STUDIES ON BUNCH MANAGEMENT PRACTICES IN TISSUE CULTURE BANANA (*Musa spp.*) cv. GRAND NAINE

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Dr. Y.S.R. HORTICULTURAL UNIVERSITY

OCTOBER, 2014

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BY

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B.Sc. (Hons.) Horticulture

THESIS SUBMITTED TO

Dr.Y.S.R. HORTICULTURAL UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

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(FRUIT SCIENCE)

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OCTOBER, 2014

DECLARATION

I, Ms. M.ANUSHA, hereby declare that the thesis entitled "**STUDIES ON BUNCH MANAGEMENT PRACTICES IN TISSUE CULTURE BANANA (*Musa spp*.) cv. GRAND NAINE"** submitted to Dr.Y.S.R. Horticultural University, Venkataramannagudem, for the Degree of Master of Science in Horticulture (Fruit Science) is the result of original research work done by me. I declare that no material contained in the thesis has been published earlier in any manner.

Place : Anantharajupet

Date : 6/12/2014

Name : M. ANUSHA

I.D.No : AHM/12-01

CERTIFICATE

Ms. M.ANUSHA has satisfactorily prosecuted the course of research and that the thesis entitled **"STUDIES ON BUNCH MANAGEMENT PRACTICES IN TISSUE CULTURE BANANA (*Musa spp*.) cv. GRAND NAINE"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination.

I certify that neither the thesis nor its part there of has been previously submitted by her for a degree of any University.

Place : ANANTHARAJUPET **(Dr.C.MADHUMATHI)**

Date : 6/12/2014 **Chairman**

CERTIFICATE

This is to certify that the thesis entitled **"STUDIES ON BUNCH MANAGEMENT PRACTICES IN TISSUE CULTURE BANANA (*Musa spp.*) cv. GRAND NAINE"** submitted in partial fulfillment of the requirements for the degree Master of Science in Horticulture (Fruit Science) of Dr.Y.S.R. Horticultural University, Venkataramannagudem, is a record of the bonafide research work carried out by **Ms. M. ANUSHA** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigations have been duly acknowledged by the author of the thesis.

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Marella Anusha

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LIST OF SYMBOLS AND ABBREVIATIONS

%	:	per cent
&	:	and
@	:	at the rate of
^{0}B	:	degree brix
^{0}C	:	degree Celsius
2,4-D	:	2,4- dichloro phenoxy acetic acid
A.M.	:	Anti Meridian
ANOVA	:	Analysis of Variance
AS	:	Ammonium sulphate
ATP	:	Adeninosine Triphosphate
B:C	:	Benefit Cost Ratio
Ca	:	Calcium
CD (P=0.05%)	:	Critical difference at 5% level
Cm	:	centimetre
cm^2	:	Square centimetre
Cu	:	Copper
cv.	:	Cultivar
DAFB	:	Days after full bloom
DNA	:	Deoxyribo nucleic acid
dsm^{-2}	:	Decisiemen per square meter
E.C	:	Electrical conductivity
et al.	:	and others
etc.	:	and so on; and other people / things
Fe	:	iron
Fig.	:	Figure

FYM	:	Farm yard mixture
g	:	grams
GA_3	:	Gibberellic acid
ha	:	hectare
i.e.,	:	that is
IPI	:	International potash institute
K	:	Potassium
K^+	:	Potassium ions
K_2SO_4	:	Potassium sulphate
Kg	:	Kilogram
KH_2PO_4	:	Potassium dihydrogen phosphate
KNO_3	:	Potassium nitrate
m^{-2}	:	Per square meter
Mg	:	Magnesium
Mha	:	Million hectares
min	:	minute
MKP	:	Monopotassium phosphate
ml	:	millilitres
mm	:	Millimeter
MMT	:	Million metric tonnes
Mn	:	Manganese
N	:	Nitrogen
NAA	:	Naphthalein acetic acid
NaoH	:	Sodium hydroxide
No.	:	Number
NS	:	Not significant
P	:	Phosphorus
P.M.	:	After noon / Post Meridian

PDP	:	Potassium dihydrogen phosphate
pH	:	Puissance de hydrogen
$Plant^{-1}$	:	Per plant
PN	:	Potassium nitrate
ppm	:	Parts per million
PS	:	Potassium sulphate
PSB	:	Phosphorus Solubilising Bacteria
RBD	:	Randomised Block Design
RNA	:	Ribo nucleic acid
S	:	Sulphur
S.Em ±	:	Standard error mean
SOP	:	Sulphate of potash
sp.	:	Species
TSS	:	Total Soluble Solids
viz.	:	Namely
Wt	:	Weight
Zn	:	Zinc

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ABSTRACT

The present investigation entitled **"Studies on Bunch Management Practices in Tissue Culture Banana (*Musa spp*.) cv. Grand Naine"** was carried out at Horticultural College and Research Institute, Anantharajupet during 2013-14. The experiment was laid out in a randomized block design replicated thrice with fourteen treatments. The treatment comprised of spraying the whole plant just after bunch emergence with different chemical combination and by adopting bunch feeding technique using cowdung in combination with different chemicals. The bunch yield attributes and quality parameters were studied.

With respect to yield parameters, less number of days for fruit maturity (86.90 days), the highest finger length (21.90cm), finger girth (13.81 cm), finger weight at harvest (153.55g), bunch weight (22.84 kg), hand weight (3.08 kg) and pulp weight (100.46g) were observed with spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea. Whereas, the highest finger weight after ripening (129.77g) was recorded in treatment with spraying of 0.5% potassium sulphate + 0.5% urea.

The highest peel weight (44.04g) was noticed in the treatment of bunch feeding with cowdung slurry containing 0.5% potassium nitrate + 0.5% potassium dihydrogen phosphate. Maximum thicknesses of peel (3.35mm) was observed in control (without any spray and bunch feeding). The highest pulp to peel ratio was recorded in spraying of 0.25% potassium nitrate + 0.25% potassium dihydrogen phosphate (2.76).

With regard to fruit quality parameters, less acidity (0.141 %), the highest total soluble solids (23.3^0B), total sugars (18.75%), reducing sugars (7.66%) and non-reducing sugars (11.09%) were observed in the treatment with spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea.

In respect of physiological characters, bunch feeding with cowdung slurry containing 0.5% potassium nitrate + 0.5% potassium dihydrogen phosphate (13.34 %) had attained least physiological loss in weight. The treatment, spraying of 0.5% potassium dihydrogen phosphate recorded the highest shelf life of 11.63 days. Spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea was superior in terms of maximum gross returns (319000.00), net returns (209590.37) and benefit-cost ratio (1.91).

Chapter-I

Introduction

CHAPTER – I

INTRODUCTION

Banana (*Musa paradisiaca*) is botanically berry, belongs to the family Musaceae and it is monocotyledonous, perennial, herbaceous succulent plant. It is known for their antiquity that is interwoven with Indian heritage and culture and it is one of the most important fruits grown and consumed worldwide. It is also called as Apple of Paradise or Fruit of heaven. Owing to its multifaceted uses of various parts ranging from underground stem to male flower, it is referred to as ‘‘Kalpataru’’ (the divine tree of life). It is considered as one of the most important energy producing foods, cheap, highly nutritious and easily digestible fruit with refreshing aroma. It grows well in humid tropical low lands and is predominantly distributed between 30^0 N and 30^0S of equator.

India is the largest producer of banana in the world. It is grown in an area of 0.776 Mha with an annual production of 26.51 MMT (Indian Horticulture database, 2013). Andhra Pradesh ranks fourth both in production and productivity of banana in India. It is widely grown in East and west Godavari, Guntur, Vizayanagaram, Kurnool and Kadapa districts.

