Corms stored in steel cupboard got spoiled by storage fungi within 45 days whereas corms stored in refrigerator at 0°C become soft and lost viability. Air tight conditions might have favoured the infection of corms. Cold injury at 0°C damaged the corms. However, corms stored at 4°C were good even after 184 days and germinated without any problem in the field. Scaled corms kept in room condition sprouted after 143 days but descaled ones at the same condition sprouted after 76 days. Descaling (removal of scales) of corms reduces the dormancy period by 50% as compared to scaled corms. Spread a layer (5cm) of soil or sand in storage room, place dry corms and cormels in 2 or 3 layers and cover again with soil or sand up to 5 cm thick. This practice is cost effective, easy, convenient and above all ensures safe storage of corms without spoilage during rainy season.

**Table 14. Effect of different environments on storage of gladiolus corms**

Treatment	Storage life (days)/days to sprouting	Viability
Soil	186	Yes
Sand	185	Yes
Saw dust	180	Yes
Coir dust	177	Yes
4°C	184	Yes
0°C	184	No
Open scaled	134	Yes
Open descaled	76	Yes
Cupboard	45	Infection



Scaled and descaled corms and linear arrangement of buds in corms



Storage of corms on platform at room condition



Low cost storage of corms during rainy season



## Yield

Spike and corm yield in gladiolus depend on cultivar, corm size, plant density, season, location and crop management. In general, yield in gladiolus is measured in terms of spikes and corms produced/ unit area. There is a positive relation between the size of corm and plant density and yield. The higher the plant density and corm grade, the more is the spike and corm yield. Marketable yield in gladiolus may be taken 10-15 % lesser than total yield. Normally small size corms produce one spike and one corm. Marketable spike yield is about 1.15 lakhs/ha whereas corm yield is nearly 1.25 lakhs when the plant population is 1.25 lakhs/ha.

### Dormancy of corms and cormels:

Corms and cormels of gladiolus exhibit dormancy which is a physiological necessity as they need certain period of rest prior to the sprouting. The period of dormancy is a varietal character and varied from 3 to 5 months (Table 15) under climatic conditions of Goa. The growth inhibitor abscissic acid (ABA) is mainly responsible for dormancy in gladiolus corms and cormels. The level of dormancy depends on the concentration of ABA in corms and cormels. Weather conditions prevailing during the crop period (Table 16) may also influence dormancy period. Corms harvested in summer have more period of dormancy than other seasons. For example, the variety Dhiraj took 92, 121 and 175 days for breaking dormancy grown during winter, rainy and summer seasons, respectively. Compared to corms, cormels have longer period of dormancy and normally the period of dormancy is 4-6 months. Thick and hard

shell is mainly responsible for prolonged dormancy in cormels. There is direct relation between the temperature and dormancy period in corms. Higher temperature enhances dormancy while lower temperature reduces it. Alternate exposure of corms to low temperature (4-6°C) and high temperature/room conditions induces sprouting earlier. Exposure of corms to low temperature (4-6°C) for three months or treatment (soaking of corms for 12-24 hours with chemical solutions like GA<sub>3</sub> (100ppm), ethrel (1000ppm), benzyl adenine (20ppm) and thiourea (500ppm) can be employed for breaking the dormancy effectively.

**Table 15. Dormancy period of corms in different varieties of gladiolus**

Variety	Dormancy period (days)	Days to sprouting
Wigs Sensation	98	98
Mascagni	105	105
Dr.Flemming	117	117
Rose Supreme	118	118
CPG-6	120	120
Dhiraj	121	121
Sindhur	124	124
White Prosperity	132	132
Peter Pears	136	136
Raffling Water	147	147
Nova Lux	154	154

**Table 16. Effect of crop season over dormancy of corms in gladiolus**

Variety	Crop period		
	Rainy	Winter	Summer
Dhiraj	121	92	175
White Prosperity	132	90	185
Mascagni	105	81	168
Nova Lux	154	86	179

## Pests and Diseases

There was a minor incidence of the following insects and diseases in gladiolus fields in Goa over a period of five years.

