EFFECT OF POST SHOOTING TREATMENTS ON YIELD, QUALITY AND MATURITY OF BANANA (*Musa paradisiaca* L.) CV. GRAND NAIN

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PATEL CHETNABAHEN MANHARBHAI

B. Sc. (Agri.)

DEPARTMENT OF HORTICULTURE

ASPEE COLLEGE OF HORTICULTURE AND FORESTRY

NAVSARI AGRICULTURAL UNIVERSITY

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ABSTRACT

EFFECT OF POST SHOOTING TREATMENTS ON YIELD, QUALITY AND MATURITY OF BANANA (*Musa paradisiaca* L.) CV. GRAND NAIN

Student	Major Advisor
Miss PATEL C. M.	Dr. N.L. PATEL

ASPEE College of Horticulture and Forestry

Navsari Agricultural University,

Navsari- 396 450.

ABSTRACT

An experiment was conducted at Regional Horticultural Research Station, Navsari Agricultural University, Navsari to study the Effect of post shooting treatments on yield, quality and maturity of banana (*Musa paradisiaca* L.) cv. 'Grand Nain' during the year 2004-05. Twenty treatment combinations, consisting of two levels of sleeving viz., no sleeving (S_0) and sleeving (S_1) and ten chemical treatments viz., GA_3 (50 and 100 mg l^{-1}), NAA (50 and 100 mg l^{-1}), 2, 4-D (10 and 20 mg l^{-1}), Ethephon (0.1 and 0.2 ml l^{-1}), Urea 2 per cent and Control (water spray) was laid out in factorial Randomized Block Design with three replications.

The banana bunches covered with blue polythene sleeve shortened the maturity period and gave maximum

production of superior quality bunches having large and better quality fruits of higher shelf life as compared to no-sleeving.

The banana bunches cv. 'Grand Nain' when sprayed with ethephon 0.2 ml l^{-1} shortened the maturity period; minimize weight loss during ripening and acidity. Whereas, bunches sprayed with GA_3 100 mg l^{-1} produced maximum yield contributed by bigger size bunch having superior quality fingers with higher shelf life. Whereas, pulp: skin ratio and TSS were maximum under NAA 100 mg l^{-1} and GA_3 50 mg l^{-1}, respectively.

The interaction between sleeving treatment and chemicals failed to show any significant effect on all the characters.

From economic point of view, the highest net income and maximum benefit cost ratio were recorded in sleeving treatment as compared to no sleeving treatment. The highest net returns along with maximum benefit cost ratio (BCR) were noted in NAA 50 mg l^{-1}.

Dr. N. L. Patel
Research Scientist,
Regional Horticultural Research Station,
ASPEE College of Horticulture and Forestry,
Navsari Agricultural University,
Navsari –396450.

CERTIFICATE

This is to certify that the thesis entitled **EFFECT OF POST SHOOTING TREATMENTS ON YIELD, QUALITY AND MATURITY OF BANANA (*Musa paradisiaca* L.) CV. GRAND NAIN** submitted by **MISS PATEL CHETNABAHEN MANAHARBHAI** in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (HORTICULTURE)** in **FRUIT CROPS** of the Navsari Agricultural University is a record of bona fide research work carried out by him under my guidance and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Place : Navsari.

Date : June 22, 2006

(N. L. Patel)

Major Advisor

DECLARATION

This is to declare that the whole of the research work submitted in this thesis for the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (HORTICULTURE) in FRUIT CROPS** is the result of investigation done by the undersigned under the direct guidance and supervision of **Dr. N. L. Patel**, Research Scientist, Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari and that no part of the work has been submitted for any other degree so far.

Patel C.M

Place : Navsari. **(PATEL C. M.)**

Date : June 22, 2006

Countersigned by

(N. L. Patel)
Research Scientist,
Regional Horticultural Research Station,
ASPEE College of Horticulture and Forestry,
Navsari Agricultural University,
Navsari – 396 450.

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Place : Navsari.

Date : June 22, 2006

Patel C.M.

(PATEL C. M.)

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ABBREVIATION

Sr. No.	Abbreviation	Meaning
1.	%	Per cent
2.	°C	Degree Celsius
3.	CD	Critical difference
4.	CV	Co-efficient of variance
5.	S.Em.	Standard error of mean
6.	cm	Centimeter
7.	Fig.	Figure
8.	g	Gram
9.	mg l^{-1}	Milligram per liter
10.	ml l^{-1}	Milliliter per liter
11.	viz.,	Namely
12.	*et al.*	*et allii* (and others)
13.	cv.	Cultivar(s)
14.	m	Meter
15.	ha	Hectare
16.	mm	Millimeter
17.	kg	Kilogram
18.	@	At the rate of
19.	AM	Ante Meridien (before noon)
20.	PM	Post Meridien (after noon)
21.	Max.	Maximum
22.	Min.	Minimum
23.	BCR	Benefit cost ratio
24.	FYM	Farm yard manure
25.	/	Per
26.	NAA	Naphthalene acetic acid
27.	2,4-D	2,4-Dichlorophenoxy acetic acid
28.	GA_3	Gibberellic acid

INTRODUCTION

I INTRODUCTION

Banana (*Musa paradisiaca* L.) is a large herbaceous perennial monocotyledonous and monocarpic crop. Banana belongs to the family Musaceae in the order Scitamineae. Banana is known as "Apple of Paradise". Its origin is the tropical region of South-East Asia. Banana crop have nutritional, medicinal and industrial value. Banana has been associated with man as food and is used for religious work. In addition, banana is one of the most important fruit crops of the world. Indeed, many consider banana one of man's first food.

In India, banana is fourth important food crops in terms of gross value and is exceeded only by paddy, wheat and milk products. It is also a dessert fruit for millions, apart from a staple food owing to its rich and easily digestible carbohydrates with a calorific value of 67-137/100 g fruit. It is a good source of vitamin A (190 IU per 100 g of edible portion) and vitamin C (100 mg/ 100g) and fair source of vitamin B and B_2. Fruits are also rich source of minerals like magnesium, sodium, potassium, phosphorus and a fair source of calcium and iron. It makes healthy and salt free balanced diet than many fruits. One hectare of banana yields 37.5 million calories of energy as compared to 2.5 million calories from wheat and multifarious uses. About 24 bananas each weighing around 100 g would provide the energy requirement (2400 calories per day) of a man (Singh, 2002).

India is the largest banana consumer and producing country in the world followed by Brazil, contributing about 15 per cent of the total world production. Among the fruits, banana holds first position in production and productivity in India. It ranks second in area after mango. In India, annual production of banana is 13.03 million tones from an area of 4.75 lakh hectares spread all over the country. Banana covers 12.50 per cent of the total area under fruits, contributing nearly one third of total fruit production in the country. In India, Tamil Nadu, Maharashtra, Karnataka, Kerala, Assam and Gujarat are the leading banana producing states. The highest productivity is 62.9 tones ha^{-1} in Maharashtra followed by Gujarat (39.9 t ha^{-1}) in the year 2002-03, Anon (2004).

In Gujarat, banana covers an area of 0.46 lakh hectares with production of 19.79 lakh tones. The largest area is covered under Bharuch district with an area of 0.11 lakh ha with the highest production of 5.02 lakh tones. Navsari district covers an area of 425 ha with a production of 19550 metric tones annually. Banana is cultivated in the districts of Bharuch, Surat, Anand, Narmada, Junagadh, Vadodara, Navsari and Valsad because of favourable agro-climatic conditions and abundant supply of well and canal irrigation water. It is also very important crop of these five districts because annual rainfall received in this region is around 70 inches. It is one of the most important fruit crop of South Gujarat region. District wise area and production estimated of banana fruit crop in the year 2004-05 is shown in appendix II.

India is one of the horticultural rich countries of the world, produces large varieties of fruits, and banana is one of

these. Since the last 50 years, a considerable research work has been done in the country on various aspects such as varieties, irrigation, weed management, spacing, post harvest technology etc. for increasing yield and quality of banana fruits.

Now- a- days, the practice of application of plant growth regulators, chemicals and sleeving treatments to banana bunches for improving the growth, maturity, yield and quality of fruits is gaining popularity. Gibberellins are phytho-hormones, known to contribute to growth by both ways, namely cell division and cell elongation. After anthesis, it is the cell expansion and cell density, which contribute the most for fruit growth, and as such, a positive correlation between growth of fruit tissues and gibberellin level is well known (Jackson and Coombe, 1966; Iwahari *et al.* 1968 and Wiltbank and Krezdon, 1969). Whereas, NAA is a synthetic auxin and auxins are well known for their growth promoting activity in plant tissues through RNA and protein synthesis. Therefore, NAA can be expected to prolong the growth period of growing banana fruits, by keeping them in active stage of growth, ultimately resulting in the delayed maturity. Ethylene stimulates respiration and protein synthesis in certain immature fruits, which may trigger a chain of biochemical events required for ripening. Presently, ethylene is considered to be one of the main ripening phyto-hormone and plant responses, which were formerly believed to be due to presence of auxins, are now being ascribed to induced ethylene production (Burg and Burg, 1966). 2, 4-Dichlorophenoxy acetic acid as auxin implicated the cell division and growth promotion process. Urea as a nitrogenous

fertilizer is well known for its growth promoting activity in plant tissues. Urea can be expected to prolong the growth period of developing fruits by keeping them in an active stage of growth (Gandhi, 1984). Bunches covered with blue polythene raises average temperature around bunches inside the bag. Microclimatic changes inside the polythene bag leads to the growing conditions very close to theoretical optimum temperature (29 and 30 ^{0}C) for fruit growth in banana as reported by Ganry and Meyer (1975).

Hence, the present investigation was planned on the commercially grown cultivar of banana i.e. locally known as 'Grand Nain'. The experiment included exogenous application of plant growth regulators, chemicals namely 50 and 100 mg l^{-1} Gibberellic acid (GA_3), 50 and 100 mg l^{-1}, Naphthalene acetic acid (NAA), 10 and 20 mg l^{-1} 2,4-D, 0.1 and 0.2 ml l^{-1} Ethephon, 2 per cent Urea and bunch covers with blue polythene bags with following objectives.

1. To know the effect of sleeving of banana bunch on yield, quality and maturity of banana.
2. To know the effect of post shooting spray of plant growth regulators and Urea on yield, quality and maturity of banana.
3. To know the interaction effect of sleeving and chemicals on yield, quality and maturity of banana.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

Today, the practical use of chemicals and sleeving in horticulture has assumed invariable significance due to revealed capacity of many compounds to exploit many significant mechanisms in plant, which have led to a situation nearly approaching the horticulture revolution. Synthetic growth regulating chemicals are becoming extremely important and valuable in fruits for manipulating growth, flowering, yield and quality of many fruit crops. A broad range of effects of both morphological and physiological effects can be observed by the application of growth regulating chemicals and sleeving.

A major advent during the past decades was the discovery that fruit size of some crops can be substantially increased by plant growth regulating chemicals and sleeving treatments and the effect is relatively independent of crop load. A reasonably larger fruit size of banana for getting higher market price and thus the economic benefits of treatments that reliably improve fruit size can be, indeed very substantial.

In present context, literature on the effect of chemicals and sleeving on maturity, yield and quality of banana have been reviewed in this chapter under following headings.

૨.1) Effect of sleeving

૨.2) Effect of chemicals

.1 Effect of Sleeving

Perumal and Adam (1968) studied the effect of agging the bunch of banana cv. 'Giant Cavendish' between nflorescence emergence and stem harvest. The results revealed hat the harvesting period was shortened by 16 days when the ruits were covered with Kraft bag and up to 8 days when overed with a perforated plastic bag. The fruits were harvested, t a specific diameter of the middle finger of the outer whorl of he second hand. It inferred that, the greater rate of increase in he finger diameter was attributed to the higher temperature associated with bagging.

Rippon and Turner (1970) reported that banana unches covered (emerged in September) with blue polyethylene sleeves combined with the use of paper inserts to avoid sunburn, ielded 22 per cent more than uncovered ones. This increase rise p to 28 per cent when a newspaper was placed over the top hand. The covering, but not the paper, hastened the growth and maturity. Covering also increased the percentage of top grade fruits and that paper inserts improved fruit quality by reducing sunburn.

Turner and Rippon (1973) carried out a two series of rials in two seasons to investigate the effects of polythene bunch overs on yield, emergence to harvest interval and maturity of ananas. Covers in 2 out of 4 trials increased final fruit size. Yield was increased in only one trial but was a function of fruit

number as well as size. If harvested when commercially full, the emergence harvest interval was reduced by bunch covers. If allowed to ripen in the plantation, the covers had no significant effect.

Heenan (1973) studied the effect of blue polythene covers on Dwarf Cavendish and Giant Cavendish banana bunches over a period of seven months. Bunch cover consistently reduced the time between bunch emergence and bunch harvest in both the varieties. The skin of fruits from covered bunches was significantly softer than those from uncovered ones. There was an indication of slight yield increase in Dwarf Cavendish under covers. He also observed a problem of sunburn and took measures to protect top hands particularly when leaf canopy was reduced.

Stevenson (1976) observed that in summer, bunch covering no particular colour of covering material substantially accelerated or delayed bunch filling, but in winter, the use of transparent material speeded up the filling and harvesting of banana bunches.

Samson (1980) reported that bagging of banana bunches protected fruits against cold, sunburn, dust, spray residue, insects and birds. The bag was left open on the underside. Even in the tropics, bagging increased the average temperature of the bunch by 0.5°C which hastened the harvest by five days. In India, an increase in temperature by 1.1-1.6°C was found and that the bunch weight rise by 1.0 kg.

Parmar (1982) used blue polythene sleeves and covered the developing bunches after emergence of inflorescence. He observed that covering shortened the time taken for harvest, and took fewer days for ripening. Further, the highest yield was obtained with covering and it recorded biggest fingers. Sleeving also resulted in maximum pulp content, higher total soluble solids, highest total as well as reducing sugars, minimum weight loss during ripening and lowered the acidity.

Robinson and Nel (1984) conducted a trial with newly emerged bunches of Dwarf Cavendish banana enclosed in blue or white (clear) polyethylene covers 36 days after flower emergence. They found that the harvested bunch weight amounted to 56 and 55 kg, respectively, compared with 49 kg for uncovered controls, and average finger weight increased from 147 (uncovered) to 187 and 174 g, respectively. Moreover, the incidence of mechanical blemishes was reduced from 29% to 10% and 17%, respectively, and covered bunches could be harvested about 2-3 weeks earlier.

Working on banana cv. 'Basrai' Gandhi (1984) reported that white and blue sleeving shortened the maturity as well as ripening. Yield and girth was improved by white sleeving. Both the sleeves type reduced loss in weight during ripening. Reducing sugar was accelerated by both treatments. Maximum TSS, total sugars and low acidity was registered under blue sleeving.

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Parmar and Chundawat (1984) reported that Basrai banana covered with blue polythene sleeves advanced the maturity of fruits and hastened the process of ripening after harvest and increased the fruit weight. The least weight loss was seen in sleeving as compared to control. While increased yield in terms of higher bunch weight due to better fruit set and bigger fruits with improved fruit quality in terms of increased TSS and pulp: skin ratio were noticed in same treatment.

EL-Hammady *et al.* (1985) observed that bunch covers were most effective in respect to weight of fingers, bunch weight and yield in order to blue polythene, yellow polythene and dried leaves of banana.

While working on banana Cuneen and McEntyre (1988) used coloured bags to cover the bunches for several reasons, to reduce the time between flower emergence and harvesting, to improve banana quality and quantity, and as a protection against injuries caused by solar radiation or by pests or mechanical injuries. Studies with different coloured plastic bags (green, blue, black, orange, blue/silver, green/silver and clear/silver) enclose a wire frame. The results indicated that, during the day the temperature inside the bags was up to 10°C higher than the outside air temperature and that, during the night, the temperature inside the bags fall slightly below the outside air temperature. The clear/silver bag resulted in the highest daytime temperature increase and the black bag the lowest increase. In studies using the bags as bunch covers, no significant difference

in yield or quality was found for the different coloured bags, although yield was highest for bunches inside the clear/silver bags; it is suggested that the clear/silver bags may be of value during the winter period.