In banana inspite of feeding the plants with recommended quantity of major and micro nutrients through soil by mineral, organic and biological means, the uptake and utilization of nutrients by plants is inadequate resulting in poor growth of the bunch and fingers. Particularly the fingers at the distal end of the bunch remain poorly developed owing to an adverse competition of the top hands with those located at the lower end of the bunch. This reduces both the total weight as well as its overall appearance leading to a lower profitability. This has been the major constraint faced by the banana growers irrespective of the variety of banana grown.

Lack of proper bunch management practices results in substandard fruits with low quality which fetches low market price. Under traditional farming system banana requires high amount of nutrients for proper growth and production. It receives last dose of fertilizers (nitrogen and potassium) at 7^{th}

month after planting *i.e.,* just before shooting, which has to support the requirement of nutrients until harvest. Since large quantity of photosynthatates are to move from source to sink *i.e.,* developing bunches, any limitation in the supply of nutrients at this crucial stage affects the bunch size and quality. Soil characters and environmental factors may cause considerable loss to nutrients applied to the soil leading to insufficient nutrient supply to the developing bunch. Because of this problem, poor filling and development of fingers is often reported. Hence an additional dose of fertilizer after shooting has become imperative.

However, it is not advisable to go for soil application of fertilizer at finger development stage, since the uptake is slow and low at this stage (Veerannah *et al.,* 1976). Many reports have indicated the usefulness of post shooting spray of various nutrients during fruit development influence the fruit yield, shelf life and quality (Kannan, 1980). During fruit development phase, the plant nutrient status and uninhibited flow of nutrients to the developing bunch increases the bunch size and quality of fruits. Foliar application of nutrients and the technique of bunch feeding provide a considerable scope not only for the effective utilization of nutrients but also safe guard the economy of the farmer by improving the yield potential and quality of the produce.

In high value crop like banana, quality standards have become the most important factor which influences the yield and farmer's income. Indian banana has lot of demand in export market, so we have to grow banana on large scale with quality standards for export and also for getting higher yields. Among the various nutrients, major nutrients play a very important role in deciding the quality of fruits. Nitrogen is a very important nutrient for the growth and development of the plant. Potassium is highly mobile in plants at all levels, from individual cell to xylem and phloem transport. Potassium also considered as a key element in fruit production and quality worldwide. Hence, there is a need to adopt systemic and sustained bunch management practices to meet this increasing demand.

In banana, simple practices like spraying with different chemicals at different intervals and bunch feeding techniques has been found to affect yield (Shira *et al*., 2012 and Kotur *et al*., 2010). Grand Naine (AAA), a member of Cavendish group of banana is very popular and commercially grown in Rayalaseema region of Andhra Pradesh and marketing of banana bunches were done on weight basis in this region. Hence any good bunch management practice can increase the weight and quality of banana will have greater impact inturns of bringing good returns to the farmers. With all these background an investigation was carried out to assess the effect of post shooting foliar application of urea, ammonium sulphate, potassium nitrate, potassium sulphate, potassium dihydrogen phosphate and bunch feeding techniques of these chemical combinations with fresh cowdung on yield and quality of banana particularly to meet the quality standards in terms of size and ultimate bunch yield in tissue culture Banana cv. Grand Naine.

Objectives of investigation

1. To study the influence of different bunch management practices on yield of banana.
2. To study the influence of different bunch management practices on fruit grade and quality of banana.

Chapter-II

Review of Literature

CHAPTER - II

REVIEW OF LITERATURE

The available literature on influence of preharvest foliar sprayings and bunch feeding treatments of urea, potassium sulphate, ammonium sulphate, potassium nitrate, potassium dihydrogen phosphate and their combinations on yield and quality aspects of banana and other fruit crops have been reviewed in this chapter.

2.1 Effect of urea on yield parameters

Venkatarayappa *et al.* (1976) studied the beneficial effect of urea spray on Dwarf Cavendish and Giant Cavendish banana and observed a remarkable positive influence on length, girth, weight of hand and bunch yield when 2% urea was applied to the plant as well as the bunch at 15 and 21 days after shooting.

Buragohain and Shanmugavelu (1986) also tried three concentrations (1%, 2%, 3%) of urea spray in Vayal Vazhai (ABB) banana which was applied to the bunch after the last hand had opened. They noticed that 3% urea spray was very much effective in increasing the bunch weight and in inducing the early maturity.

Patel and Patel (1987) from their studies on effect of foliar applications of urea on maturity and yield of banana cv. Basrai observed that foliar spray of urea @ 4% produced the highest fruit yield (20.57 kg/plant).

Ancy *et al.* (1998) studied the urease activity in banana fruit and revealed that use of urea as an additional dose of fertilizer to the bunch stalk end and as urea spray not only enhanced urease activity in fruits of banana but also increased the bunch characters. Combination of 2nd week pruning of male bud with 30g urea placement and foliar spray of 5% urea had increased the bunch weight with excellent finger characteristics, like finger weight and grade.

Ghosh and Chattopadhyay (1992) studied the foliar application of urea on yield and physico-chemical composition of mango fruits cv. Himsagar under rainfed condition and reported that three applications of 4% urea resulted in the highest fruit yield per tree (mean 41.7 kg/tree), whereas fruit weight was the highest (259 g) with 3% urea.

Ancy and Kurien (2000) analysed the effect of urea feeding at the cut stalk end of tissue culture Nendran banana. This experiment revealed that placing 30g urea on the cut stalk end at 2 or 4 weeks after complete emergence of the bunch resulted in maximum yield, bunch weight, and finger weight, filling index, length and grade of finger.

Yadav (2001) observed that fruit size and fruit weight of ber was improved with the foliar spray of 3% urea and 1.5% potassium sulphate in combination.

Gorakh *et al.*(2002) recorded the highest fruit weight when 25% urea was applied as foliar spray in guava cv. Allahabad safeda.

Bhati and Yadav (2003) observed the effects of foliar application of urea and NAA on the yield parameters of ber (*Ziziphus mauritiana* Lamk.) cv. Gola. The results showed that the greatest fruit length (3.304 cm), fruit breadth (3.222 cm), fruit weight (18.868 g), pulp to stone ratio (11.68), fruit retention (55.96%), yield per tree (54.32 kg) and benefit cost ratio (2.57) were obtained with 2% urea spray.

Gupta and Brahmachari (2004) observed that 4% urea spray on mango cv. Bombai resulted significantly maximum fruit size, fruit weight and fruit yield.

Mahendra *et al. (*2007) studied the effect of foliar application of nutrients on physico-chemical attributes of phalsa. The results showed that combined spray of zinc sulphate @ 0.4% + urea @ 2% + potassium sulphate @ 0.2% attained maximum fruit length, fruit breadth and fruit weight.

Dutta and Banik (2007) observed maximum fruit length, individual fruit weight, crop yield and ascorbic acid content in the treatment combination of urea + K_2SO_4 + zinc + NAA as foliar spray in guava cv. Sardar.

According to Anju *et al.* (2008) maximum fruit size in terms of length and breadth, fruit weight, volume and yield were obtained with 2% urea spray. However, maximum specific gravity recorded with 1% urea spray in guava cv. Sardar.

Ramezanian *et al.* (2009) examined the effects of foliar application of calcium chloride and urea on quantitative and qualitative characteristics of pomegranate fruits. The results showed that urea at concentrations of 1% and 2% significantly increased aril size, fruit length and diameter.

Shinde and Haldankar (2010) concluded that foliar application of urea @ 0.5% twice increased the length, breadth, circumference and fruit weight in kokum.

Shira *et al.* (2012) studied bunch management techniques in banana cv.cultivar Martman for improving yield and quality. The results revealed that maximum bunch weight, hand weight, finger weight and highest yield were obtained with the treatment combination of 500g fresh cowdung with 20g urea.