**Aphids** (*Aphis gossypii*, *Aphis craccivora*): Aphids suck the sap from tender parts of the plant and the infected plants become weak and get deformed. They excrete honey dew which attracts sooty mould and ants. Incidence of aphids is commonly seen during February and March. It can be controlled by spraying of Malathion 0.1% or Rogor 0.1% at fortnightly interval.

**Thrips** (*Taeniothrips simplex*): This is a major pest in gladiolus and causes serious damage to the crop. Yellow nymphs and black adults damage leaves and spikes by rasping tissue and sucking the sap. Affected leaves and spikes develop silver coloured streaks which later turn brown, get deformed and dry if the damage is severe. It also attacks corms in storage and infected corms become sticky, shrivel and produce weak plants when planted. It can be controlled by weekly spraying of Rogor 0.2% or Malathion 0.1%.

**Cut worms** (*Agrostis segetum*): Incidence of cut worms is normally observed in the first month of crop. Eggs of moth are seen near the ground level on plant parts. Larvae feed on emerging shoots and cut the plants at the ground level during night. Some times they damage under ground corms and developing spikes. Spraying of Methyl Parathion 0.05% or Quinolphos 0.05% at fortnight interval provides protection.

**Leaf eating caterpillar** (*Spodoptera litura*): Egg masses covered with hair are seen on under surface of the leaves. Early instar larvae feed on lower surface of leaves by scraping while mature larvae eat leaves voraciously during night time. Skelitenization of leaves is the main symptom. Spraying of Quinolphos 0.05% or Chlorpyrifos 0.05% or Carbaryl 0.1% at 10 days interval controls the incidence effectively. Neem oil 1% or neem kernel extract 4% checks damage caused by early instar larvae.

**Mealy bug**: Both nymphs and adults attack corms by sucking sap causing shriveling and drying of affected corms in severe cases. Incidence of mealy bugs starts in the field during dry conditions and then it is carried to the storage. Movement of ants on plants is the sign of mealybug infestation. Methyl Parathion 0.04% or Dimethoate 0.04% or Acephate 0.1% at fortnight interval can be applied to effectively control mealy bug.

**Borer** (*Heliothis armigera*): Larvae feed on leaves and unopened buds. Spraying of Thiodon 0.5-0.8%, Endosulphon 0.07% or Methyl Parathion 0.05% or Ekalux 0.5-0.8% at fortnight interval can control the pest. Neem kernel extract 4% or neem oil 1% can also control the pest.

## Diseases:

**Wilt** (*Fusarium oxysporium f.sp.gladioli*): Wilt is a major fungal disease in gladiolus. It is soil borne and spread through corms from season to season. High temperature, high level of nitrogen,



anaerobic condition and accumulation of carbon dioxide ( $\text{CO}_2$ ) favour the fungus. Yellowing of older leaves, browning of vascular tissue and wilting of whole plant are the symptoms of the disease. Roots can not absorb nutrients and water due to damage of vascular tissues. Soil solarization is reported to give good results but it is laborious and not practical in large areas. The best way to control the wilt is to plant healthy corms and follow crop rotation. Farmers should avoid the use of infected/sick soils for cultivation. Treat corms in hot water ( $38-40^\circ\text{C}$ ) containing 2.5g each of Benlate and Captan for 30 minutes for effective management of wilt.

**Corm rot:** Corm rot is a common problem caused by group of fungi namely *Fusarium*, *Curvularia*, *Stromatinia* and *Penicillium spp.* It causes heavy loss particularly during storage. Anaerobic conditions, storage in air tight rooms and more humidity favour the infection. Black, brown, greenish or yellowish mouldy growth on corms is seen during the storage. Under poor air circulation the corms may rot and emit foul smell. Hot water treatment ( $38-40^\circ\text{C}$ ) containing 2.5g each of Benlate and Captan for 30 minutes has been quite effective. Damage to corms at the time of lifting, improper curing and dampness in storage should be avoided.