Jannoyer and Chillet (1988) covered banana bunches cv. 'Grand Nain' with Katryx bag and stated that use of Katryx bag reduced the flowering to harvest period, improved fruit growth and significantly improved the yield.

Reddy (1989) covered Robusta banana bunches with 200 gauge blue polythene sleeves, measuring 60 cm in diameter and 1.5 m in length, when the last hand was opened. The upper end of sleeve was tightly tied to the stalk and lower end was loosely tied to allow accumulated water to drain out. Bunch covers significantly increased finger weight and finger diameter and reduced the time taken for bunch maturity.

Johns and Scott (1989) recorded an increase in finger length and diameter with bunch cover. Daniells *et al.* (1987; 92) and Irizzary *et al.* (1992) reported the beneficial effect of bunch cover on increase in finger length. The results are in close confirmation with the findings of Patil *et al.* (1989) and Ganry and Meyer (1975). Cuneen and McEntyre (1989) also reported an increase in bunch weight and yield of banana.

Choudhury *et al.* (1996) reported that in banana cv. Dwarf Cavendish the yield attributes viz.; bunch weight, bunch length, number of fingers per bunch, finger length, finger weight, finger volume and weight of second hand was significantly

influenced by bunch cover treatment. The highest bunch weight and yield were obtained from the white polyethylene cover + mustard oil cake treatment as compared to control. The BCR of this treatment was low (1:2.8). The lowest BCR (1:1.92) was obtained from the mustard oil cake treatment. The highest BCR (1:3.53) was observed in the white bunch cover treatment.

Eckstein and Fraser (1996) conducted a trail on banana cv. 'Chinese Cavendish' fruits to which bunch covers were applied at the bell-removal stage to protect against hail damage as compared with cv. 'Williams' fruits to which no bunch covers were applied. They pointed out that the covered Chinese Cavendish bunches yielded higher total and first-grade pack outs (74.9 and 72.6%, respectively) than the uncovered Williams bunches (52.9 and 65.4%, respectively).

According to Johns (1996) banana bunches (10-year-old Great Cavendish cv. Williams plants) were either covered single or double on three occasions during winter, double covering increased finger weight of the top 6 hands by 4 per cent. Double covering did not affect the yield of extra-large fruits.

Choudhury *et al.* (1997) carried out an experiment on different bunch covers (black, white or blue polyethylene covers, gunny bags or dry banana leaves) and soil application of mustard oil cake (1 kg/plant, alone or in combination with white polyethylene bunch covers) on the quality of banana cv. Jahaji. The results indicated that the highest quality fruits viz.; total

soluble solids content, fresh weight were harvested under white polyethylene bunch cover + mustard oil cake treatment. However, control fruits recorded the lowest total soluble solids, total sugars and acidity.

Costa (1999) carried out a trial on bagging of banana cv. 'Grand Nain' at three times after flowering (10, 20 or 30 days). The variable analyzed were; bunch weight, days between flower emergence and harvest for the export market and internal market, and length, diameter and density of fruits. Bagging, irrespective of when it took place resulted in smaller interval between flowering and harvesting date for the export market. Bagging 10 days after flowering increased the length and diameter of the fruits of the 2nd superior hand. Bagging did not affect bunch weight of density of green fruits.

Rodrigues *et al.* (2001) studied the effect of polyethylene covers on banana crop characteristics in Minas Gerais, Brazil. The results revealed that harvest time for plants with bunch covers was 12 days earlier than uncovered plants. Bunch covers had no effect on bunch weight, total fruit weight, mean fruit weight, mean hand weight, length, weight and girth of central fruit.

Debnath *et al.* (2001) conducted a trial on bunch management technology of Cavendish banana cv. Giant Governor with different bunch covers viz., transparent blue, yellow, red and black polythene (0.08 mm thick), jute bags and dried banana leaves. The results indicated that bagging of bunches with

transparent and blue polythene covers increased the size and weight of fingers. However, fruit yield was increased by 20 and 16 per cent respectively, over control (uncovered bunches). While, highest harvest index was obtained under transparent polythene cover whereas, shooting to harvest index interval was reduced by 15 days in the same treatment.

Narayana *et al.* (2002) noted that opaque coloured bunch covers with 6 per cent ventilation holes was optimum for obtaining the highest yield. The factors like number of fingers per bunch, individual hand weight, finger weight, length and girth of fingers, etc. were significantly higher in 6 per cent ventilated bunch covers than 4 or 2 per cent or colour treatments. The harvest index was highest in 6 per cent ventilation compared to others.

Bhagwan *et al.* (2002) covered the banana bunches with 100-guage blue or white polythene bags measuring 160 cm length and 100 cm width with 15 per cent ventilation at the time of last hand emergence. The results showed improved finger length and girth, which ultimately reflected in bunch weight in all the cultivars tested. Bunch covers hastened bunch maturity by a week. Only a marginal significant variation in time for bunch maturity in sleeved bunches was observed among cultivars. Bunch sleeving resulted in harvest of attractive light green lustrous fruits without any bruises and signs of biological infestation.

Costa *et al.* (2002) studied the effect of bagging anana cv. Nanicao (Musa sp. AAA) at different times on roduction and on the interval between inflorescence and arvest. Bagging was done with polythene Sacks at three times 21 May and 17 December 1996 and 26 February1997). They found no significant correlation between bagging and time of agging. However, bagging decreased the interval between flowering and harvest during the first and second bagging time.

Chiang-ShihChao *et al.* (2004) studied the effect of wo types of banana bunch cover (Kraft paper and blue polyethylene (PE) cover) on the bunch development and post harvest quality of cv. Pei-Chiao (Musa, AAA Cavendish). No significant differences in bunch weight, finger length and width nd finger diameter were recorded between banana bagged with Kraft paper and PE covers. Kraft paper covers reduced sunburn damage and uneven degreening of banana hands by 50 per cent in 2 of the 3 cropping years. Kraft paper cover also tended to slightly increase the total soluble solids and decrease the water ontent of banana pulp. Analysis of spectrum of simulated light bsorption by the two types of bunch covers revealed that Kraft paper cover blocked more blue-green and ultraviolet lights and allowed more infrared rays to pass through than blue PE cover.

Patel and Patel (2004) revealed that covering of banana bunch with white or blue polythene bags after winter produced blemish less of good quality, higher fruit yield and

computed maximum BCR value (1:1.75) due to fetching higher price in market.

Pandey *et al.* (2005) covered banana bunches with white poly sleeves to extend the quality of banana Robusta and Rasthali main and ratoon crops. Bunches were covered after emergence of last hand. Bunch covering resulted in harvesting of attractive, light green, lustrous fruits without any bruises and sign of biological infections. Besides, covering also protects bunches from severe cold and advances the ripening during winter season and produced blemish free quality fruits.

2.2 Effect of Chemicals

Tomi *et al.* (1970) sprayed Dwarf Cavendish banana bunches with GA_3 (10 and 20 ppm) and 2, 4-D (10 and 40 ppm), either separately or together at various times between flowering and about a month before harvest. The results revealed that TSS content was enhanced by all treatments, while the pulp percentage was increased only with 2, 4-D 10 ppm sprayed during flowering.

Sampio *et al.* (1977) reported non-significant effect on the development of banana fruit cv. 'Nanicao', in terms of number of hands per bunch, number of fruits per hands or on length of fruits with application of 50-200 ppm GA_3 at inflorescence emergence, when the bunch development was completed and again 30 days later.

Venkatrayappa *et al.* (1978) studied the effect of two per cent Urea spray, at post shooting stage, on development and

composition of banana fruits. Two per cent Urea was applied twice at 15 and 21 days after shooting on bunch alone or whole plant or through the soil. The results revealed that the whole plant sprayed with Urea significantly increased the weight and volume of fruits. The treatment also increased the length: girth ratio and pulp: skin weight ratio. However, the ripening of fruits was delayed by the treatment. They further, noted that sugar content at 'eating ripe' stage was generally more in the fruits.

Deshmukh and Chakrawar (1980) conducted a trial on banana at MAU, Parbhani. They sprayed GA_3 (25 or 50 ppm) and ethrel (200 or 300 ppm) on Basrai banana plants, 50-60 days after flowering and again a month later and observed an improvement in fruit yield and quality as compared to control.

Patel (1980) applied NPK (1 % - 1.5 % - 1 %), (2 % - 0.75 % - 2 %) and (3 % - 1 % - 3 %) on banana cv. 'Basrai', at pre-shooting, post shooting and pre as well as post shooting stages, and studied the response on growth, yield and quality. The results revealed that pre as well as post shooting sprays of NPK (1 % - 0.5 % - 1 %) was found most promising with respect to increase in bunch weight, fruit weight and size as well as quality of fruits including the net return. The next best treatment was that NPK sprays (2 % - 0.75 % - 2 %) applied at both the stages.

Mishra *et al.* (1981) applied GA_3 (100 ppm) to 35 and 55 days old banana bunches thrice on alternate days, and found an increase in the weight and volume of fingers in both the

young and old bunches. Further, they also found that the response to GA_3 treatment was better in younger fruits.

Arvindakshan (1981) sprayed banana bunches with ethrel (100, 200 and 400 ppm), 2, 4-D (2, 4 and 10 ppm) and NAA (50, 100 and 200 ppm) soon after female phase was over. The results revealed that all the treatments increased the finger length and finger weight but there was no effect on finger girth. The application of 2, 4-D at 10 and 4 ppm increased the fruit weight. However, the quality of fruits was increased by all the growth regulators as evidenced by increased T.S.S and low acidity

VijayaKumar and Shanmugavelu (1983) noticed that both GA_3 (50 ppm) and 2, 4-D (20 ppm) application made immediately after opening of last hand, completely overcome the seediness in Kottaivazhai (seeded poovan). The treated bunches were found better than the normal poovan in respect of the bunch and fruit characters and quality.

Rajendran (1982) conducted a trial on banana cv. 'Palayankodan' with 2, 4-D (5, 10 15 and 20 ppm) and NAA (20, 30, 40 and 50 ppm) at three stages being 3rd month, 4th and after female phase of bunch development. The results revealed that 2, 4-D at 10 and 20 ppm significantly reduced the total crop duration by 15 to 22 days. However, NAA 50 ppm increased the bunch weight and bunch grade.

The One per cent nitrogen spray applied before as well as after, shooting gave maximum yield accompanied with

early maturity as compared to control in Basrai banana. (Anon., 1984).

Tadros *et al.* (1984) carried out an investigation for two years with sprays of aqueous solution of GA_3 at 10-50 ppm in banana cv. 'Hindi' to 5th and 6th ratoon crop. They found that there was significant increase in finger weight, size and bunch weight but delayed the maturity. However, GA_3 had little effect on pulp: skin ratio and TSS.

Parmar and Chundawat (1984) revealed that treatment to Basrai banana with ethephon 250 ppm advanced the maturity of fruits and hastened the process of ripening after harvest also increased the yield and improved the fruit quality. Significantly higher fruit weight at maturity and ripening was noted in GA_3. The least weight loss was seen in ethephon 250 ppm, whereas GA_3 100 ppm and NAA 10 ppm prolonged the maturity.

Parmar (1982) reported that an application of ethephon 250 ppm at full emergence of inflorescence followed by another spray after a month reduced the days to harvest and ripening period, while GA_3 100 ppm and NAA 100 ppm delayed the same. All the treatments significantly increased the yield, which was mainly a contribution of higher number of fingers and hands per bunch and large size of fruits in these treatments. Maximum increase was recorded in GA_3 100 ppm followed by NAA 100 ppm. Similarly, all the treatments recorded higher pulp content, increased TSS, total sugars, reducing and non-reducing sugars, and low acidity. The highest quality fruits were harvested in GA_3

(100 ppm) treatment. NAA sprays took fewer days for ripening but delayed the maturity.

Gandhi (1984) observed that ethephon (50, 100 and 200 ppm) shortened the maturity as well as ripening, whereas all levels of GA_3, NAA and Urea in general delayed the same. The significant delay in harvest was observed under GA_3 100 ppm. All the levels of NAA and GA_3 as well as 1.0 and 2.0 per cent Urea significantly extended the shelf life of banana fruits. The next and best treatments with regard to delay in ripening were GA_3 100 and NAA 50 ppm. All the treatments, in general (but not significantly) improved the yield. However, the noteworthy treatments were all levels of Urea and GA_3 as well as NAA 50 ppm. The significant increase in size of berry in terms of girth was recorded under GA_3 (25, 50 and 100 ppm), Urea (0.5 and 1.0 per cent), NAA (25, 50 and 100 ppm) and ethephon (200 ml ppm). Pulp content was higher in all the treatments as compared control. Ethephon (100 and 200 ppm), NAA (50 and 100 ppm), GA_3 (100 ppm) and Urea (1.0 and 2.0 per cent) significantly reduced the loss in weight during ripening. The highest TSS percentage was observed in GA_3 50 ppm, NAA 25 ppm and ethephon 100 ppm. The highest reducing sugar was registered in all the treatments as compared to control. The highest total sugars were recorded in GA_3 100 ppm and ethephon 200 ppm. On the other hand, NAA 25 and 50 ppm and Urea 0.5 per cent registered significantly low total sugars. Ethephon (500 and 100 ppm) and NAA (50 and 100 ppm) registered significantly low acidity in fruits.

Satyanarayana (1985) sprayed aqueous solution of ome growth regulators at different concentrations on tender uits just after opening of the bunch in October, while control uits were sprayed with distilled water. The results compiled at the sprays of 2, 4-D at 25 ppm and GA_3 at 2000 ppm ignificantly improved the fruit size, fruit weight, and bunch eight and total soluble solids in pulp. GA_3 at 1000 and 1500 pm had a favorable but less pronounced influence, while 2, 4-D 50 ppm had a depressing effect. In summer GA_3 even at 1000 pm improved yield but 2, 4-D at 25 ppm had adverse effects.

Patel (1985) conducted a trial on banana cv. Basrai ith four concentrations of Urea (1, 2, 3 and 4 per cent) and ree levels of sprays namely two, four and six sprays given just ter the emergence of spadix. The interval between consecutive rays in two, four and six spray was 30, 15 and 10 days spectively. He concluded that two sprays of four per cent Urea gnificantly improved the yield and quality of banana fruits.

Buragohain and Shanmugavelu (1986) observed that e mean bunch weight was greater with tying of urea at 15 g and 0 g followed by 3 per cent Urea spraying. All the treatments used early maturity and increased the hand weight. Whereas, arvesting was 15 days earlier with 2 per cent urea spray than ntrol. Incase of tying urea in polythene bags, harvesting of unches was 11 days earlier with tying at 10 g and it was 6 days ith 15 g urea.

Pradhan *et al.* (1988) sprayed growth substances on banana cv. 'Giant Governor' and noted that GA_3 at 100 ppm and ethrel 250 ppm were markedly effective in increasing bunch and uit weight and pulp: skin ratio. However, maximum sugar: acid itio was obtained with ethrel at 500 ppm

Chattopadhyay and Jana (1988) treated 'Giant overnor' Cavendish banana bunches with growth substances 30 ays after emergence of inflorescence with and without male ud. The results compiled that GA_3 was found to be more ffective in increasing length, girth and weight of fruit without ale bud. Similarly, TSS and sugar content of fruits was creased, also pulp: skin ratio was higher without male bud. hereas NAA and 2, 4-D treated plants showed beneficial ffects over control.

Chattopadhyay and Abu Hassan (1996) sprayed anana bunches with NAA and GA_3 each at 10, 25 and 50 ppm, 4-D at 5, 10 and 20 ppm at the on set of male phase. The pplication of GA_3 50 ppm resulted in maximum yield and took ss number of days for fruit maturity. However, maximum idity was also recorded with the same treatment.