Sharad *et al.* (2011) concluded that application of 2% urea in combination with 2% calcium nitrate significantly improved the fruit diameter, fresh fruit weight, specific gravity, stone weight, pulp- stone ratio, moisture content and yield of aonla cv. NA-7.

Rhman *et al.* (2014) studied the effect of foliar sprays of urea and zinc on yield and physico-chemical composition of ber. The results revealed that urea at 1% or 2% concentration with zinc at both 0.4% and 0.6% increased the fruit weight, fruit length, fruit width, fruit volume and fruit diameter.

Babul and Rahim (2013) from their studies on foliar application of potassium nitrate and urea on mango revealed that the plants treated with 4% urea produced the biggest fruits.

Sayyad and Shahsavar (2013) examined the influence of foliar application of boric acid, urea and zinc sulphate on quantitative traits of olive fruits, they observed increase in fruit diameter with foliar application of urea at 5% concentration at first harvest. The highest fruit weight and diameter observed at 5% urea and 4% zinc sulphate along with 4% boric acid + 7.5% urea at second harvest respectively.

Zaeneldeen (2014) studied the effect of foliar application of urea on productivity of Succary Abiad mango trees. The results revealed that foliar application of urea at 2% in combination with GA_3 at 50 ppm thrice improved the productivity.

Giriraj and Kacha (2014) observed that 1.5% urea treatment as foliar spray gave significantly the maximum number of fruit retention (63.17 %), fruit weight (155.47 g), highest number of fruits per plant (511.07) and yield of guava fruits (22095 kg/ha).

2.2 Effect of urea on fruit quality parameters

Patel and Patel (1987) observed that foliar spray of urea @ 1% recorded maximum total sugars in fruits (15%) of banana cv. Basrai.

Surender and Ahlawat (1995) noticed an improvement in total soluble solids, ascorbic acid contents and low acidity in ber fruits with foliar application of 1.5% urea and 0.5% zinc sulfate.

Ghosh and Chattopadhyay (1992) studied the foliar application of urea on yield and physico-chemical composition of mango fruits cv. Himsagar under rainfed condition and reported that three applications of 4% urea resulted in the highest TSS and total sugar contents.

Yadav (2001) observed improvement in total soluble solids and total sugars with the foliar spray of 3% urea and 1.5% potassium sulphate in combination, which also resulted in decreasing the acidity in case of ber.

Foliar application of 25% urea on guava cv.Allahabad safeda resulted in the highest fruit TSS, ascorbic acid and reducing sugar content (Gorakh *et al*., 2002).

Bhati and Yadav (2003) recorded the maximum total sugars (11.65%), reducing sugars (4.43%) and minimum titrable acidity (0.15%) in fruits when 2% urea was applied as foliar spray in Ber cv. Gola.

Nirmaljit *et al.* (2005) reported that 1% urea application registered the best quality fruits in case of kinnow mandarin.

Satheesh and Bangaruswamy (2006) from their experiment of post shooting application of certain nutrients on fruit quality and post harvest storage life of banana cv. Rasthali noticed maximum non-reducing sugar content with 4% urea spray.

Mahendra *et al. (*2007) recorded that combined spray of zinc sulphate @ 0.4% + urea @ 2% + potassium sulphate @ 0.2% attained maximum juice percentage, TSS, total sugars, ascorbic acid content and minimum acidity in phalsa fruits.

Anju *et al.* (2008) recorded maximum total soluble solids with 1% urea spray in guava cv. Sardar.

Shinde and Haldankar (2010) recorded the highest TSS content with foliar application of urea @ 0.5% in kokum fruit.

Sharad *et al.* (2011) recorded increased TSS, acidity, ascorbic acid and total sugars with the foliar application of 2% urea in combination with 2% calcium nitrate in case of aonla cultivar NA-7.

2.3 Effect of potassium sulphate on yield parameters

Kumar and Kumar (2007) concluded that SOP @ 1.5% as foliar spray during the post shoot growth stage of banana cv. Ney Poovan significantly increased yield, quality and economic traits over control.

Kumar *et al.* (2008) recorded the highest bunch weight, finger weight and pulp to peel ratio with the foliar spray of 1.5% concentration of sulphate of potash twice (first immediately after opening of the last hand and second 30 days after the first spray) in banana cv. Robusta.

Kumar and Kumar (2009) concluded that post shooting application of either SOP at 1.5% concentration or combination of 0.5% potassium dihydrogen phosphate + 1% urea + 20ppm 2,4-D as foliar spray twice, first at the time last hand emergence and second 30 days after first spray to produce bunches with less number of maturity days and maximum bunch weight, finger weight and pulp to peel ratio in banana cv. Nendran.

Singh and Shailendra (2011) studied the effect of cycocel, potassium sulphate and benlate on morphology and fruit quality of ber (*ziziphus mauritiana*) cv. Banarasikaraka. The results reported that foliar application of 2% K_2SO_4 was found effective to increase the fruit length, diameter and weight followed by 1% K_2SO_4.

Nandan *et al.* (2011) studied the effect of certain pre harvest treatments in improving the yield and quality of banana cv. Nanjangudu Rasabale. The results reported that bunch weight and finger weight was the highest in GA spray @ 200ppm followed by SOP @ 2% whereas, maximum girth of finger by 2% SOP sprays.

Deependra *et al.* (2014) analysed the effect of foliar application of potassium compounds on yield of ber and reported that highest fruit retention, fruit yield per tree, fruit size, weight, and pulp to stone ratio with foliar application of 2% potassium sulphate.

2.4 Effect of potassium sulphate on fruit quality parameters

Sharma *et al.* (2008) revealed that 1% K_2S0_4 spray improved TSS, sugars, TSS/acid ratio, ascorbic acid content and reduced acidity content of fruits of Ber cv. Umran.

Kumar *et al.* (2008) analysed the effect of post shooting spray of sulphate of potash on quality of banana cultivar Robusta. The findings of this research showed that foliar spray of 1.5% concentration of sulphate of potash twice (first immediately after opening of the last hand and second 30 days after the first spray) showed increase in TSS, total sugars, reducing sugars, non-reducing sugars shelf life and decrease in acidity and physiological loss in weight.

Kumar and Kumar (2009) revealed that foliar application of either SOP at 1.5% concentration or combination of 0.5% potassium dihydrogen phosphate +1% urea + 20ppm 2,4-D as foliar spray twice, first at the time of last hand emergence and second 30 days after first spray improved TSS, reducing sugars, total sugars, non-reducing sugars, sugar: acid ratio, shelf life and reduced acidity and physiological loss in weight of banana fruit cv. Nendran.

Shira *et al.* (2013) examined the effect of post shoot application of potassium through bunch feeding on fruit quality characters of banana in west Bengal. The results showed that potassium sulphate in combination with cowdung gave higher TSS, reducing, non-reducing sugars and high vit-C content in fruits.

Nandan *et al.* (2011) reported that maximum pulp to peel ratio, TSS and shelf life was recorded with the foliar application of 2% SOP in banana cv. Nanjangudu Rasabale.

Gill *et al. (*2012) observed the effect of foliar sprays of potassium on fruit size and quality of 'Patharnakh' pear and observed that foliar spray of 2% potassium sulphate thrice at 15 days after full bloom (DAFB), at 30 DAFB and at 45 DAFB increased soluble solids and total sugars in fruits.

In an experiment conducted by Shira *et al.* (2012) on bunch management techniques in banana cv. Martman reported that TSS (25.5%), reducing sugars (8.51%), total sugars (17.8%) and non-reducing sugars (9.29%) in fruits were maximum by feeding the bunch with 500g fresh cowdung blended with 20g potassium sulphate.

Rajive *et al.* (2013) observed the effect of pre harvest foliar application of potassium sulphate on storability of ber observed minimum physiological loss in weight even after 8^{th} day of storage in fruits sprayed with 1% potassium sulphate at one month after fruit set.