**Curvularia blight:** It is caused by many fungi but the most important are *Curvularia trifolii* and *Curvularia ergrostitidis*. Water soaked oval to elongated brownish spots appear on leaves,

sheaths and petals and later they coalesce in advanced stage. The patches turn to brown and finally black. Moist and warm conditions spread the blight very fast. It is effectively controlled by Mancozeb 0.2% spray at 10 days interval.

### Marketing

Climatic and soil conditions of Goa are suitable for gladiolus production. There is a great demand for gladiolus flowers in the state and it occupies the third place in flower trade next only to rose and china aster. The most important aspect from farmers angle is marketing of the produce at profitable price. Gladiolus is mainly preferred by business establishments, house holds, government offices and foreign tourists. It is estimated that more than 17 lakh gladiolus spikes are consumed annually in the state. It is in demand round the year, so the market is not at all a problem in the state. Each spike fetches Rs.2.5-3.5 to the grower. So, there is no organized system of marketing in Goa and the growers have to sell flowers on personal contact basis. There is a need for growers association to get higher price for their produce. Locally produced spikes are preferred on account of freshness and better shelf life. The peak period of consumption is November - February and farmer gets the maximum price during this period. Goa is having very wide network of flower shops (120) spread in length and breadth of the state. Krishi Ghars established by Goa State Horticulture Development Corporation are also involved in marketing of flowers so farmers can avail this facility for getting better income.

### Economics of gladiolus cultivation

Gladiolus cultivation is a profitable venture and the net profit mainly depends on the market price and productivity. Labour, planting material, manures, fertilizers, pesticides and management are the major inputs required for successful cultivation and high productivity of the crop. Planting material is very expensive and

farmer has to spend huge amount of money for purchasing them. Average cost of small to large size corms varies from Rs.2 to 4. Selling price of gladiolus spike at the field level ranges from Rs. 2.50 to 3.50. The following (Table 17) account gives a reliable estimate of expenditure and income expected from gladiolus production in an area of 1000sq.m.

**Table 17. Cost of gladiolus cultivation and income**

Unit area	: 1000sq. m
Plant population/unit area	: 12500
Spacing	: 40 x 20cm
Planting material	: Small size (2.5-3.2cm) corms imported from Holland @RS.2.25/corm.

Particulars of expenditure	Cost (Rs)	
	1 year	2 year
Land preparation	600	600
Planting material(imported)-Rs.2.25/small corm	28125	-----
Manures	1000	1000
Fertilizers	600	600
Labour charges for application of manure& fertilizers, planting of corms, earthing up etc.	1260	1260
Weeding	1920	1920
Plant protection	600	600
Irrigation	1000	1000
Harvesting & post harvest handling	1200	1200
Miscellaneous	600	600
<b>Total expenditure</b>	<b>36905</b>	<b>8780</b>

Particulars of income	I year	2 year
Marketable yield (90% of total yield)	11250	11250
Sale of spikes@Rs.3/spike	33750	33750
Yield of corms	12500	12500
Value of corms@Rs.3/corm	37500	37500
<b>Total income</b>	<b>71250</b>	<b>71250</b>
<b>Total expenditure</b>	<b>36905</b>	<b>8780</b>
<b>Net income</b>	<b>34345</b>	<b>62470</b>
<b>Cost Benefit Ratio (CBR)</b>	<b>1:1.9</b>	<b>1:8</b>





Field view of gladiolus



Success of gladiolus cultivation in farmer's field

It is clear from the above table that farmers do not get any profit and just meet the expenditure in the first year if they purchase corms. However, if growers avail the subsidy given by the Directorate of Agriculture, Govt of Goa, they will get some income in the first crop itself. Farmers need not purchase corms for the second crop. Therefore, the net income from second year onwards will be more as cost of production is very less. Cost Benefit Ratio in the first year and second year is 1:1.9 (includes the value of corms) and 1:8, respectively.

Gladiolus production is highly suitable for all types of farmers. Family labour is sufficient to cultivate gladiolus successfully in small areas (1000 sq.m.) and earn good income. Farmers can approach ICAR Research Complex for Goa, Krishi Vigyan Kendras, Directorate of Agriculture, Goa State Horticulture Development Corporation for the technical guidance and Directorate of Agriculture, Government of Goa for availing the subsidy.