Kumar *et al.* (1998) applied growth substances onsisted of GA_3 (100 and 200 ppm) and 2, 4-D (10 and 20 ppm) banana cv. 'Neypoovan' at emergence of the last hand of the unch and one-month later. The highest bunch weight and pulp: kin ratio was recorded in GA_3 200 ppm whereas, TSS content as recorded maximum in GA_3 100 ppm.

Athani *et al.* (1999) conducted a trial on banana cv. ajapuri' to study the effect of growth regulators on crop aturity and yield. The growth regulators were sprayed on nches at 7 and 15 days after shooting (DAS). Results showed at for plant crop, 2, 4-D (30 ppm) at 7 DAS produced the ortest time to maturity and also highest yield per hectare as mpared to control. The results for the ratoon crop followed a nilar pattern.

Athani *et al.* (2002) conducted an experiment on nana cv. 'Rajapuri' (Musa AAB). The results indicated that nch length was maximum when bunches were sprayed with A_3 100 ppm 15 (DAS) days after shooting at both the stages lant and ratoon- crop). In plant crop, the bunch circumference ffered significantly at all stages of observation. Bunch cumference was significantly maximum when bunches were rayed with 2, 4-D at 30 ppm 7 DAS.

Sarma and Chakrabarty (2003) applied 2, 4-D at 10 d 25 ppm on banana bunches at the opening of last hand and ted the longest fingers in the treatment 2, 4-D at 25 ppm.

MATERIAL AND METHODS

III. MATERIAL AND METHODS

The details of material used, experimental methods followed and the techniques adopted during the course of this investigation are given below:

3.1 Experimental site

The present investigation on "Effect of post shooting treatments on yield, quality and maturity of banana (*Musa paradisiaca* L.) cv. Grand Nain" was carried out at Experimental Farm of Regional Horticultural Research Station, Navsari Agricultural University, Navsari.

3.2 Soil characteristics

As per the seventh approximation, the soil of Navsari has been placed under the great group of vertic ustochrepts, Sub order chrepts and order inceptisols with Jalalpore series, which include deep, moderately drained clayey soil, which was classified earlier as "deep black soil".

The soil of experimental site is black, deep and rich in organic matter and potash having good water holding capacity with good drainage. The soil was considered quite suitable for banana crop under South Gujarat condition.

The soil samples were taken randomly from five different places covering the complete experimental block with the help of augar up to 30cm depth. The soil analysis was done as

of the soil of experimental block have been presented in Table 3.1 and Table 3.2, respectively.

3.3 Climate and weather

The climate of this region is typically tropical characterized by hot summer, moderately cold winter and humid and warm monsoon. In general, the monsoon sets during the second fortnight of June and ends by the second fortnight of September. Pre-monsoon rains in the last week of May and or first week of June are most uncommon.

The total precipitation received during the monsoon of 2005 was 2427 mm distributed in 52 rainy days.

Winter commences from October onwards and ends by the middle of February. The temperature falls down from the beginning of November. December and January are the coldest months of the year. The summer season commences from the middle of February and ends by the first week of June. April and May are the hottest months of summer.

The mean weekly meteorological data on maximum and minimum temperatures, rainfall, relative humidity and sunshine hours during the course of investigation recorded at observatory of the N.M. College of Agriculture, Navsari Agricultural University, Navsari are presented in Appendix- I

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Table-3.1: Physical properties of the soil

Sr. No.	Particulars	Value in per cent (0-30 cm depth)	Texture
1	Coarse sand	0.69	-
2	Fine sand	09.17	-
3	Silt	24.94	Clay
4	Clay	65.20	-

Table-3.2: Chemical characteristics of the soil

Sr. No.	Particulars	Value (0-30 cm depth)	Methods employed
1	Soil pH (1:2.5 soil: water ratio)	7.7	Backman's pH meter (Jackson,1967)
2	Total N (%)	0.052	Modified kjeldahl's method (Jackson,1967)
3	Available N (kg ha^{-1})	160.00	Alkaline permanganate method (Jackson,1967)
4	Available P_2O_5 (kg ha^{-1})	40.02	Olsen's method (Olsen's et al., 1954)
5	Available K_2O (kg ha^{-1})	384.50	Flame photometer (Jackson,1967)

3.4 Location

The experiment was laid out in Plot No -1 of the Block-E at the experimental farm of Regional Horticultural Research Station, N.A.U., Navsari during the year 2004- 2005.

3.5 Land preparation

The experimental plot was prepared by deep ploughing, harrowing and leveling. The pits of 30 x 30 x 30cm were dug out at a spacing of 2.1 x 1.5m^2 and well-decomposed fine textured Farm Yard Manure (FYM) at the rate of 10 kg per pit was applied at planting.

3.6 Planting material

Well hardened, healthy tissue culture plants of Grand Nain banana having 5-6 leaves were used for planting.

3.7 Planting time

Planting was done in August 2005.

3.8 Application of fertilizers

Each plant was fed with 300g N_2; 90g P_2o_5; 200g K_2o. Nitrogen and potash were applied at 3^{rd}, 4^{th} and 5^{th} months after planting in three equal split doses while complete dose of phosphorus was applied at 3^{rd} month after planting.

The soil application method was adopted to give the fertilizer treatments. The fertilizers N, P and K were applied in the form of Urea, Single super phosphate and Murate of potash, respectively. The fertilizers were applied by making shallow ring

around the pseudo stem and were covered with a thin layer of soil over it.

3.9 Cultural practices

The cultural practices were adopted according to the recommendations for the cultivation of banana crop. Earthing up was done after completion of fertilizer dose in order to support the plants.

Weeding was done manually to keep the experimental plot weed free; desuckering was also done manually with the help of sharp sickles. The dry and diseased leaves were removed regularly in order to keep the field clean and hygienic. Propping was done after inflorescence emergence with the help of bamboo poles or wooden stakes to support the plants. Denavelling (removal of male flower bud) was done after complete opening of bunch.

3.10 Irrigation

The crop was irrigated at 4-6 days interval during summer and 8-10 days interval in winter seasons. Whenever there was a dry spell, if needed, the crop was irrigated in monsoon months.

3.11 Experimental details

Salient features of variety:

It is a tall mutant of 'Dwarf Cavendish'. It is gaining popularity among growers of South Gujarat. It is more vigorous

and robust with well-spaced hands, fingers of bigger size and heavy bunches.

Crop and variety : **Banana cv. Grand Nain**

Experimental details

(a) Design : Factorial Randomized Block Design (FRBD)

(b) Replications : Three (3)

(c) No. of plants/treatment : 4

(d) No. of treatments : 20

(e) Total no. of plants : 240

(f) Spacing : 2.1m x 1.5 m

(g) Plot size : Row planting (4 plants $^{-1}$ row considered as 1 plot)

(h) Total area : 42 x 18 m^2

(i) Treatment details

Sleeving 1) S_1 – No sleeving

2) S_2 - Sleeving with blue polythene

Chemicals

C_1 -GA_3 50 mg l^{-1}

C_2 - GA_3 100 mg l^{-1}

C_3 - NAA 50 mg l^{-1}

C_4 - NAA 100 mg l^{-1}

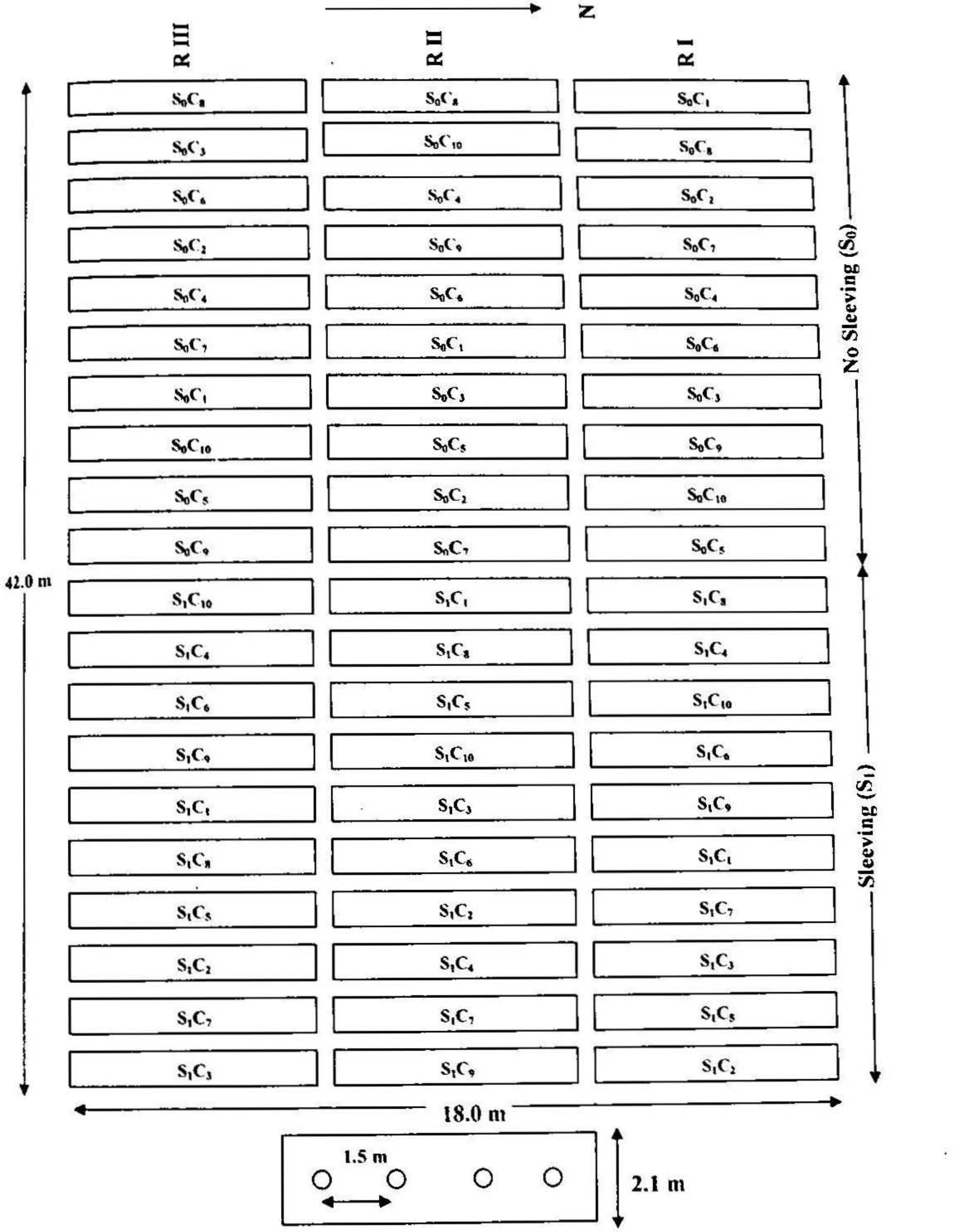


Fig.1: Plan of layout of experiment



Plate-1: General view of experiment

C_5 - 2, 4-D 10 mg l^{-1}

C_6 - 2, 4-D 20 mg l^{-1}

C_7 - Ethephon 0.1 ml l^{-1}

C_8 - Ethephon 0.2 ml l^{-1}

C_9 - Urea 2 per cent

C_{10} - Control (water spray)

(Total 20 treatment combinations)

Number of sprays: Two

Time of spray:

(1) After complete opening of inflorescence

(2) After seven days of first spray

3.12 Preparation of stock solution:

3.12.1 Gibberellic acid (GA_3):

The required quantity of powder was weighed, dissolved in alcohol just sufficient to dissolve the powder and then the final volume of stock solution was then made up with distilled water.

3.12.2 Naphthalene acetic acid (NAA):

The required quantity of powder was weighed, dissolved in 1.0 per cent sodium hydroxide just sufficient to dissolve the powder and transferred to the volumetric flask. The final volume of stock solution was then made up with distilled water.

3.12.3 2,4-D:

The required quantity of 2,4-D powder was weighed and was dissolved in distilled water and final volume of stock solution was made.

3.12.4 Ethephon:

The required quantity of Ethephon liquid was taken by micropipette and mixed in distilled water and the final volume was made.

3.12.5 Urea:

The required quantity of Urea was weighed, dissolved in water and then the final volume was made.

3.12.6 Sleeving:

For sleeving treatments, blue polythene bags were used. The whole bunch was covered with polythene bags having 110 cm length and 75 cm diameter. The upper portion of bag was tied with cotton thread while, the lower portion was kept open. Blue polythene bags had 200 gauge thickness.

3.13 Procedure of spray:

The stock solution of chemical was diluted with water for preparing the required strength of the spray. The 250 ml volume of the solution was sufficient for thorough wetting of bunch. The first spray was given after complete emergence of inflorescence. The second spray was given seven days after first spray. Teepol a wetting agent was added to increase the

absorption of chemicals. The spraying of chemical was done by hand sprayer. Spraying was done on bunch from all sides.

Observations recorded:

Date of inflorescence emergence

No. of hands/bunch

No. of fingers/bunch

Weight of bunch

Yield (kg/ha)

Size of bunch (a) Length (b) Breadth

Length of fruit from third hand

Girth of fruit from third hand

Weight loss during ripening

Pulp: Skin ratio

TSS

Acidity

Reducing sugar

Total sugar

Shelf life of fruit

Methodology adopted for recording above-mentioned observations is as under.

3.14.1 OBSERVATIONS ON DURATION OF CROP:

3.14.1.1 Days taken from inflorescence emergence to harvest:

The number of days taken from flowering to harvest were recorded and then averaged.

3.14.2 OBSERVATIONS ON YIELD AND YIELD ATTRIBUTING CHARACTERS:

3.14.2.1 Number of hands per bunch

After emergence of all the female hands, the number of hands per bunch was counted and mean number of hands per bunch were calculated.

3.14.2.2 Number of fingers per bunch

Number of fingers per bunch was counted from each bunch after complete opening of inflorescence and mean number of fingers per bunch was calculated.

3.14.2.3 Bunch weight (kg)

The bunches were harvested when the fruit skin colour changed from green to light green and the ridges on the fruits disappeared. The bunches were weighed immediately after harvest.

3.14.2.4 Yield (t /ha)

The data of the yield per net plot was recorded and multiplied by multiple factor computed on area basis to give the final data for total yield in tones per hectare.

3.14.3 OBSERVATIONS ON FRUIT:

3.14.3.1 Size of bunch (Length and Girth) (cm)

The length and girth of the bunch was measured by measuring tape and average size of bunch was calculated and expressed in cm.

3.14.3.2 Length of fruit from third hand (cm)

Length of finger from third hand was measured with the help of thread and was calculated on scale and average size of finger was expressed in cm.

3.14.3.3 Girth of fruit from third hand (cm)

Girth of finger from third hand was measured with the help of thread and was calculated on scale and average size of finger was expressed in cm.

3.14.3.4 Weight loss during ripening (g)

Loss in weight of fruit from third hand was calculated based on the difference in fresh weight of the fruit at the time of harvest and the weight of fruit at the time of ripening stage. The weight loss was then averaged per fruit.

3.14.3.5 Pulp: Skin ratio

The fruits, which were used for recording the weight loss during ripening, were used to calculating pulp: skin ratio. Pulp to skin ratio was calculated by dividing respective pulp weight by respective skin weight.

3.14.4 QUALITY PARAMETERS OF FRUITS

3.14.4.1 Total Soluble Solids (T.S.S.)

The TSS value of the fruit was recorded by using hand refractometer having range of 0-32° Brix.

3.14.4.2 Acidity (%)

The method described by Rangana (1977) was adopted for estimation of titrable acidity. Weighed amount of pulp was transferred to a volumetric flask and the volume was made up with distilled water to a known amount. After thirty minutes, the suspension was filtered through Whatman No. 1 filter paper and the filtrate was used subsequently.