Deependra *et al.* (2014) observed highest total soluble solids, ascorbic acid content and lowest acid content with the foliar application of 2% potassium sulphate in ber fruits.

2.5 Effect of potassium nitrate on yield characters

Suresh *et al.* (2003) concluded that early flowering was noticed with potassium nitrate spray followed by potassium dihydrogen phosphate besides this more number of fruits per tree (yield) with both potassium dihydrogen phosphate and potassium nitrate spray in mango cv. Baneshan.

Ramzy *et al.* (2011) studied productivity and fruit quality of three mango cultivars in relation to foliar sprays of calcium, zinc, boran and potassium. The results revealed that calcium nitrate @ 2% and potassium nitrate @ 2% enhanced the yield and fruit weight and also had positive effects on fruit quality.

Gill *et al.* (2012) revealed that foliar application of potassium nitrate at 1.5% had a positive effect in the final fruit size as compared to control in fruits of patharnakh pear.

Sarrwy *et al.* (2012) observed the effect of foliar application of potassium forms on yield and quality of Balady mandarin trees. The results showed that enhanced yield charcters with foliar spray of potassium nitrate @ 1.5% concentration along with 0.5% chelated zinc.

Sudha *et al.* (2012) found that foliar application of potassium nitrate @ 2% concentration increased number of panicles, panicle length, number of hermaphrodite flowers, fruit set, number of fruits and fruit yield in case of mango cv. Alphonso.

Abd *et al.* (2011) reported that foliar sprays of trees by GA_3 at 50ppm with or without urea were superior for inducing the increased fruit set and yield, whereas KNO_3 at 4% increased fruit size, peel thickness and juice acidity in washington navel oranges.

Babul and Rahim (2013) analysed the yield and quality of mango as influenced by foliar application of potassium nitrate and urea. The results revealed that the plants treated with 4% KNO_3 produced the highest number of fruits per plant and fruit yield.

2.6 Effect of potassium nitrate on fruit quality parameters

Ramzy *et al.* (2011) studied productivity and fruit quality of three mango cultivars in relation to foliar sprays of calcium, zinc, boran and potassium. The results revealed that maximum TSS, total sugars, vitamin C content and minimum acidity were recorded with the foliar application of 2% potassium nitrate.

Sarrwy *et al.* (2012) observed the effect of foliar application of potassium forms on yield and quality of Balady mandarin trees and reported that enhanced TSS and vitamin C content were obtained with foliar spray of 1.5% potassium nitrate supported with 0.5 percent chelated zinc.

2.7 Effect of potassium dihydrogen phosphate on yield characters

Venkatarayappa *et al.* (1979) studied the effect of potassium dihydrogen phosphate applied after shooting on Dwarf Cavendish and Giant Cavendish. They reported that the treatments significantly influenced the volume and weight of the fruit in both the clones. In Giant Cavendish and Dwarf Cavendish a maximum increase in fruit volume of 26.88% and 27.40% and weight of 62.56%

and 32.60% over control respectively. The ripening of the fruit was also delayed in both the clones by chemical treatment. They also reported that an entire plant spray of chemicals was effective over bunch spray alone.

Lavon *et al.* (1995) studied the influence of foliar spray with monopotassium phosphate (MKP) on the yield, fruit size and fruit quality of Star-Ruby grapefruit. The results showed that the fruit peel of treated trees with monopotassium phosphate was thinner than that of untreated trees and flesh diameter was significantly greater, therefore flesh: peel was also higher.

Ceylan *et al.* (1999) observed that potassium dihydrogen phosphate application increased the grape yield by 34% and 5% in two consecutive years.

Saleh *et al.* (2007) studied the effect of KH_2PO_4 on yield and fruit quality of Thompson seedless Grapevines. The results indicated that foliar spray of potassium dihydrogen phosphate at 1% concentration every 10 days or 1.5% every 20 days had a positive effect on leaf mineral content, yield, weight and fruit quality.

Kumar and Reddy (2008) had done the preliminary investigations on the effect of foliar spray of chemicals on flowering and fruiting characters of mango cv. Baneshan noticed that the highest percentage of hermaphrodite flowers, fruit yield and average fruit weight with 1% KH_2PO_4 spray.

Mukadam and Haldankar (2013) from their studies on effect of paclobutrazol and post foliar sprays of nutrients for accelerating harvesting of karonda observed that foliar spay of 1% urea at fruit set and 0.5% mono potassium phosphate 20 days after fruit set resulted in early harvest of the fruit (64% of total fruits) before rains.

2.8 Effect of potassium dihydrogen phosphate on fruit quality parameters

Lavon *et al.* (1995) studied the influence of foliar spray with monopotassium phosphate (MKP) on the yield, fruit size and fruit quality of Star-Ruby grapefruit showed that juice percentage and quality was greater in treated trees.

Satheesh and Bangaruswamy (2006) conducted an experiment on effect of post shooting application of certain nutrients on fruit quality and post harvest storage life of banana cv. Rasthali. They observed that spray combination of urea @ 4% + potassium dihydrogen phosphate @ 2% + calcium chloride @ 0.5% + boric acid @ 0.2% be the best for enhancing TSS of banana fruits.

Shinde and Haldankar (2010) reported the effect of post flowering foliar sprays of nutrients on physico-chemical properties of kokum (*Garcinia indica)*. The results revealed that the lowest acidity (3.73%), the highest reducing sugar (6.05%), non-reducing sugar (5.54%) and total sugar (11.59%) were observed in the fruits of plants treated with 0.5% mono potassium phosphate spray twice.

2.9 Effect of ammonium sulphate on yield parameters

Kotur and Murthy (2008) reported that an application of 15g of ammonium sulphate and 7.5g sulphate of potash in 500g of fresh cowdung feeding through distal stalk end of the bunch improved bunch yield without affecting the fruit quality in banana cv. Robusta.

Kotur and Murthy (2010) studied the effect of denavelling and feeding N, K and S through distal stalk end of the bunch to enhance the fruit yield in Ney Poovan banana. Results showed that application of 5g ammonium sulphate and 2.5g SOP bended in 500 g of fresh cowdung to the distal stalk end of the bunch of Ney Poovan cultivar was the most promising treatment in boosting the yield,

improving the nutritional composition in respect to N, K and S without adversely affecting the fruit quality.

Kotur and Murthy (2010) revealed the influence of denavelling and stalk end nutrient application on nutrient composition of Robusta banana fruits. The results indicated that dipping stalk end of the bunch in fresh cowdung which is blended with 15g of ammonium sulphate and further addition of 7.5g of potassium sulphate showed maximum bunch weight.

Chapter- III

Materials and Methods

CHAPTER - III

MATERIALS AND METHODS

The investigation on "Studies on bunch management practices in tissue Culture Banana cv. Grand Naine" was carried out during 2013-2014 at Horticulture College and Research Institute, Dr.Y.S.R. Horticultural University, Anantharajupet, YSR District, Andhra Pradesh. The materials used and methods followed in this investigation are described here under.

3.1 THE EXPERIMENTAL FIELD

3.1.1 Geographical location of the experimental site

The experiment was carried at HC&RI Anantharajupet which is located in Rayalaseema region of the Andhra Pradesh at an altitude of 215 meters (531 feet) above mean sea level. The geographical situation is 13.98^0 North Latitude and 79.40^0 East Longitudes.

3.1.2 Climate

The meteorological data pertaining to rainfall, mean minimum and maximum temperatures, humidity during the period of experimentation (October 2013 to September 2014) were recorded and presented in Appendix –1.

During the crop period, the rainfall received was 90.8 mm. The weakly mean maximum & minimum temperatures during the crop growth period ranged from 25.8^0C to 40.0^0C and 17.9^0C to 26.6^0C respectively. The relative humidity during the period of crop growth ranged from 75 to 85%.

3.1.3 Soil type

Experimental site's soil type is sandy loam with good drainage facility and soil pH is varying from 7.3 to 8.0 with EC 0.23 dSm^{-1}.

Plate 1: Overview of the experimental plot

3.1.4 Soil analysis

Soil samples were taken before planting of banana plants. Soil samples were analyzed for the following physico-chemical characters.

Table 3.1Physicochemical properties of experiment site

A. Chemical composition

Properties	**Characterization**	**Method of analysis**
Soil pH	7.58	Glass electrode pH meter model 335 (Jackson, 1973)
Electrical conductivity (dSm^{-1})	0.232	Conductivity Bridge ELICO Model EM 88 (Jackson,1973)
Available nitrogen ($kg\ ha^{-1}$)	204.30	Alkaline permanganate method (Subbaiah and Asija, 1956)
Available phosphorus (P_2O_5) ($kg\ ha^{-1}$)	18.84	Olsen's method (Olsen *et al.*, 1954)
Available potassium (K_2O) ($kg\ ha^{-1}$)	395.0	Neutral normal Ammonium Acetate method using Flame Photometer (Muhr, 1965).

B. Physical composition

Properties	**Characterization**	**Method of analysis**
Sand (%)	70	

Silt (%)	10	International pipette method (Piper, 1966)
Clay (%)	20	
Textural class	Sandy loam	

3.2 Experimental details

Crop : Banana

Variety : Grand Naine

Spacing : 1.8 X 1.8m

Date of planting : 12-10-2013

Plot size : 5.4 X 5.4m

No of Treatments : 14

Design : RBD

Replications : 3

Location : Horticulture College and Research Institute, Anantharajupeta.

3.2.1 Treatments

T_1. Spraying of 1.0% Urea

T_2. Spraying of 0.5% Potassium dihydrogen phosphate

T_3. Spraying of 0.5%Potassium nitrate

T_4. Spraying of 0.5% Potassium sulphate

T_5. Spraying of 0.5% Ammonium sulphate

T_6. Spraying of 0.25% Potassium nitrate + 0.25% Potassium dihydrogen phosphate

T_7. Spraying of 0.25% Potassium sulphate + 0.5% Urea

T_8. Spraying of 0.25% Ammonium sulphate + 0.25% Potassium dihydrogen phosphate

T_9. Spraying of 0.25% Potassium dihydrogen phosphate + 0.5% Urea

T_{10}. Bunch feeding with cow dung slurry containing 0.5% Potassium nitrate + 0.5% Potassium dihydrogen phosphate

T_{11}. Bunch feeding with cow dung slurry containing 0.5% Potassium sulphate + 1.0 % Urea

T_{12}.Bunch feeding with cow dung slurry containing 0.5% Ammonium sulphate + 0.5% Potassium dihydrogen phosphate

T_{13}. Bunch feeding with cow dung slurry containing 0.5% Potassium dihydrogen phosphate + 1.0% Urea

T_{14}. Control (without any spray and bunch feeding).

3.2.2. Preparation of spray solution and bunch feeding blend

Pre-weighed chemicals *viz.*, urea, potassium dihydrogen phosphate, potassium nitrate, potassium sulphate and ammonium sulphate were directly dissolved in the required quantity of water with dhanuvit as a wetting agent. This solution was sprayed directly to the entire plant including bunch. Bunch spraying treatments were imposed thrice, first immediately after opening of the last hand and second 30 days after the first spray and again 45 days after first spray.

Bunch feeding treatment was done by excising the distal end of the bunch along with the male bud by giving a slanting cut (10-15cm below the last hand) immediately after the pistillate flowers had formed into fruits that is 5-7 days after opening of the last hand in the bunch. Blending of the required dose of chemicals and 500g of fresh cowdung with 100ml of water was done to form slurry. The blend was placed in a polythene bag and tied

securely to dip the excised rachis into the slurry. The cowdung blended polybags were retained till harvest.

Cowdung contained about 1.4% of N, 0.5% of P, 0.9% of K, 1.8% of Ca, 0.8% of Mg, 0.4% of S, 250ppm of Fe, 80ppm of Mn, 64ppm of Zn and 38ppm of Cu (Kotur and Murthy, 2010).

3.2.3 Experimental design and layout

The experiment was laid out in Randomized Block Design (RBD) with 14 treatments and 3 replications. Treatments were allocated randomly to each replication. Each treatment consisted of 9 plants and each replication had 126 plants. Total 3 replications had 378 plants. The total area under the experiment was 1224.72m^2.