An aliquot was taken and titrated against standard sodium hydroxide using phenolphthalein as an indicator. Titrable acidity was expressed as percentage malic acid equivalent adopting the following formula.

$$\text{Acidity (\%)} = \frac{\text{Titre x Normality of alkali}}{\text{Volme of sample taken for estimation}} \times \frac{\text{Volume made up}}{\text{Weight of sample}} \times \frac{\text{Eq. Wt. of Malic acid}}{1000} \times 100$$

3.14.4.3 Reducing sugar (%)

The titrimetric method of Lane and Eynon described by Rangana (1977) was adopted for estimation of reducing sugar. The method is based on the principle that invert sugar or reducing sugar reduces the copper in the Fehling's solution to red insoluble cuprous oxide. Sugar in a sample was estimated by determining

the volume of unknown sugar solution required to completely reduce a measured volume of Fehling's solution. Before using the mixture (1:1) of Fehling's solution A and B was standardized against standard glucose for obtaining glucose equivalent and to arrive at a conversion factor.

Procedure:

A weighed amount of the pulp was taken in a volumetric flask and 2 milliliter of 45 per cent basic lead acetate solution was added for clarification. After 10 minutes, the solution was deleaded by adding potassium oxalate crystals in excess (added till excess of crystals remained undissolved) and the volume was made upto a known amount with distilled water and filtered through Whatman No. 1 filter paper. The filtrate was taken in a burette and titrated against boiling Fehling's mixture (5 ml of Fehling's solution A + 5 ml of Fehlings solution B) till the blue colour faded. Then 1 ml of methylene blue indicator (1%) was added and titration was continued till the contents attained a brick red colour and titre value was noted. The percentage of reducing sugar was calculated according to following formula.

$$\text{Reducing sugar (\%)} = \frac{\text{Glucose Eq. (0.05)}}{\text{Titre}} \times \frac{\text{Total volume made up}}{\text{Weight of the pulp}} \times 100$$

3.14.4.4 Total sugars (%)

For estimation of total sugars, the filtrate obtained in the above estimation was used. An aliquot from the filtrate was taken and to one-fifth of its volume, hydrochloride acid (1:1) was

added and the inversion was carried out at room temperature for 24 hours. Subsequently, the contents were cooled and neutralized with 40 per cent sodium hydroxide using phenolphthalein as an indicator and the final volume was made. The solution was filtered through Whatman No. 1 filter paper and titration was carried out using filtrate as detailed for reducing sugars.

The total sugars content was expressed as percentage in terms of invert sugars according to the formula.

$$\text{Total sugar (\%)} = \frac{\text{Glucose Eq. of Fehling's solutions (0.05)}}{\text{Titre}} \times \frac{\text{Total volume made up}}{\text{Weight of pulp taken}} \times \frac{\text{Volume made up after inversion}}{\text{Aliquot taken for inversion}} \times 100$$

3.14.4.5 Shelf-life of the fruit

The shelf life of the fruit was noted by keeping the fruits at room temperature and humidity conditions. The shelf life of fruits was recorded as the days taken from harvesting to optimum eating stage.

3.15 Statistical Analysis

The statistical analysis of data for the different characters studied during the investigation was carried out as per the procedure given by Panse and Sukhatme (1967).

3.16 Economics

The gross income in terms of rupees per hectare was worked out on the basis of mean yield for each treatment and the prevailing market prices of banana bunch. The cost of different treatment combinations was worked out by considering prices of

labour employed for treatments and cultivation cost. The net income was worked out by deducting cultivation cost and the cost required for different treatments from the gross income per hectare for respective treatments and recorded accordingly.

$$\text{Benefit Cost Ratio (BCR)} = \frac{\text{Net income}}{\text{Cost of cultivation}}$$

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

This chapter embodies the results of the present investigation on "Effect of post shooting treatments on yield, quality and maturity of banana (*Musa paradisiaca* L.) cv. Grand Nain" carried out under South Gujarat (Navsari) conditions during the year 2005 at Regional Horticultural Research Station, Navsari Agricultural University, Navsari. The data collected during experimentation on various aspects were subjected to statistical analysis using Factorial Randomized Block Design. The results along with statistical inference are presented here.

4.1 DAYS TAKEN FROM FLOWERING TO HARVESTING

The data on days taken from flowering to harvesting as influenced by sleeving treatment with different chemicals are presented in Table-4.1 and graphically depicted in Fig. 2.

4.1.1 Effect of sleeving

A perusal of data presented in Table 4.1 revealed that sleeving treatment had significant effect on days taken from flowering to harvesting. Significantly, the minimum days taken from flowering to harvesting (85.87 days) were noticed in sleeving treatment (S_1) as compared to no-sleeving treatment (S_0).

4.1.2 Effect of chemicals

The data presented in Table 4.1 indicated that there was significant difference in days taken from flowering to harvesting due to chemical spraying. However, the minimum days

taken from flowering to harvesting (83.26 days) were recorded in C_8 treatment (plant sprayed with ethephon 0.2 ml l^{-1}) which was at par with C_7, C_{10} and C_6 treatments. The maximum days taken from flowering to harvesting (93.90 days) were noticed in plant sprayed with GA_3 100 mg l^{-1} (C_2) which was at par with C_3, C_1, C_4, C_5, C_9 and C_6 treatments.

4.1.3 Interaction effect

The interaction of sleeving treatment and chemicals failed to show any significant effect on days taken from flowering to harvesting (Table 4.1).

4.2 NUMBER OF FINGERS PER BUNCH

The mean data pertaining to number of fingers per bunch of banana are presented in Table 4.1.

4.2.1 Effect of sleeving

The data presented in Table 4.1 indicated that there was a no any significant difference in sleeving treatment in respect of number of fingers per bunch.

4.2.2 Effect of chemicals

It is evident from data presented in Table 4.1 revealed that different chemicals did not significantly influence the number of fingers per bunch. However, the maximum (165.09) number of fingers per bunch was noted in NAA 50 mg l^{-1} (C_3) and the minimum (156.10) number of fingers per bunch was noticed in 2, 4-D 20 mg l^{-1} (C_6).

4.2.3 Interaction effect

Interaction effect between sleeving treatment and chemicals on number of fingers per bunch was found to be non-significant (Table 4.1).

4.3 NUMBER OF HANDS PER BUNCH

The mean data regarding the number of hands per bunch of banana as influenced by sleeving treatment and various chemicals are presented in Table 4.1.

4.3.1 Effect of sleeving

The data presented in Table 4.1 clearly indicated that there were no any significant differences in number of hands per bunch due to sleeving treatment.

4.3.2 Effect of chemicals

It is evident from the data (Table 4.1) that different chemicals had no any significant effect on number of hands per bunch. However, the maximum number of hands per bunch (10.10) was recorded in NAA 50 mg l^{-1} treatment (C_3) and the minimum number of hands per bunch (9.54) was noticed in GA_3 100 mg l^{-1} treatment (C_2).

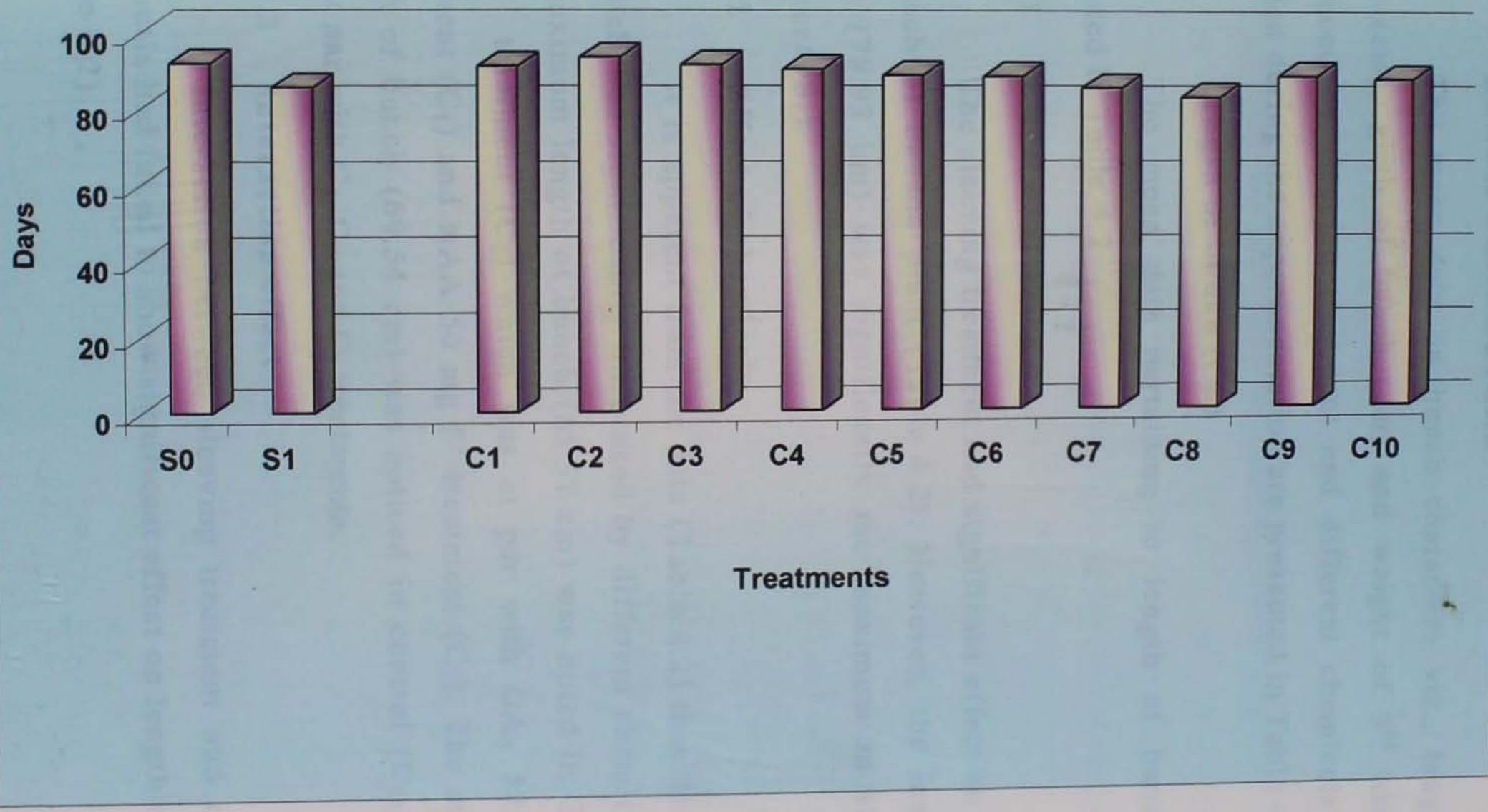
4.3.3 Interaction effect

The interaction between sleeving and chemicals failed to depict any significant effect on number of hands per bunch (Table 4.1).

Table-4.1: Effect of post shooting treatments on days taken from flowering to harvesting, number of fingers and hands per bunch of banana cv. 'Grand Nain'

Treatments	Days taken from flowering to harvesting	Number of fingers per bunch	Number of hands per bunch
S- Sleeving			
S_0 - No-sleeving	92.27	159.15	9.87
S_1 - Sleeving	85.87	159.77	9.70
S. Em.	0.87	1.13	0.099
CD at 5 %	2.48	NS	NS
C – Chemicals			
C_1 - GA_3 50 mg l^{-1}	91.52	160.99	9.79
C_2 - GA_3 100 mg l^{-1}	93.90	158.56	9.54
C_3 - NAA 50 mg l^{-1}	91.83	165.09	10.10
C_4 - NAA 100 mg l^{-1}	90.66	161.13	9.86
C_5 - 2-4,D 10 mg l^{-1}	89.01	157.89	9.91
C_6 - 2-4,D 20 mg l^{-1}	88.76	156.1	9.98
C_7 - Ethephon 0.1 ml l^{-1}	85.76	157.7	9.75
C_8 - Ethephon 0.2 ml l^{-1}	83.26	159.09	9.58
C_9 - Urea 2 %	88.93	158.04	9.58
C_{10} - Control (Water spray)	88.07	160.00	9.78
S.Em. ±	1.94	2.52	0.222
CD at 5 %	5.55	NS	NS
Interaction			
S.Em. ±	2.74	3.57	0.315
CD at 5 %	NS	NS	NS
CV %	5.33	3.88	5.57

Fig. 2 : Effect of post shooting treatments on days taken from flowering to harvesting of banana cv. 'Grand Nain'



S0	No-sleeving	C3	NAA 50 mg l^{-1}	C7	Ethephon 0.1 ml l^{-1}
S1	Sleeving	C4	NAA 100 mg l^{-1}	C8	Ethephon 0.2 ml l^{-1}
C1	GA_3 50 mg l^{-1}	C5	2-4,D 10 mg l^{-1}	C9	Urea 2 %
C2	GA_3 100 mg l^{-1}	C6	2-4,D 20 mg l^{-1}	C10	Control (Water spray)

4.4 BUNCH CHARACTERS

The mean data on bunch characters viz., length of bunch (cm), girth of bunch (cm) and weight of 3rd hand as influenced by sleeving treatment and different chemicals were recorded during the experimentation are presented in Table 4.2.

4.4.1 Length of bunch (cm)

The mean data pertaining to length of bunch are presented in Table 4.2.

4.4.1.1 Effect of sleeving

The sleeving treatment had significant effect on length of bunch of banana plant (Table 4.2). However, the length of bunch (78.93 cm) was significantly the maximum in sleeving treatment (S_1).

4.4.1.2 Effect of chemicals

It is apparent from the data (Table-4.2) that the length of bunch was significantly influenced by different chemicals and the maximum length of bunch (85.57 cm) was noted in GA_3 100 mg l^{-1} treatment (C_2) which was at par with GA_3 50 mg l^{-1} treatment (C_1) and NAA 50 mg l^{-1} treatment (C_3). The minimum length of bunch (69.54 cm) was noticed in control (C_{10}) which was at par with C_8, C_7 and C_9 treatments.

4.4.1.3 Interaction effect

Interaction between sleeving treatment and different chemicals had failed to show significant effect on length of bunch (Table 4.2).

4.4.2 Girth of bunch (cm)

The data on girth of bunch as influenced by sleeving treatment and different chemicals are presented in Table 4.2

4.4.2.1 Effect of sleeving

The data presented in Table 4.2 clearly indicated that there were significant differences in sleeving treatment with respect to girth of bunch. Significantly, the maximum girth of bunch (109.51 cm) was observed in sleeving treatment (S_1).

4.4.2.2 Effect of chemicals

In present investigation, different chemicals significantly influenced the girth of banana bunch. It is evident from the data (Table 4.2) that significantly the maximum girth of bunch (115.31 cm) was recorded in GA_3 100 mg l^{-1} (C_2) treatment, which was at par with GA_3 50 mg l^{-1} (C_1) and NAA 100 mg l^{-1} treatment (C_4). The minimum girth of bunch (100.79 cm) was noticed in control (C_{10}) which was at par with C_7, C_8 and C_9 treatments.

4.4.2.3 Interaction effect

Interaction between sleeving treatment and different chemicals failed to show any significant effect on girth of bunch (Table 4.2).

4.4.3 Weight of third hand (kg)

The data on weight of 3rd hand as influenced by sleeving treatment with different chemicals are presented in Table 4.2.

4.4.3.1 Effect of sleeving

The data presented in Table 4.2 clearly indicated that there was significant difference in weight of 3rd hand due to sleeving treatment. Significantly, the maximum (3.109 kg) weight of 3rd hand was recorded in sleeving treatment (S_1).

4.4.3.2 Effect of chemicals

It is evident from the data (Table 4.2) that spray of chemicals recorded any significant differences in respect to weight of 3rd hand. Significantly, the maximum weight of 3rd hand (3.524 kg) was observed under GA_3 100 mg l^{-1} (C_2) treatment, which was at par with GA_3 50 mg l^{-1} (C_1) treatment and NAA 100 mg l^{-1} treatment (C_4). The minimum weight of 3rd hand (2.411 kg) was noted in control (C_{10}) which was at par with C_8, C_7, C_9 and C_6 treatments.

4.4.3.3 Interaction effect

Interaction between sleeving treatment and different chemicals failed to show any significant effect on weight of 3rd hand (Table 4.2).

4.5 FINGER CHARACTERS

The mean data on finger characters viz., weight of finger, length of finger and girth of finger as influenced by sleeving treatment and foliar spray of different chemicals are presented in Table 4.3 and graphically illustrated in Fig. 3.

Table-4.2: Effect of post shooting treatments on bunch characters of banana cv. 'Grand Nain'

Treatments	Length of bunch (cm)	Girth of bunch (cm)	Weight of 3rd hand (kg)
S- Sleeving			
S_0 - No-sleeving	74.83	107.09	2.765
S_1 - Sleeving	78.93	109.51	3.109
S. Em.	0.92	0.81	0.067
CD at 5 %	2.65	2.34	0.192
C - Chemicals			
C_1 - GA_3 50 mg l^{-1}	83.16	113.39	3.390
C_2 - GA_3 100 mg l^{-1}	85.57	115.31	3.524
C_3 - NAA 50 mg l^{-1}	79.74	109.79	3.217
C_4 - NAA 100 mg l^{-1}	78.98	110.79	3.078
C_5 - 2-4,D 10 mg l^{-1}	76.32	107.31	2.969
C_6 - 2-4,D 20 mg l^{-1}	75.84	108.04	2.847
C_7 - Ethephon 0.1 ml l^{-1}	73.26	104.91	2.636
C_8 - Ethephon 0.2 ml l^{-1}	72.82	106.12	2.530
C_9 - Urea 2 %	73.66	106.51	2.771
C_{10} - Control (Water spray)	69.54	100.79	2.411
S.Em. ±	2.07	1.83	0.150
CD at 5 %	5.92	5.22	0.43
Interaction			
S.Em. ±	2.92	2.58	0.212
CD at 5 %	NS	NS	NS
CV %	6.59	4.13	12.49

4.5.1 Weight of finger (g)

The data pertaining to weight of finger as affected by sleeving treatment and spray of different chemicals are presented in Table 4.3.

4.5.1.1 *Effect of sleeving*

The perusal of data given in Table 4.3 revealed that weight of finger was significantly influenced by sleeving treatment. The sleeving treatment (S_1) recorded significantly maximum (154.02 g) weight of finger.

4.5.1.2 Effect of chemicals

The data given in Table 4.3 indicated that weight of finger was significantly influenced by spray of different chemicals. Significantly, the maximum (159.69 g) weight of finger was noticed under GA_3 100 mg l^{-1} treatment (C_2). The minimum (121.36 g) weight of finger was recorded in control.

4.5.1.3 Interaction effect

The interaction between sleeving treatment and spray of different chemicals failed to show any significant effect on weight of finger (Table 4.3).

4.5.2 Length of finger (cm)

The data on length of finger are presented in Table 4.3.

4.5.2.1 Effect of sleeving

It is evident from the data presented in Table 4.3 that sleeving treatment had significant effect on length of finger. It is

clear from the data that bunch covered with blue polythene (S_1) recorded significantly the maximum (24.14 cm) length of finger.

4.5.2.2 Effect of chemicals

The results presented in Table 4.3 revealed that different chemicals significantly influenced the length of finger. The maximum (25.53 cm) length of finger was observed under GA_3 100 mg l^{-1} (C_2) treatment, which was at par with GA_3 50 mg l^{-1} treatment (24.92 cm), NAA 100 mg l^{-1} (24.27 cm) and NAA 50 mg l^{-1} (24.35 cm). The minimum length of finger (21.18 cm) was noted in control (C_{10}).

4.5.2.3 Interaction effect

Interaction of sleeving treatment and spray of different chemicals failed to show any significant difference on length of finger (Table 4.3).

4.5.3 Girth of finger (cm)

The mean data related to girth of finger as influenced by sleeving treatment and spray of different chemicals are presented in Table 4.3.

4.5.3.1 Effect of sleeving

The data presented in Table 4.3 clearly indicated that there were significant differences in sleeving treatment with respect to girth of finger. The sleeving treatment (S_1) recorded significantly the maximum (13.40 cm) girth of finger.

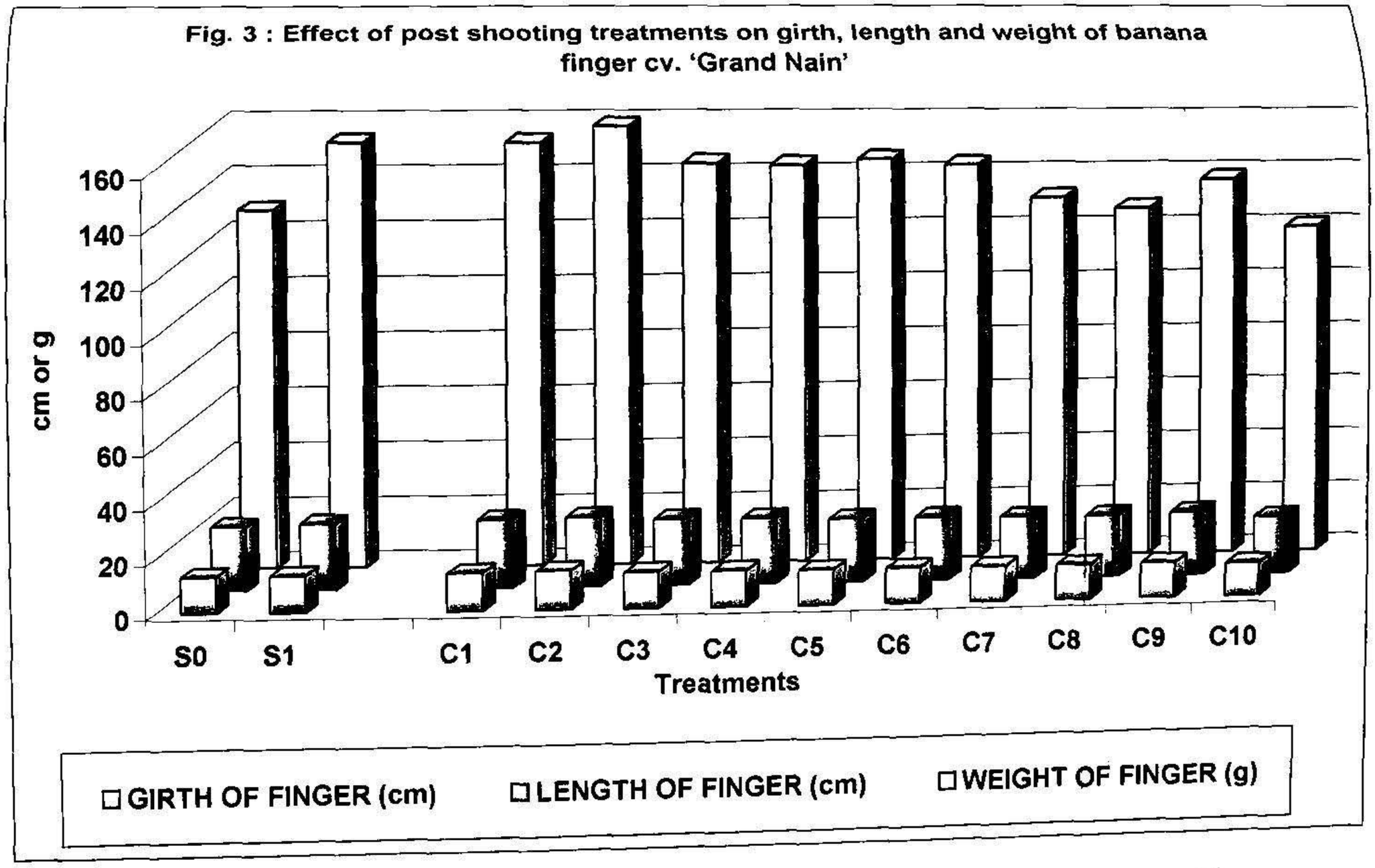
4.5.3.2 Effect of chemicals

It is apparent from the data (Table 4.3) that the girth

Table-4.3: Effect of post shooting treatments on finger characters of banana cv. 'Grand Nain'

Treatments	Weight of finger (g)	Length of finger (cm)	Girth of finger (cm)
S- Sleeving			
S_0 - No-sleeving	129.65	23.22	13.14
S_1 - Sleeving	154.02	24.14	13.40
S. Em.	0.68	0.28	0.09
CD at 5 %	1.94	0.80	0.25
C - Chemicals			
C_1 - GA_3 50 mg l^{-1}	153.83	24.92	13.98
C_2 - GA_3 100 mg l^{-1}	159.69	25.53	14.33
C_3 - NAA 50 mg l^{-1}	145.99	24.35	13.47
C_4 - NAA 100 mg l^{-1}	145.11	24.27	13.42
C_5 - 2-4,D 10 mg l^{-1}	147.08	23.43	13.11
C_6 - 2-4,D 20 mg l^{-1}	144.86	23.51	13.17
C_7 - Ethephon 0.1ml l^{-1}	132.59	23.05	12.98
C_8 - Ethephon 0.2 ml l^{-1}	128.63	22.99	12.94
C_9 - Urea 2 %	139.16	23.61	13.04
C_{10} - Control (Water spray)	121.36	21.18	12.28
S.Em. ±	1.51	0.62	0.20
CD at 5 %	4.33	1.78	0.56
Interaction			
S.Em. ±	2.14	0.88	0.28
CD at 5 %	6.12	NS	NS
CV %	2.61	6.42	3.62

Fig. 3 : Effect of post shooting treatments on girth, length and weight of banana finger cv. 'Grand Nain'



S0	No-sleeving	C3	NAA 50 mg l^{-1}	C7	Ethephon 0.1 ml l^{-1}
S1	Sleeving	C4	NAA 100 mg l^{-1}	C8	Ethephon 0.2 ml l^{-1}
C1	GA_3 50 mg l^{-1}	C5	2-4,D 10 mg l^{-1}	C9	Urea 2 %
C2	GA_3 100 mg l^{-1}	C6	2-4,D 20 mg l^{-1}	C10	Control (Water spray)

of finger was significantly influenced by spray of different chemicals and the maximum (14.33 cm) girth of finger was noticed under GA_3 100 mg l^{-1} (C_2) treatment, which was at par with GA_3 50 mg l^{-1} treatment (13.98 cm). The minimum length of finger (12.28 cm) was noted in control (C_{10}).

4.5.3.3 Interaction effect

Effect of interaction between sleeving treatment and chemicals on length of finger was found to be non-significant (Table 4.3).

4.6 Weight loss during ripening (g)

The mean data pertaining to weight loss during ripening of banana are presented in Table 4.4 and graphically depicted in Fig. 4.

4.6.1 Effect of sleeving

It is evident from the data (Table 4.4) that sleeving treatment recorded the significant differences in weight loss during ripening. Significantly, the minimum (23.287 g) weight loss during ripening was recorded under sleeving treatment (S_1).

4.6.2 Effect of chemicals

It is apparent from the data (Table 4.4) that the weight loss during ripening was significantly influenced by spray of different chemicals and the minimum (19.110 g) weight loss during ripening was noted under spray of ethephon 0.2 ml l^{-1} (C_8) treatment, which was at par with ethephon 0.1 ml l^{-1} (20.391 g). The maximum (28.753 g) weight loss during ripening was recorded under control (C_{10}).

4.6.3 Interaction effect

Interaction between sleeving treatment and spray of different chemicals showed non-significant effect on weight loss during ripening (Table 4.4).

4.7 Pulp: skin ratio

The mean data regarding pulp: skin ratio are presented in Table-4.4.

4.7.1 Effect of sleeving

A perusal of data presented in Table 4.4 revealed that sleeving treatment had no significant effect on pulp: skin ratio. The maximum (3.652) pulp: skin ratio was noticed under sleeving treatment (S_1).

4.7.2 Effect of chemicals

The results presented in Table 4.4 revealed that the pulp: peel ratio was significantly influenced by spray of different chemicals and the maximum (4.233) pulp: skin ratio was recorded under NAA 100 mg l^{-1} treatment (C_4) which was at par with NAA 50 mg l^{-1} treatment (4.012). The minimum (3.025) pulp: skin ratio was noticed under control which was at par with C_9 (3.296) and C_5 (3.368) treatments.

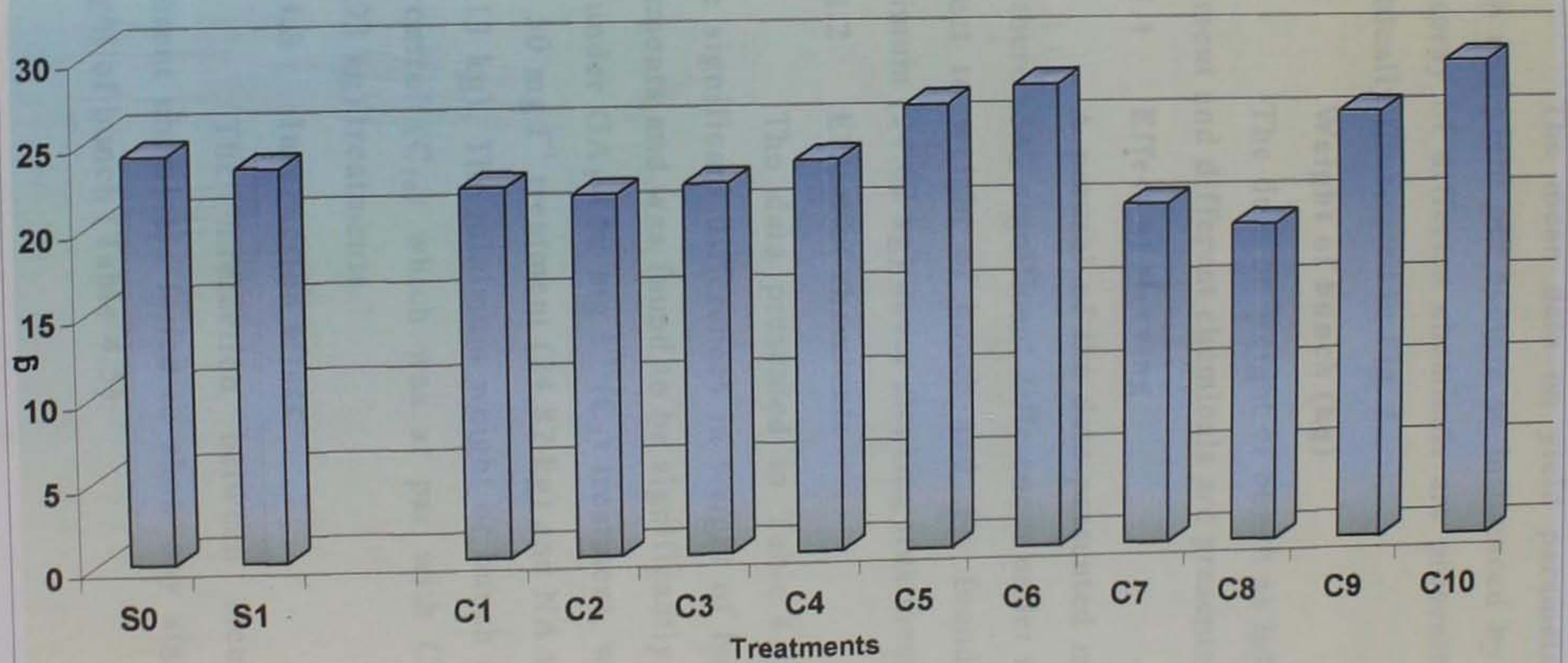
4.7.3 Interaction effect

Interaction between sleeving treatment and different chemicals failed to show any significant effect on pulp: skin ratio (Table 4.4).