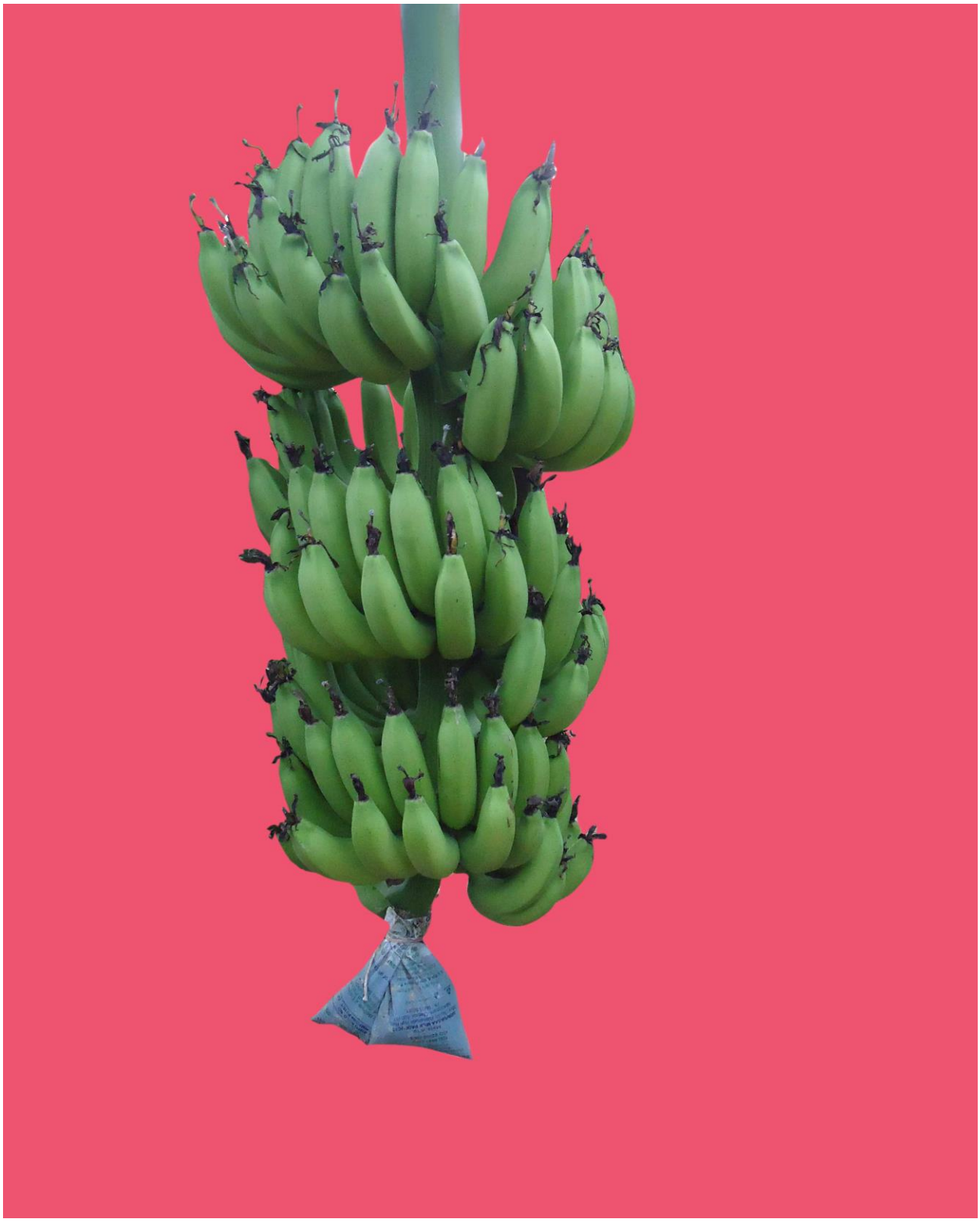


Plate 2 : Bunch Feeding Technique

T_1	IRRIGATION CHANNEL	T_8	T_7	IRRIGATION CHANNEL	T_{14}	T_2	IRRIGATION CHANNEL	T_4
T_2		T_9	T_6		T_{13}	T_3		T_1
T_3		T_{10}	T_4		T_{12}	T_{11}		T_5
T_4		T_{12}	T_5		T_{11}	T_6		T_7
T_{11}		T_5	T_3		T_{10}	T_8		T_9
T_6		T_{13}	T_2		T_9	T_{10}		T_{14}
T_{14}		T_7	T_1		T_8	T_{13}		T_{12}

Layout plan of experiment

3.3 CULTIVATION DETAILS

3.3.1 Preparatory cultivation

The experimental field was thoroughly ploughed with tractor drawn mould board plough to a depth of 30 cm and harrowed twice to a fine tilth. The field was levelled and divided into plots as per the layout of the experiment.

3.3.2 Digging of pits

Pits of 45 × 45 × 45 cm size were dug at a spacing of 1.8 × 1.8 m and allowed to expose to sunlight for one week before planting of tissue culture plants.

3.3.3 Planting material

Healthy, disease free and uniform sized tissue culture Banana plants cv. Grand Naine (Cavendish sub group, AAA) were procured from Brook field tissue culture laboratory and planted in the experimental site.

3.3.4 Quantities of organic manures and inorganic fertilizers

Recommended dose of fertilizers for banana is 300:50:300 g NPK plant^{-1} crop^{-1} under Anantharajupet conditions. The present investigation was carried out with 80 percent of the recommended dose of nutrients (240:40:240 g NPK plant^{-1} crop^{-1}) through inorganic sources and 20 percent of the recommended dose of nutrients (60:10:60g NPK plant^{-1} crop^{-1}) through farmyard manure(5.3 kg/plant) and biofertilizers *viz., Azospirillum* and PSB @ 50 g each plant^{-1} and *Frateuria aurantia* @ 25 g plant^{-1} standardized by Firoz (2013) in tissue culture Banana cv. Grand Naine under Anantharajupet conditions.

3.3.5 Inoculation of biofertilizers

For this study, biofertilizers *viz*., *Azospirillum lipoferum* (strain ICM 1001) and phosphate solubilizing bacteria (PSB) *Bacillus megatherium* and *Frateuria aurantia* (potassium solubilizing bacteria) were procured from Agricultural Research Station (Acharya N G Ranga Agricultural University), Amaravathi, Andhra Pradesh. *Azospirillum*

and PSB @ 50 g each plant^{-1}, where as *Frateuria aurantia* @ 25 g plant^{-1} were applied in the pits at the time of planting.

3.3.6 Time and method of manure and fertilizers application

Calculated quantities of farmyard manure and biofertilizers were applied at the time of planting. Eighty percent of nitrogen in the form of urea and potassium in the form of Muriate of potash were applied in twelve equal split doses at an interval of 15 days starting from 15 days after planting till shooting by pocketing method at 30 cm away from plant on either side of plant, while entire dose of phosphorus was applied at the time of planting.

3.3.7 Planting of tissue culture plants

Tissue culture plants of banana were planted in the pits during the month of October and irrigation was given immediately after planting.

3.3.8 Cultural operations

The experimental field was kept weed free by regular hand weeding. Irrigation was given at regular intervals on need basis. Desuckering was done whenever suckers arise besides the plant.

3.4 OBSERVATIONS RECORDED

Three plants from each treatment plot were selected at random and tagged for recording the observations on the following yield and quality parameters. The data were averaged and expressed per plant. The middle finger in the top and bottom rows of the second hand was selected to record observations.

3.4.1 YIELD ATTRIBUTES

3.4.1.1 Days taken for maturity

Number of days taken from the emergence of inflorescence to fruit maturity (disappearance of angles and fullness of the fruit of the middle hand in the bunch) were recorded from tagged plants; average was worked out and presented as days taken for maturity.

3.4.1.2 Number of hands in a bunch

The number of hands in a bunch was recorded by counting the number of hands on each bunch harvested from tagged plants and average was worked out.

3.4.1.3 Number of fruits in a bunch

The number of fruits (fingers) in a bunch was recorded by counting all the fingers on each bunch.

3.4.1.4 Finger length (cm)

The length of finger (middle finger of the second hand) was measured from the base of the pedicel to the tip along the dorsal curve and expressed in centimeters.

3.4.1.5 Finger girth (cm)

The circumference of finger (middle finger of the second hand) was measured in the middle portion of the fruit by using a thread and expressed in centimeters.

3.4.1.6 Weight of finger (g)

Individual weight of finger was determined by weighing the finger on an electrical balance immediately after harvest and expressed in grams.

3.4.1.7 Weight of pulp (g)

Individual weight of pulp of a finger was determined by weighing the pulp of individual finger on an electrical balance after the fruit had ripened and expressed in grams.

3.4.1.8 Weight of peel (g)

Individual weight of peel of a finger was determined by weighing the peel of individual finger on an electrical balance after the fruit had ripened and expressed in grams.

3.4.1.9 Weight of hand (kg)

Weight of individual hand was determined by weighing the hand on an electrical balance immediately after harvest and expressed in kilograms.

3.4.1.10 Bunch weight (kg)

Individual bunch weight was determined by weighing the bunch on an electrical balance immediately after harvest and expressed in kilograms.

3.4.2 FRUIT QUALITY CHARACTERS

3.4.2.1 Total Soluble Solids (^{0}B)

Total soluble solids (TSS) of the fruit were determined using hand refractometer of 0.32 range (Erma make, Japan) at eating ripe stage of fruit and the values were corrected at 20^{0}C and expressed as Degree Brix (^{0}Brix).

3.4.2.2 Reducing sugars (%)

Reducing sugars content in fruit was estimated by Lane and Eynon method described by Ranganna (1986) at fruit ripening stage. In this method, 20g of pulp is thoroughly mixed by adding 20ml of water and add 2 ml of 45 percent basic lead acetate solution to the sample for clarification. Keep it for 10 min and then add 2ml of potassium oxalate solution then made up the sample upto 250 ml with distilled water and then filtered the sample. The filtrate solution was taken into a burette and titrated against with Fehling A and B solution 5ml each in a boiling condition using methyl blue as indicator and continued the titration till brick red colour precipitate is formed. Titrate value is noticed. Percent reducing sugars was calculated by using the formula.

$$Reducing\ sugars\ (\%) = \frac{0.05 \times 250 \times 100}{titre\ value \times wt.of\ sample}$$

3.4.2.2 Total sugars (%)

The percentage of total sugars was estimated by A.O.A.C method (1980). Twenty ml of juice was taken into 100ml conical flask and 20 ml of distilled water was added. Add 5ml of 6N HCL to the contents and kept in a hot water bath at 70^{0}C for exactly 8 minutes. After that, the flask was removed from water bath and cooled to room temperature. The excess acidity was neutralized by adding 40% sodium hydroxide to the conical flask using phenolphthalein as indicator. This was indicated by the formation of pink colour. Then the solution was made upto 100ml by using distilled water and then filtered. The filtrate was taken into a burette and titrated against 10 ml of Fehling solution (5ml of both A and B) in hot condition using methyl blue as indicator and continued the titration till the brick red

colour precipitate was formed. Titrate value was noticed. The percentage of total sugars was estimated by using the factor 10ml of Fehling solution = 0.05g glucose.

$$Total\ sugars = \frac{0.05 \times 100 \times 100}{\text{titre value} \times \text{wt. of sample}}$$

3.4.2.3 Non-reducing sugars (%)

Non- reducing sugars were computed by subtracting reducing sugars from total sugars.