Table-4.4: Effect of post shooting treatments on weight loss during ripening and pulp: skin ratio of banana fruit cv. 'Grand Nain'

Treatments	Weight loss during ripening (g)	Pulp: skin ratio
S- Sleeving		
S_0 - No-sleeving	24.070	3.506
S_1 - Sleeving	23.287	3.652
S. Em.	0.257	0.060
CD at 5 %	0.735	NS
C - Chemicals		
C_1 - GA_3 50 mg l^{-1}	21.931	3.415
C_2 - GA_3 100 mg l^{-1}	21.439	3.446
C_3 - NAA 50 mg l^{-1}	22.003	4.012
C_4 - NAA 100 mg l^{-1}	23.299	4.233
C_5 - 2-4,D 10 mg l^{-1}	26.487	3.368
C_6 - 2-4,D 20 mg l^{-1}	27.610	3.419
C_7 - Ethephon 0.1 ml l^{-1}	20.391	3.633
C_8 - Ethephon 0.2 ml l^{-1}	19.110	3.948
C_9 - Urea 2 %	25.760	3.296
C_{10} - Control (Water spray)	28.753	3.025
S.Em. ±	0.57	0.133
CD at 5 %	1.64	0.382
Interaction		
S.Em. ±	0.81	0.189
CD at 5 %	NS	NS
CV %	5.94	9.12

Fig. 4 : Effect of post shooting treatments on weight loss during ripening of banana fruit cv. 'Grand Nain'



S0	No-sleeving	C3	NAA 50 mg l^{-1}	C7	Ethephon 0.1 ml l^{-1}
S1	Sleeving	C4	NAA 100 mg l^{-1}	C8	Ethephon 0.2 ml l^{-1}
C1	GA_3 50 mg l^{-1}	C5	2-4,D 10 mg l^{-1}	C9	Urea 2 %
C2	GA_3 100 mg l^{-1}	C6	2-4,D 20 mg l^{-1}	C10	Control (Water spray)

4.8 YIELD

The mean data on yield parameters viz., weight of bunch and yield per hectare as influenced by sleeving treatment and spray of different chemicals are presented in Table 4.5 and graphically illustrated in Fig. 5.

4.8.1 Weight of bunch (kg)

The data on weight of bunch as influenced by sleeving treatment and different chemicals are presented in Table 4.5

4.8.1.1 Effect of sleeving

A perusal of the data presented in Table 4.5 revealed that there was significant differences under sleeving treatment in respect to weight of bunch and it found to be significantly maximum (24.62 kg) under sleeving treatment (S_1).

4.8.1.2 Effect of chemicals

The data presented in Table 4.5 revealed that there were significant differences in weight of bunch due to chemical treatments and was found to be significantly the maximum (25.30 kg) under GA_3 100 mg l^{-1} (C_2) treatment, which was at par with GA_3 50 mg l^{-1} treatment (24.82 kg) and NAA 100 mg l^{-1} treatment (24.13 kg). The minimum weight of bunch (19.43 kg) was noted in control (C_{10}) which was at par with C_8 (20.48 kg) and C_7 (20.93 kg) treatments.

4.8.1.3 Interaction effect

The interaction between sleeving treatment and different chemicals failed to show any significant difference in weight of bunch (Table 4.5).

4.8.2 Yield per hectare (t ha^{-1})

The mean data regarding the yield per hectare are presented in Table 4.5.

4.8.2.1 Effect of sleeving

The data presented in Table 4.5 clearly indicated that sleeving treatment had significant effect on yield per hectare. Significantly, the maximum (78.15 t ha^{-1}) yield per hectare was recorded under sleeving treatment (S_1).

4.8.2.2 Effect of chemicals

It is evident from the data (Table 4.5) that the different chemicals had significant effect on yield per hectare. Significantly, the maximum (80.31 t ha^{-1}) yield per hectare was noticed under GA_3 100 mg l^{-1} (C_2) treatment, which was at par with GA_3 50 mg l^{-1} treatment (78.79 t ha^{-1}) and NAA 100 mg l^{-1} treatment (76.60 t ha^{-1}). The minimum (61.69 t ha^{-1}) weight of bunch was noted in control (C_{10}) which was at par with C_8 (65.01 t ha^{-1}) and C_7 (66.44 t ha^{-1}) treatments.

4.8.2.3 Interaction effect

Interaction between sleeving treatment and different chemicals failed to show any significant effect on yield per hectare (Table 4.5).

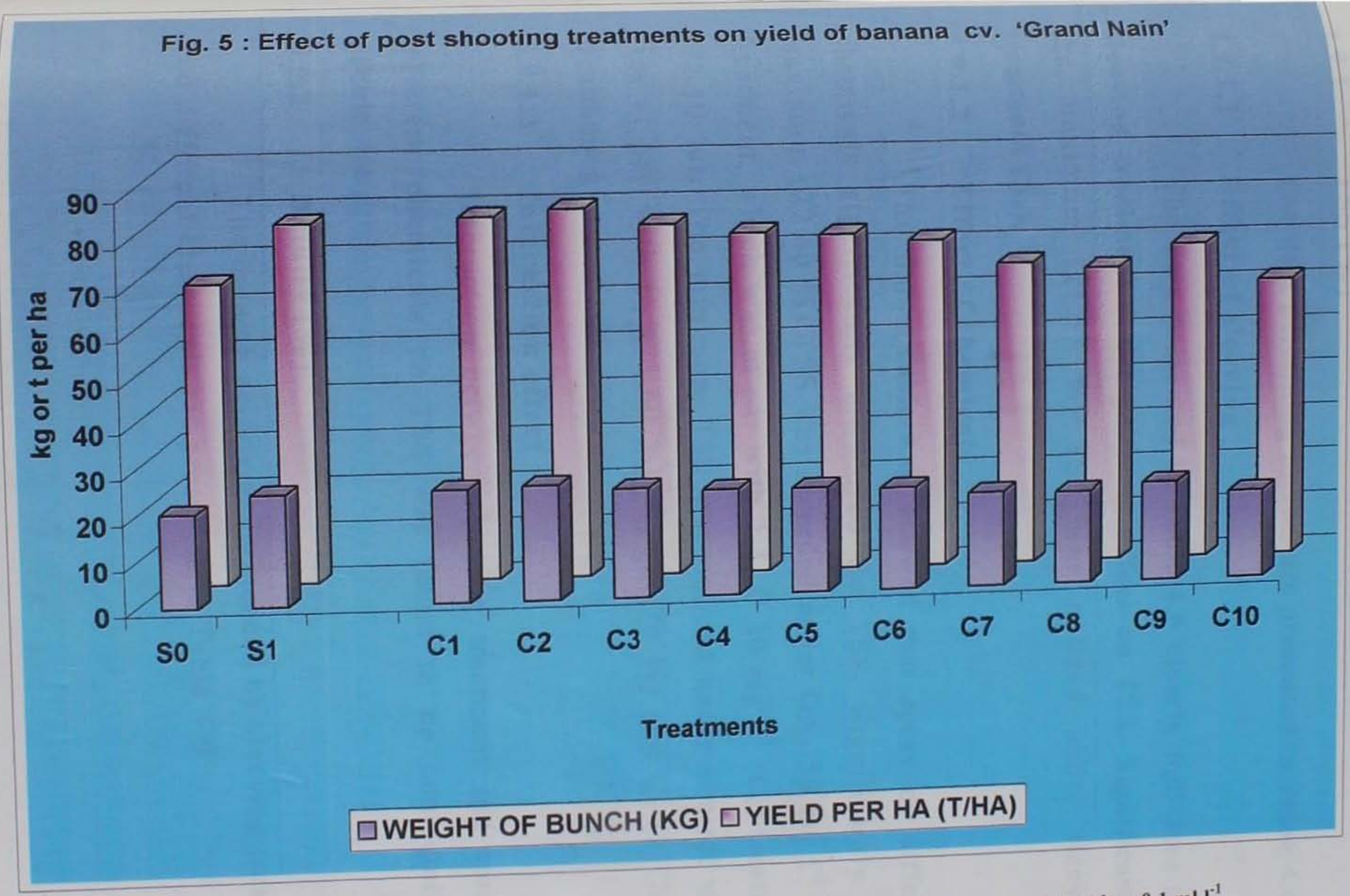
4.9 QUALITY PARAMETERS

The mean data on quality parameters viz., TSS, acidity, ascorbic acid, total sugars and reducing sugar as influenced by sleeving treatment and spray of different chemicals

Table 4.5: Effect of post shooting treatments on yield of banana cv. 'Grand Nain'

Treatments	Weight of bunch (kg)	Yield per ha (t/ha)
S- Sleeving		
S_0 - No-sleeving	20.64	65.53
S_1 - Sleeving	24.62	78.15
S. Em.	0.25	0.79
CD at 5 %	0.71	2.27
C - Chemicals		
C_1 - GA_3 50 mg l^{-1}	24.82	78.79
C_2 - GA_3 100 mg l^{-1}	25.30	80.31
C_3 - NAA 50 mg l^{-1}	24.13	76.60
C_4 - NAA 100 mg l^{-1}	23.40	74.30
C_5 - 2-4,D 10 mg l^{-1}	23.15	73.50
C_6 - 2-4,D 20 mg l^{-1}	22.62	71.82
C_7 - Ethephon 0.1 ml l^{-1}	20.93	66.44
C_8 - Ethephon 0.2 ml l^{-1}	20.48	65.01
C_9 - Urea 2 %	22.04	69.98
C_{10} - Control (Water spray)	19.43	61.69
S.Em. ±	0.56	1.77
CD at 5 %	1.60	5.07
Interaction		
S.Em. ±	0.78	2.51
CD at 5 %	NS	NS
CV %	6.04	6.04

Fig. 5 : Effect of post shooting treatments on yield of banana cv. 'Grand Nain'



S0	No-sleeving	C3	NAA 50 mg l^{-1}	C7	Ethephon 0.1 ml l^{-1}
S1	Sleeving	C4	NAA 100 mg l^{-1}	C8	Ethephon 0.2 ml l^{-1}
C1	GA_3 50 mg l^{-1}	C5	2-4,D 10 mg l^{-1}	C9	Urea 2 %
C2	GA_3 100 mg l^{-1}	C6	2-4,D 20 mg l^{-1}	C10	Control (Water spray)

are presented in Table-4.6.

4.9.1 TSS (%)

The data pertaining to TSS are presented in Table 4.6.

4.9.1.1 Effect of sleeving

The data presented in Table 4.6 clearly indicated that sleeving treatment had significant effect on TSS. Significantly, the maximum (21.67 %) TSS was noticed under sleeving treatment (S_1).

4.9.1.2 Effect of chemicals

The data (Table 4.6) showed that spray of different chemicals significantly influenced the TSS. Significantly, the maximum (22.60 %) TSS was recorded under GA_3 50 mg l^{-1} (C_1) treatment, which was at par with 2-4, D 20 mg l^{-1} (C_6) treatment (22.10 %). The minimum TSS was noticed under control which was at par with C_9 (21.60 %), C_8 (21.70 %) and C_4 (21.70 %) treatments.

4.9.1.3 *Interaction effect*

Interaction between sleeving treatment and spray of different chemicals on TSS was found to be non-significant (Table 4.6).

4.9.2 Acidity (%)

The data on acidity as influenced by sleeving treatment and different chemicals are presented in Table 4.6.

4.9.2.1 Effect of sleeving

A perusal of the data presented in Table 4.6 revealed that there was significant difference in acidity due to sleeving treatment. The minimum (0.404 %) titrable acidity was recorded under sleeving treatment (S_1).

4.9.2.2 Effect of chemicals

It is evident from the data (Table 4.6) that the titrable acidity was significantly influenced by different chemicals and the minimum (0.321 %) acidity was recorded under ethephon 0.2ml l^{-1} (C_8) treatment, which was at par with GA_3 100 mg l^{-1} (0.362 %) treatment. The maximum (0.542 %) acidity was noticed under control.

4.9.2.3 Interaction effect

The interaction between sleeving treatment and spray of different chemicals failed to show any significant difference in titrable acidity (Table 4.6).

4.9.4 Total sugars (%)

The data pertaining to total sugar are presented in (Table 4.6.).

4.9.4.1 Effect of sleeving

It is apparent from the data (Table 4.6) that the total sugars were significantly influenced by sleeving treatment and the maximum (13.06 %) total sugars were observed under sleeving treatment (S_1).

4.9.4.2 Effect of chemicals

The data given in Table 4.6 indicated that total sugars were significantly differ by different chemicals and the maximum (13.81 %) total sugars were recorded under GA_3 100 mg l^{-1}(C_2) treatment which was at par with C_1 (13.67 %), C_8 (13.56 %), C_7 (13.42 %), C_4 (13.19 %), C_2 (13.07 %), C_5 (12.41 %) and C_6 (12.21 %) treatments. The minimum (10.62%) total sugars were noticed under urea 2 per cent which was at par with control (10.86 %), C_6 (12.21 %) and C_5 (12.41 %) treatments.

4.9.4.3 Interaction effect

The interaction between sleeving treatment and chemicals failed to show any significant effect on total sugars (Table 4.6).

4.9.5 Reducing sugar (%)

The data regarding to reducing sugar are presented in Table 4.6.

4.9.5.1 Effect of sleeving

The data presented in Table 4.6 clearly indicated that there was significant difference in reducing sugar due to sleeving treatment. Significantly, the maximum (5.19 %) reducing sugar was noticed under sleeving treatment (S_1).

4.9.5.2 Effect of chemicals

A perusal of data given in Table 4.6 revealed that the different chemicals had significant effect on reducing sugar and the maximum (6.06 %) reducing sugar was recorded under NAA

Table-4.6: Effect of post shooting treatments on quality of banana fruit cv. 'Grand Nain'

Treatments	TSS (%)	Acidity (%)	Total sugar (%)	Reducing sugar (%)
S- Sleeving				
S_0 - No-sleeving	20.93	0.433	12.30	4.77
S_1 - Sleeving	21.67	0.404	13.06	5.19
S. Em.	0.12	0.009	0.19	0.10
CD at 5 %	0.34	0.027	0.54	0.29
C - Chemicals				
C_1 - GA_3 50 mg l^{-1}	22.60	0.455	13.67	4.80
C_2 - GA_3 100 mg l^{-1}	21.70	0.362	13.81	5.70
C_3 - NAA 50 mg l^{-1}	21.60	0.391	13.07	6.06
C_4 - NAA 100 mg l^{-1}	20.70	0.455	13.19	5.47
C_5 - 2-4,D 10 mg l^{-1}	21.50	0.455	12.41	4.95
C_6 - 2-4,D 20 mg l^{-1}	22.10	0.401	12.21	4.85
C_7 - Ethephon 0.1 ml l^{-1}	21.30	0.401	13.42	4.67
C_8 - Ethephon 0.2 ml l^{-1}	20.07	0.321	13.56	4.40
C_9 - Urea 2 %	20.70	0.401	10.62	4.36
C_{10} - Control (Water spray)	20.20	0.542	10.86	4.57
S.Em. ±	0.27	0.021	0.74	0.21
CD at 5 %	0.77	0.061	2.12	0.59
Interaction				
S.Em. ±	0.373	0.030	0.60	0.29
CD at 5 %	NS	NS	NS	NS
CV %	3.08	12.46	8.18	10.15

50 mg l^{-1} (C_3) treatment which was at par with C_4 (5.47 %) and C_2 (5.70 %) treatments. The minimum (4.36 %) reducing sugar was noticed under Urea 2 per cent which was at par with C_8 (4.40 %), control (4.57 %), C_7 (4.67 %), C_6 (4.85 %) and C_5 (4.95 %) treatments.

4.9.5.3 Interaction effect

The reducing sugar was not significantly affected by interaction of sleeving treatment and different chemicals interactions (Table 4.6).

4.10 SHELF LIFE (DAYS)

The mean data on shelf life of banana fruit as influenced by sleeving treatment and chemicals are presented in Table 4.7 and graphically illustrated in Fig. 6.

4.10.1 Effect of sleeving

It is evident from the data (Table 4.7) that the sleeving treatment had no any significant effect on shelf life of fruit. However, the maximum (11.19 days) shelf life of fruit was recorded under non-sleeving treatment (S_0).

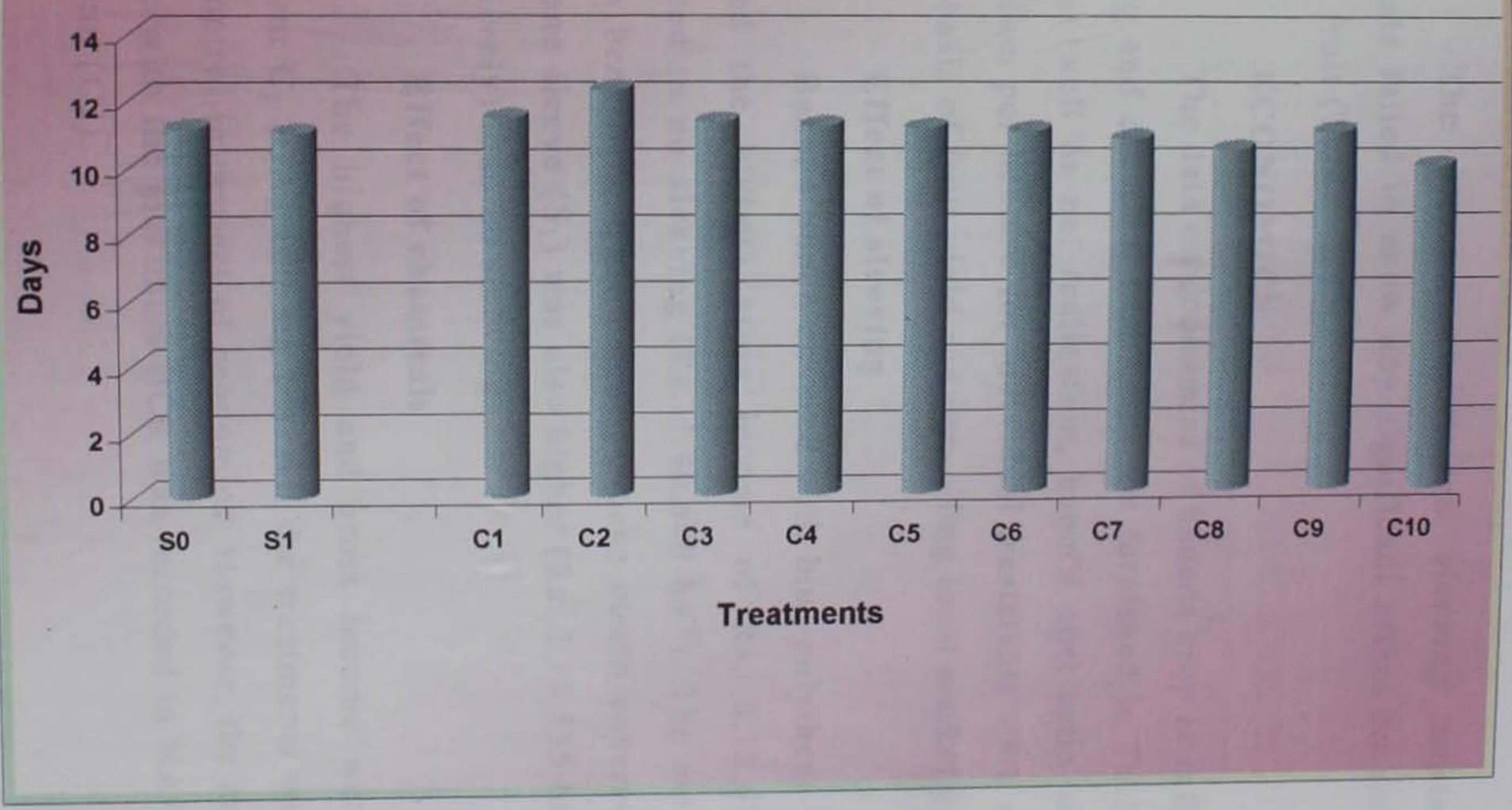
4.10.2 Effect of chemicals

The different chemical treatments had significant effect on shelf life of banana fruit. The data presented in Table-4.7 revealed that significantly the maximum (12.33 days) shelf life was noticed under GA_3 100 mg l^{-1} (C_2) treatment, which was at par with GA_3 50 mg l^{-1} treatment (11.50 days) and NAA 50 mg l^{-1} treatment (11.38 days). Significantly, the minimum shelf life

Table-4.7: Effect of post shooting treatments on shelf life of banana fruit cv. 'Grand Nain'

Treatments	Shelf life (days)
S- Sleeving	
S_0 - No-sleeving	11.19
S_1 - Sleeving	11.04
S. Em.	0.161
CD at 5 %	NS
C - Chemicals	
C_1 - GA_3 50 mg l^{-1}	11.50
C_2 - GA_3 100 mg l^{-1}	12.33
C_3 - NAA 50 mg l^{-1}	11.38
C_4 - NAA 100 mg l^{-1}	11.25
C_5 - 2-4,D 10 mg l^{-1}	11.18
C_6 - 2-4,D 20 mg l^{-1}	11.09
C_7 - Ethephon 0.1 ml l^{-1}	10.85
C_8 - Ethephon 0.2 ml l^{-1}	10.52
C_9 - Urea 2 %	11.07
C_{10} - Control (Water spray)	10.03
S.Em. ±	0.351
CD at 5 %	1.00
Interaction	
S.Em. ±	0.50
CD at 5 %	NS
CV %	7.76

Fig. 6 : Effect of post shooting treatments on shelf life of banana fruit cv. 'Grand Nain'



S0	No-sleeving	C3	NAA 50 mg l^{-1}	C7	Ethephon 0.1 ml l^{-1}
S1	Sleeving	C4	NAA 100 mg l^{-1}	C8	Ethephon 0.2 ml l^{-1}
C1	GA_3 50 mg l^{-1}	C5	2-4,D 10 mg l^{-1}	C9	Urea 2 %
C2	GA_3 100 mg l^{-1}	C6	2-4,D 20 mg l^{-1}	C10	Control (Water spray)

was observed under control, which was at par with C_8 (10.52 days) and C_7 (10.85 days) treatments.

4.10.3 Interaction effect

The interaction between sleeving treatment and chemicals failed to show any significant effect on shelf life of banana fruit (Table 4.7).

4.11 ECONOMICS

The data on economics of banana crop as influenced by sleeving and chemical treatments are furnished in Table 4.8. The gross as well as net realization, benefit cost ratio and cost of cultivation per hectare for individual treatments were worked out on the basis of fruit yield and prevailing local market prices.

4.11.1 Effect of sleeving

Banana bunch covered with blue polythene sleeve (S_1) recorded the highest gross income of Rs. 3,12,611 ha^{-1} as compared to no sleeving (Rs. 1,96,500 ha^{-1}). The net income as well as benefit cost ratio under banana bunch covered with blue polythene sleeve (S_1) was also higher (Rs. 2,20,535 $ha^{-1}$and 2.40, respectively) than no sleeving.

4.11.2 Effect of chemicals

The highest yield and gross income were noted in treatment C_2 (GA_2 100 mg l^{-1}). All the treatments were superior over control in respect of economics. However, the maximum net income with the maximum BCR was recorded in NAA 50 mg l^{-1} treatment (C3).

fruit cv. Grand Nain

Treatments	Yield (t ha^{-1})	Gross income (Rs. ha^{-1})	Cost of treatment (Rs. ha^{-1})	Cost of cultural operations (Rs. ha^{-1})	Total cost (Rs. ha^{-1})	Net income (Rs. ha^{-1})	BCR
S - Sleeving							
S_0. No-sleeving	65.53	196500	-	79375	79375	117125	1.48
S_1. Sleeving	78.15	312611	12700	79375	92075	220535	2.40
C -Chemicals							
C_1 -GA_3 50 mg l^{-1}	78.79	236370	7112	79375	86487	149876	1.73
C_2 - GA_3 100 mg l^{-1}	80.31	240930	14224	79375	93599	147336	1.57
C_3. NAA 50 mg l^{-1}	76.60	229800	330	79375	79705	150086	1.88
C_4. NAA 100 mg l^{-1}	74.30	222900	660	79375	80035	142850	1.77
C_5. 2-4,D10 mg l^{-1}	73.50	220500	76	79375	79451	141053	1.78
C_6. 2-4,D 20 mg l^{-1}	71.82	215460	152	79375	79527	135929	1.77
C_7. Ethephon 0.1 ml l^{-1}	66.44	199320	108	79375	79483	119828	1.51
C_8. Ethephon 0.2 ml l^{-1}	65.01	195030	216	79375	79591	115433	1.45
C_9 - Urea 2 %	69.98	209940	130	79375	79505	130426	1.64
C_{10}. Control (Water spray)	61.69	185070	0	79375	79375	105696	1.33

Cost of cultivation 1. Cost of Urea: Rs. 5.1 kg^{-1}
2. Cost of GA_3: Rs. 112 g^{-1}
3. Cost of NAA: Rs. 5.2 g^{-1}
4. Cost of ethephon: Rs. 850 l^{-1}
5. Cost of 2, 4-D: Rs.6 g^{-1}
6. Cost of blue polythene: Rs.20 bag $^{-1}$ / 5 years i.e. Rs. 4 bag $^{-1}$year^{-1}

Market price of banana fruit:
A. sleeving: Rs. 4 kg^{-1}
B. No sleeving: Rs. 3 kg^{-1}

DISCUSSION

V DISCUSSION

An experiment was conducted to study the response of exogenous application of plant growth regulators and chemicals; namely GA_3, NAA, 2, 4-D, Ethephon and Urea as well as bunch sleeving treatments with blue polythene on banana cv. 'Grand Nain'. The objectives of the experiment were to improve the yield, quality as well as maturity of fruit and to extend the shelf life of fruits. The results, obtained in response to these treatments, have been discussed in this chapter under following headings.

5.1. Effect of sleeving

5.2. Effect of chemicals

5.3. Economics

5.1. Effect of Sleeving

The results of the present investigation revealed that blue polythene covers significantly gave the most promising results by advancing the harvesting of banana bunches as compared to uncovered bunches. The probable reason is that bunch covers raised the average temperature around bunches inside the bag. This might caused a reduction in shooting-harvest interval possibly due to better and advanced filling of fingers by assimilates with the creation of optimum favourable microclimatic condition inside the cover. Debnath *et al.* (2001). These results are in agreement with the findings of Perumal and Adam (1968), Heenan (1973), Ganry (1975), Stevenson (1976),

Robinson and Nel (1984), Gandhi (1984), Parmar and Chundawat (1984), EL-Hammady *et al.* (1985), Daniells *et al.* (1987), Cuneen and McEntyre (1988), Reddy (1989), Daniells *et al.* (1992), Rodrigues *et al.* (2001) Narayana *et al.* (2002) and Bhagwan *et al.* (2002).

It is clearly indicated from the data that the number of fingers and hands per bunch were maximum in sleeving treatment as compared to no sleeving, though the difference was not significant. More or less similar results were obtained by Gandhi (1984), Parmar and Chundawat (1984) and Narayana *et al.* (2002).

It is evident from the results that the length and girth of bunch were significantly the maximum in bunch covers as compared to uncovered ones. The probable reason might be due to rise in atmospheric temperature inside the bag, which increased the length and girth of bunch, (Debnath *et al.* 2001). More or less similar results were also reported by Choudhury *et al.* (1996).

In present investigation bagging bunches with blue olythene cover significantly increased the weight of third hand, eight of bunch and yield per hectare over uncovered bunches. It ight be due to higher atmospheric temperature inside the cover. he increase in weight and yield also might be due to better illing of finger inside the covers. An increase in bunch weight nd yield due to bunch covers was also reported by Rippon and urner (1970), Turner and Rippon (1973), Samson (1980),

Gandhi (1984), Parmar and Chundawat (1984), EL-Hammady *et al.* (1985), Daniells *et al.* (1987 and 1992), Johns (1988) Choudhury *et al.* (1996) and Patel and Patel (2004).

The results of the present studies indicated that, use of polythene covers was most effective in improving finger size length and girth) as compared to uncovered ones. Robinson and Nel (1984) also observed highest length of finger in Cavendish banana with covered bunches against uncovered ones. The beneficial effect of bunch cover on increase in finger length was also reported by Daniells *et al.* (1987 and 1992) and Irizarry *et al.* (1992). An increase in finger length and diameter with bunch cover was also reported by Johns and Scott (1989) and Choudhury *et al.* (1996). The increase in finger size might be due to better filling under bunch cover treatment, which had more temperature than that of open air. The results are in close conformity with the findings of Cuneen and McEntyre (1988) and Patil *et al.* (1989). An increase in fruit size under bunch covers was perhaps due to modification in temperature, humidity and radiation inside the bag. Among the bunch covers, microclimatic changes inside the polythene bag led to the growing conditions very close to theoretical optimum temperature (29 and 30^0 c) for fruit growth in banana as reported by Ganry and Meyer (1975).

It is clear from the data that there was a significant increase in weight of finger in blue polythene covers as compared to uncovered bunch. Bunch covers found most

effective in improving the weight of fingers. These results are in conformity with the findings of EL-Hammady *et al.* (1985) working with 'Hindi' banana in Egypt. Work in support of increase in finger weight was also reported by Reddy (1989). An increase in temperature inside the polythene cover might cause better filling of finger resulting in higher weight, which are also supportted by Cuneen and McEntyre (1988) and Patil *et al.* (1989). Besides, polythene cover allows passing more solar radiation necessary for efficient photosynthesis, which might have led to higher finger weight as compared to uncovered ones. These findings are also close to Narayana *et al.* (2002) and Bhagwan *et al.* (2002).

The data of present investigation clearly showed that weight loss during ripening was significantly low in bunch covers as compared to uncovered bunch. This might be due to slow rate of dehydration and respiration of fruits. These results are also in conformity with those of Parmar and Chundawat (1984) and Gandhi (1984), Perumal and Adam (1968) and Rippon and Turner (1970).

It is clear from the data that pulp: skin ratio was higher in blue polythene covers. The probable reason might be due to more supply of photosynthates, faster conversion of carbohydrates and efficient nitrate reductase activity owing to comparatively higher temperature around the bunches (Parmar and Chundawat, 1984; Gandhi, 1984; and Debnath *et al.*, 2001).

In present investigation sleeving treatment improved he fruit quality in terms of increased TSS, reducing sugar, total ;ugars and decreased titrable acidity. The increase in TSS and otal sugars might be due to higher conversion of starch into ;ugar. These results are also in conformity with those of Perumal ınd Adam (1968), Rippon and Turner (1970), Parmar and :hundawat (1984), Gandhi (1984) and Choudhury *et al.* (1997).

The results of the present studies clearly indicated hat blue polythene covers accelerated the ripening whereas, it was delayed in uncovered bunches however, failed to reach the evel of statistical significance. The probable reason might be lue to degradation of chlorophyll during ripening and increase in :ndogenous level of ethylene, which favoured early ripening.

In blue sleeving, certain amount of energy of electromagnetic radiation is reflected and temperature rises. Hence, probably there was no sunburn effect in blue sleeving. Sleeving has now accepted as a commercial practice in some banana exporting countries of the world, for producing high quality fruit. This practice was also found to provide some protection against the problem of pre-mature ripening from which the present banana industry of south Gujarat suffers. The problem of sunburn (scorching effect) in banana can be avoided by covering the banana bunches with polythene sleeves lined with paper inserts. However, this part needs extensive field study.

Effect of chemicals

It is clear from the data that the application of thephon gave the most promising results by advancing the arvesting of banana bunches irrespective of their oncentrations. The best results, however, were noticed in thephon 0.2 ml l^{-1} as compared to control. The activity of thephon has been attributed primarily to its ability to release thylene in plant tissues. Ethylene stimulates respiration and rotein synthesis in certain immature fruits, which may trigger a hain of biochemical events required for ripening. Presently thylene is considered to be one of the main ripening phyto-ormone and plant responses, which were formerly believed to e due to presence of auxins, are now being ascribed to induced thylene production (Burg and Burg, 1966). Further, the dramatic influence of ethylene on fruit maturity and ripening has been demonstrated. Similar findings are in conformity with those of Deshmukh and Chakrawar (1980), Parmar and Chundawat (1984) and Gandhi (1984).