Non-Reducing sugars = Total sugars – Reducing sugars

3.4.2.4 Titrable acidity (%)

Acidity was determined using Ranganna (1986) method. In this method, 10ml of water was added to 10g sample and mixed thoroughly. The sample solution was titrated against 0.1N NaoH using phenolphthalein as the indicator. Appearance of light pink color denotes the end point. The acidity of the fruit was expressed in per cent and calculated by using the formula

$$Titrable\ acidity\ (\%) = \frac{1 \times \text{Eq.wt of acid} \times \text{Normality of NaOH} \times \text{Titre value} \times 100}{10 \times \text{Wt.of sample}}$$

***** Equivalent weight of acid (Malic acid) is 67.0.

3.4.3 PHYSIOLOGICAL CHARACTERS

3.4.3.1 Physiological loss in weight (%)

Physiological loss in weight of fingers was calculated as per the formula given below.

$$Physiological\ loss\ in\ weight\ (\%) = \frac{\text{Initial weight} - \text{Weight at the end of shelf life}}{\text{Initial weight}}\ \text{X}\ 100$$

3.4.3.2 Shelf life (days)

Shelf life was treated as a period (in days) between harvest of the fruit (bunch) and end of edible life of the fruit at room temperature. End of shelf life was treated at a stage where 50 per cent of the stored fruits became unfit for consumption.

3.4.4. Statistical analysis

The experimental data were statistically analyzed following the standard procedures (Panse and Sukhatme, 1985). The statistical significant difference was tested with the help of F test at 0.05 level of probability.

Chapter-IV

Results and Discussion

Chapter IV

RESULTS AND DISCUSSION

The present investigation entitled “Studies on bunch management practices for tissue culture banana cv. Grand Naine” was conducted at Horticulture College and Research Institute, Anantharajupet during 2013-2014. The data were recorded after the bunches were harvested with regard to yield attributes, fruit quality characters and physiological characters. The data were statistically analysed and the results are presented here under.

4.1 Yield attributes

4.1.1 Days taken for fruit maturity

Significant differences were observed among the treatments with respect to days taken for fruit maturity (Table 4.1. and Fig 1.). All bunch management treatments advanced the fruit maturity in Grand Naine banana compared to control. Combined spray of 0.25% potassium dihydrogen phosphate and 0.5% urea (86.90 days) recorded the least number of days for fruit maturity followed by post shooting spray of 0.5% potassium nitrate alone (89.24 days). Maximum number of days taken for fruit maturity (96.02 days) was recorded in control.

The reduction in bunch development phase observed with the post shooting bunch management practices, in this investigation due to higher leaf chlorophyll contents which resulted in faster growth rate of fingers owing to additional nutrient supply and faster rate of translocation of assimilates from source to sink, aided by additional nitrogen, phosphorus and potassium.

In a determinate crop like banana, retention of more number of green leaves with high chlorophyll content at post shooting phase contributes a sizeable portion of currently synthesized assimilates to the developing sink through current photosynthesis. Potassium is a general metabolic activator, increasing the respiration and photosynthetic rate. Thus, additional potassium application as foliar spray induced faster development of bunches (Evans, 1971; Martin-Prevel, 1972). Kumar and Kumar (2009) also reported early fruit

maturity in banana cv. Nendran with post shooting spray of potassium dihydrogen phosphate + urea + 2,4-D by retention of more number of functional leaves with high chlorophyll content. The results were in tune with the findings of Buragohain and Shanmugavelu (1986) in Vayal Vazhai banana and Mukadam and Haldankar (2013) in Karonda.

4.1.2 Number of hands in a bunch

The differences among the treatments were not significant for number of hands in a bunch at harvest, since the chemical treatments were imposed after the formation of hands in a bunch.

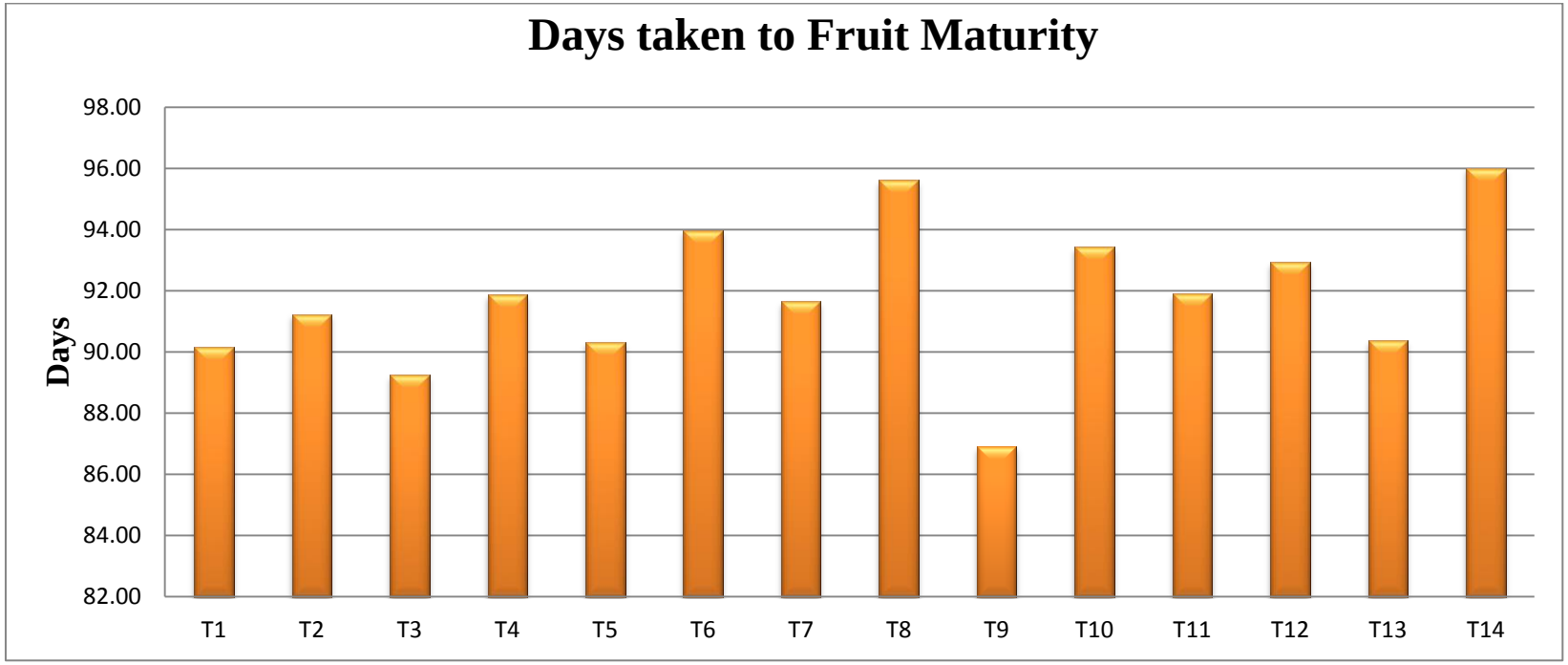
4.1.3 Number of fingers in a bunch

There was no significant differences among the treatments for number of fingers in a bunch at harvest, as the chemical treatments were imposed only after all the fingers had formed.