The spray of urea delayed the harvesting over control. This might be due to urea as a nitrogenous fertilizer and is well known for its growth promoting activity in plant tissues. Urea can be expected to prolong the growth period of developing fruits by keeping them in an active stage of growth Gandhi (1984).

In present investigation 2, 4-D also significantly delayed the harvesting as compared to control. The probable

reason might be that 2, 4-D as auxin implicated the cell division and growth promotion process. More or less similar results were obtained by Parmar and Chundawat (1984) and Gandhi (1984).

The spray of NAA also tended to delay the harvest period in general as compared to control. NAA is a synthetic auxin and auxins are well known for their growth promoting activity in plant tissues through RNA and protein synthesis. Therefore, NAA can be expected to prolong the growth period of growing banana fruits, by keeping them in active stage of growth, ultimately resulting in the delayed maturity. The delayed effects of NAA in fruit maturity are in accordance with the results of Parmar and Chundawat (1984) and Gandhi (1984).

In contrast to ethephon, a progressive and consistently the more time taken for harvest as well as ripening were observed in application of GA_3 as compared to control. Gibberellins are phytho-hormones, known to contribute to growth by both ways, namely cell division and cell elongation. After anthesis, it is the cell expansion and cell density, which contribute the most for fruit growth, and as such, a positive correlation between growth of fruit tissues and gibberellin level is well known (Jackson and Coombe, 1966; Iwahari *et al.* 1968 and Wiltbank and Kretdorn, 1969). Higher level of GA_3 through exogenous application in the present investigation, might have kept the protein synthesis in an active state, allowed the fruit to continue growth for longer period, and thus delayed the maturity. These findings are close to those of Lockard (1975).

In the present investigation, number of fingers as well as hands per bunch were found to be non-significant due to chemicals. The probable reason could be that the plant regulators were applied after complete opening of inflorescence, whereas, the number of hands and fingers were already fixed at initiation of inflorescence from underground stem long before. The findings are supported with those of Parmar and Chundawat (1984) and Gandhi (1984).

The results of the present studies revealed that the spray of GA_3 at both the concentrations increased the length and girth of bunch, weight of third hand as well as bunch weight, length, and girth of finger as compared to control. Gibberellins are phytho-hormones, known to contribute the growth by both ways, namely cell division and cell expansion. After anthesis, it is the cell expansion and cell density, which contribute the most for fruit growth, and as such, a positive correlation between growth of fruit tissues and gibberellin level is well known (Jackson and Coombe, 1966; Iwahari *et al.* 1968 and Wiltbank and Kretdorn, 1969). Higher level of gibberellins, through exogenous application in the present investigation, might have kept the protein synthesis in an active state and allowed the fruit to continue growth for longer period. The increase in weight associated with fruit growth, is largely as a result of cell division and cell elongation and therefore, is responsible for increase in fruit size as well as fruit weight, which has contributed to an over all increase in yield. It is already well established that GA_3 does bring about certain metabolic changes, which are reflected

y more accumulation of food constituents in the fruit and nereby through increased weight of an individual berry and unch as well. The increase in berry size with gibberellins is resumably primarily due to augmentation of the native supply f those hormones; which, in present investigation have also een found to markedly increase the berry size, when given at he time of flowering and a month later. Favorable effect of GA_3 n increasing the size of seedless fruits is now a well-established act (Weaver, 1972). These findings are in conformity with thers in banana by Lockard (1975), Deshmukh and Chakrawar 1980), Arvindakshan (1981), Mishra *et al.* (1981), Parmar and Chundawat (1984), Gandhi (1984), Satyanarayana (1985), Chattopadhyay and Jana (1988), Pradhan *et al.* (1988) and Kumar et *al.* (1998).

The weight loss during ripening was significantly influenced by chemical sprays. Weight loss of fruit during ripening decreased as the concentration of ethephon increased. The probable reason for lesser weight, with an increase in concentration of ethephon, is that ethephon accelerates the chain of biochemical events required for ripening. Hence, it could be presumed that fruits under ethephon treatments took minimum time for ripening and thereby resulted in the minimum losses. However, maximum weight loss was noticed in control. This might be due to rapid rate of dehydration and respiration of fruits. More or less similar results were noticed by Parmar and Chundawat (1984) and Gandhi (1984).

The results of the present studies indicated that pulp: kin ratio was significantly higher in application of NAA as ompared to control. The probable reason might be due to more upply of photosynthates, faster conversion of carbohydrates. hese findings are in conformity with those of Parmar and hundawat (1984) and Gandhi (1984).

In present investigation, with respect to quality of anana fruit, both the concentrations of GA_3 recorded ignificantly higher TSS as compared to control. Increase in TSS s because of more accumulation of metabolites during the fruit levelopment and GA_3 is well known for its capacity to attract netabolites from other regions of the plant (Crane, 1965). Looking to an increase in TSS, total sugars and minimum acidity with GA_3, fruit quality is bound to improve due to increased sweetness of the fruit pulp. More or less, similar findings are supported by Tomi *et al.* (1970), Deshmukh and Chakrawar (1980), Arvindakshan (1981), Parmar and Chundawat (1984) and Gandhi (1984), Satyanarayana (1981), Chattopadhyay and Jana (1988), Kumar *et al.* (1998) and Athani *et al.* (1999).

The results of the present studies revealed that application of ethephon reduced the titrable acidity as compared to control. An increase in total soluble solids and sugars is mainly due to starch hydrolysis. Similarly, Aziz and EL- Tanahy (1975) recorded increase in total soluble solids and total sugars in banana with the application of ethephon. Parmar and Chundawat (1984) sprayed 0.25 ml l^{-1} ethephon, recorded

increased TSS, total sugars, and reduced acidity in basrai anana. More or less similar, findings are also reported by jandhi (1984).

The results revealed that of GA_3 significantly increased he total sugars as compared to control. This might be due to igher accumulation of metabolites in developing fruits helped in his activity. Plant regulators are known to function in plants as a nobilizer of metabolites and increased level of TSS and sugars in the treatment is the result. This findings are in conformity with Tomi *et al.* (1980), Deshmukh and Chakrawar (1980), Parmar and Chundawat (1984) and Gandhi (1984).

In present investigation, it was observed that GA_3 delayed the ripening as compared to control. This might be due to GA_3 induced enzyme synthesis and delayed degradation of chlorophyll during ripening. More or less similar, findings are also obtained by Gandhi (1984) and Parmar and Chundawat (1984).

3.3 Economics

Economics is the major consideration for the farmers while taking a decision regarding the adoption of a new technology, hence the cost of cultivation, gross income, net income and benefit cost ratio were computed for sleeving and chemical treatments.

Effect of Sleeving

The highest net income with highest benefit cost ratio were recorded under sleeving treatment, which was due to higher

yield of quality fruit, which fetched higher price in the market. Though the sleeving material cost was higher, but it can be re used for another four years. Therefore, year wise cost reduced by five times. These findings are also obtained by Gandhi (1984) and Parmar and Chundawat (1984).

Effect of chemicals

The highest yield and gross income were recorded in GA_3 100 mg l^{-1} (C_2) but higher cost of GA_3 nullifies the higher gross income. All the treatments gave higher net income and higher benefit cost ratio over control. However, the highest cost benefit ratio was maximum in NAA 50 mg l^{-1} (C_3) which was due to lower cost of NAA. Similar findings were also obtained by Gandhi (1984) and Parmar and Chundawat (1984).



Plate-2: Banana bunch covered with blue sleeve



Plate-3: Size of finger in control (C_{10}) treatment



Plate-4: Size of finger in GA_3 100 mg l^{-1}(C_2) treatment



Plate-5: Banana bunch harvested from no sleeving (S_0) and sleeving (S_1) treatment

SUMMARY AND CONCLUSIONS

VI SUMMARY AND CONCLUSION

An experiment was conducted during the year 2005 at Regional Horticultural Research Station, Navsari Agricultural University, Navsari to assess the performance of post shooting treatments on yield, quality and maturity of banana (*Musa paradisiaca* L.) cv. 'Grand Nain' in South Gujarat conditions. The salient features of the results presented and discussed in preceding chapter are epitomized here under.

6.1 Effect of sleeving

6.1.1 Significantly, the minimum days taken from flowering to harvesting were noticed in sleeving treatment (S_1) as compared to no-sleeving treatment (S_0).

6.1.2 Number of fingers and number of hands per bunch did not significantly differ with each other due to sleeving treatments.

6.1.3 The bunch characters of banana cv. 'Grand Nain' in terms of length and girth of bunch and weight of third hand was superior in sleeving (S_1).

6.1.4 Weight, length and girth of finger was maximum under sleeving (S_1).

6.1.5 Weight loss during ripening was significantly minimum under sleeving (S_1), whereas pulp: skin ratio was found to be non-significant.

6.1.6 The weight of bunch and yield per hectare were maximum under sleeving (S_1) as compared to non-sleeving (S_0).

6.1.7 The quality characters of banana cv. 'Grand Nain' in terms TSS, acidity, total sugar and reducing sugar were superior in sleeving (S_1).

6.1.8 Shelf life of banana fruits cv. 'Grain Nain' was superior under sleeving (S_1).

6.2 Effect of chemicals

6.2.1 Significantly, minimum days taken from flowering to harvesting were noticed in the banana cv. Grain Nain when bunches were sprayed with ethephon 0.2 ml l^{-1} (C_8).

6.2.2 Number of fingers per bunch and number of hands per bunch did not significantly difference with each other due to different chemical treatments.

6.2.3 The bunch characters of banana cv. 'Grand Nain' in terms of length and girth of bunch and weight of third hand was the maximum under GA_3 100 mg l^{-1} (C_2).

6.2.4 The finger characters of banana cv. 'Grand Nain' like weight, length and girth of finger was superior when banana bunches were sprayed with GA_3 100 mg l^{-1} (C_2).

6.2.5 Weight loss during ripening was significantly minimum under ethephon 0.2 ml l^{-1} (C_8), whereas pulp: skin ratio was the maximum under NAA 100 ml l^{-1} (C_4).

6.2.6 The weight of bunch and yield per hectare was maximum under GA_3 100 mg l^{-1} (C_2).

6.2.7 The quality characters of banana cv. 'Grand Nain' in terms of total sugars and reducing sugar was superior in GA_3 100 mg l^{-1} (C_2) while, TSS was maximum in GA_3 50 mg l^{-1} (C_1) and acidity was minimum under ethephon 0.2 ml l^{-1} (C_8).

6.2.8 Shelf life of banana fruits cv. 'Grain Nain' was superior under GA_3 100 mg l^{-1} (C_2).

6.3 Interaction effect

The interaction between sleeving treatment and chemicals failed to show any significant effect on all characters.

6.4 Economics

The highest BCR was obtained in sleeving (S_1) and NAA 50 mg l^{-1} treatment (2.40 and 1.88, respectively) with net returns of Rs. 220535 and Rs. 150086 ha^{-1}, respectively.

CONCLUSION

Based on the results obtained from the present investigation following inferences may be drawn.

1. The banana bunches covered with blue polythene sleeve shortened the maturity period of cv. 'Grain Nain' banana and produced superior quality bunches with large fingers and maximum production with better quality fruits and maximum shelf life as compared to no-sleeving.

2. The banana bunches cv. 'Grain Nain' when sprayed with ethephon 0.2 ml l^{-1} shortened the maturity period; minimize weight loss during ripening and acidity. Whereas, bunches sprayed with GA_3 100 mg l^{-1} produced maximum yield contributed by superior quality, bigger size fingers with higher shelf life of banana fruits. Whereas, pulp: skin ratio and TSS was the maximum under NAA 100 mg l^{-1} and GA_3 50 mg l^{-1}, respectively.

3. From economic point of view the highest net returns along with maximum benefit cost ratio (BCR) was noted in sleeving and NAA 50 mg l^{-1} treatment individually.

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APPENDICES

APPENDIX- I: Meteorological data during the year 2005

Months	Temperature (^{0}C)		Rainfall (mm)	Rainy days	Relative humidity (%)		Sunshine hours
	Max.	Min.			AM	PM	
May	34.1	27.1	0.0	-	86	51	10.8
June	32.7	28.6	1243.8	8	83	66	7.4
July	30.2	27.4	466.5	11	89	78	3.5
August	29.4	25.8	329.2	17	86	77	4.1
September	29.8	25.5	388.2	16	92	80	4.1
October	34.3	22.7	0.0	-	84	48	8.3
November	33.7	18.2	0.0	-	70	31	9.5
December	30.2	14.4	0.0	-	74	34	8.4

Source: Agricultural Meteorological Observatory, N. M. College of Agriculture, Navsari

APPENDIX-II: District wise area and production (estimated) of banana in Gujarat State in year 2004-2005

Sr. No.	District	Area (ha)	Production (MT)
1	Ahmedabad	194	6984
2	Amreli	0	0
3	Banaskantha	0	0
4	Bharuch	11969	502698
5	Narmada	4403	189329
6	Bhavnagar	65	1625
7	Dang	2	25
8	Gandhinagar	2	56
9	Jamnagar	0	0
10	Junagadh	1700	47600
11	Porbandar	0	0
12	Kutch	668	26720
13	Kheda	248	8184
14	Anand	9361	430606
15	Mehsana	0	0
16	Patan	0	0
17	Panchmahal	200	7000
18	Dahod	0	0
19	Rajkot	0	0
20	Sabarkantha	375	11625
21	Surat	10260	513000
22	Surendranagar	0	0
23	Vadodara	6185	204105
24	Valsad	290	10150
25	Navsari	425	19550
Total		**46347**	**1979257**

Source: - Directorate of Horticulture, Gandhinagar (Gujarat State)

APPENDIX-III: State wise area and production (estimated) of banana fruit crop in year 2002-2003

Sr. No.	State / UT'S	Area (in'000 ha)	Production (in'000 MT)
1	Andra Pradesh	46.8	1096.9
2	Arunachal Pradesh	4.4	13.8
3	Assam	42.6	589.6
4	Bihar	27.5	439.7
5	Chhatisgarh	0.5	21.9
6	Delhi	0.0	0.0
7	Goa	2.1	15.7
8	Gujarat	35.2	1403.1
9	Haryana	0.0	0.0
10	Himachal Pradesh	0.0	0.0
11	Jammu and Kashmir	0.0	0.0
12	Jharkhand	0.8	24.8
13	Karnataka	52.6	1286.3
14	Kerala	50.9	375.9
15	Madhya Pradesh	16.2	653.8
16	Maharashtra	57.4	3607.6
17	Manipur	1.9	14.8
18	Meghalaya	5.3	65.7
19	Mizoram	3.0	9.2
20	Nagaland	1.0	18.3
21	Orrisa	19.7	234.6
22	Punjab	0.0	0.0
23	Rajasthan	0.0	0.0
24	Sikkim	0.0	0.0
25	Tamil Nadu	76.8	2836.9

Cont.....

26	Tripura	5.0	63.7
27	Uttaranchal	0.0	0.0
28	Uttar Pradesh	1.5	55.0
29	West Bengal	22.0	452.5
30	Andaman Nicobar	1.6	7.9
31	Chandigarh	0.0	0.0
32	Dadar and Nagar Haveli	0.0	0.0
33	Daman and Diu	0.0	0.0
34	Lakshdweep	0.1	0.4
34	Pondicherry	0.4	15.6
Total		**475.3**	**13304.4**

Source: Indian Horticulture Database, 2004. National Horticulture Board

CERTIFICATE

This is to certify that I have no objection to supply one copy of any part of this thesis at a time to any scientist through reprographic process for rendering reference services in a library or documentation centre.

Place : Navsari.

Date : June 22, 2006

Patel C.M.

(PATEL CHETNABAHEN M.)