Table 4.1. Influence of different bunch management practices on days taken for fruit maturity, number of hands and number of fruits in a bunch in banana cv.Grand Naine (AAA)

	Treatments	Days taken for fruit maturity (days)	Number of hands in a bunch	Number of fruits in a bunch
T_1.	Spraying of 1.0% Urea	90.16	9.34	136.69
T_2.	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	91.23	9.34	136.67
T_3.	Spraying of 0.5%Potassium nitrate (PN)	89.24	9.33	136.46
T_4.	Spraying of 0.5% Potassium sulphate (PS)	91.88	9.35	136.66
T_5.	Spraying of 0.5% Ammonium sulphate (AS)	90.32	9.34	136.47
T_6.	Spraying of 0.25% PN + 0.25% PDP	93.98	9.33	136.31
T_7.	Spraying of 0.25% PS + 0.5% Urea	91.65	9.30	136.56
T_8.	Spraying of 0.25% AS+ 0.25% PDP	95.62	9.33	136.53
T_9.	Spraying of 0.25% PDP + 0.5% Urea	86.90	9.35	136.58
T_{10}.	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	93.42	9.34	136.06
T_{11}.	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	91.91	9.31	136.11
T_{12}.	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	92.92	9.30	135.91
T_{13}.	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	90.26	9.32	136.51
T_{14}.	Control (without any spray and bunch feeding)	96.02	9.30	134.10
	SEm (±)	0.583	0.092	1.287
	CD (P=0.05)	1.703	NS	NS

Fig.1. Influence of different bunch management practices on Days taken to fruit maturity in banana cv. Grand Naine (AAA)



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 % PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

4.1.4 Finger length (cm)

The data on mean finger length of Grand Naine banana are presented in Table 4.2 and Fig 2. It was clear from the data that the mean length of finger was more in both foliar applied and bunch feeding treatments over control. The differences among the treatments were significant.

Foliar application of 0.25% potassium dihydrogen phosphate + 0.5% urea (T_9) registered significantly higher finger length (21.90 cm) and it was on par with spraying of 1.0% urea (21.65 cm), spraying of 0.5% potassium dihydrogen phosphate (21.56 cm), bunch feeding with cowdung slurry containing 0.5% potassium nitrate + 0.5% potassium dihydrogen phosphate (21.49 cm), spraying of 0.5% potassium sulphate (21.16 cm), spraying of 0.5% ammonium sulphate (21.33 cm) and spraying of 0.25% potassium nitrate + 0.25% potassium dihydrogen phosphate (21.11 cm). The fruit length was significantly shorter in plants from control treatment (19.45 cm) and it was on par with spraying of 0.25% AS+ 0.25% PDP (19.48 cm) and bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea (19.76 cm).

4.1.5 Finger girth (cm)

A perusal of data (Table 4.2. and Fig 2.) showed that bunch management treatments had significant effect on girth of finger in banana. The treatment with 0.25% potassium dihydrogen phosphate + 0.5% urea recorded significantly higher finger girth (13.81cm) and it was on par with bunch feeding with cowdung slurry containing 0.5% potassium nitrate + 0.5% potassium dihydrogen phosphate (13.79cm), spraying of 1.0% urea (13.76cm), spraying of 0.5% potassium nitrate (13.70cm), spraying with 0.5% potassium dihydrogen phosphate (13.67cm), spraying with 0.25% potassium nitrate + 0.25% potassium dihydrogen phosphate (13.57cm), bunch feeding with cow dung slurry containing 0.5% ammonium sulphate + 0.5% potassium dihydrogen phosphate (13.60cm) and spraying of 0.5% potassium sulphate + 0.5% urea (13.39cm). However, the least finger girth has registered in control (12.14cm).

Improvement in fruit size *viz.*, finger length and girth might be attributed due to the beneficial effect of both urea and potassium dihydrogen phosphate. Foliar nutrition by urea

was utilized more for cell elongation of the fruits rather than cell multiplication and the cell enlargement which resulted in more length. Increase in fruit size might also be due to exogenous potassium supply which acted as an activator of several enzymes (Mustaffa *et al*., 2004). Potassium plays important role in maintenance of the osmotic potential of the phloem sap and the volume flow rate increases which might be responsible for accumulation of more assimilates and increases the cell size (Kumar and Kumar, 2010).

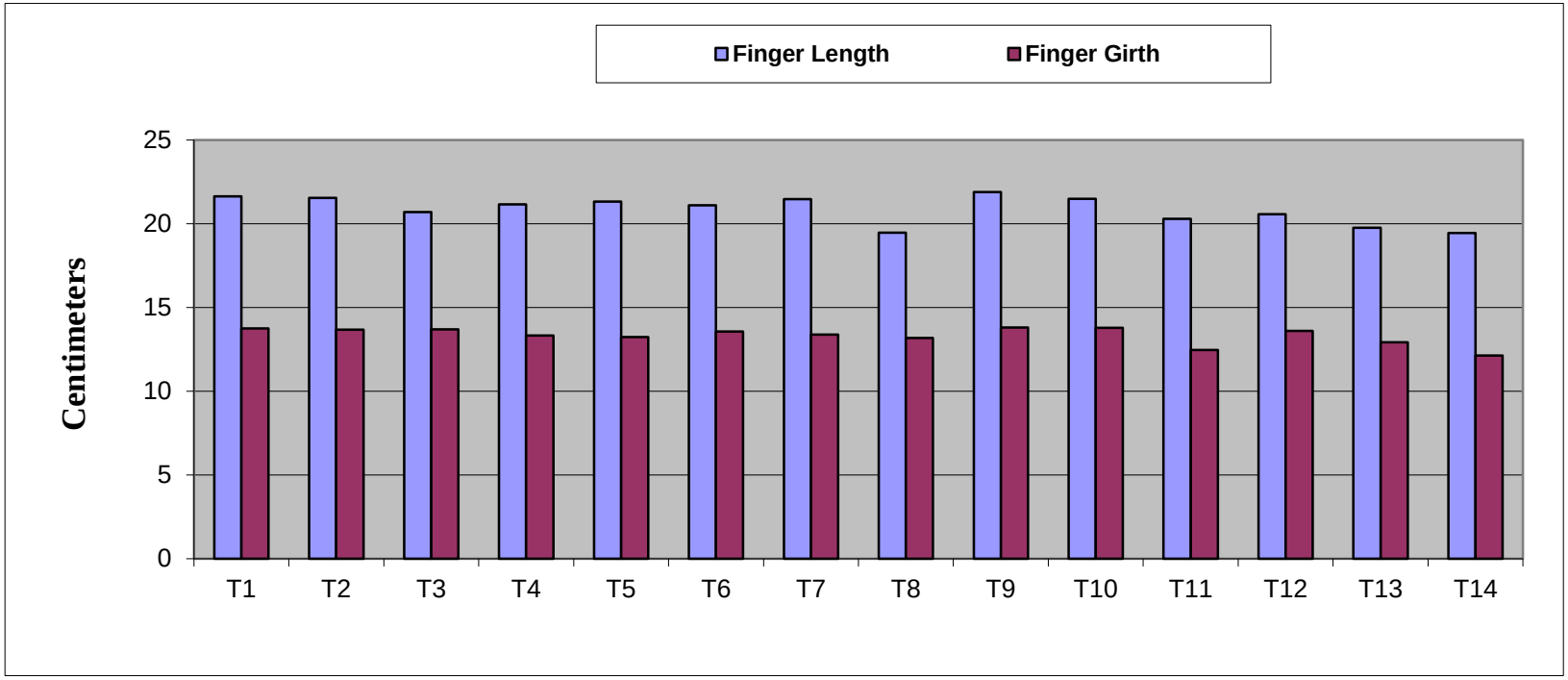
Phosphorous in the potassium dihydrogen phosphate, is one of the major elements for growth and development of plants. Phosphorous is an essential part of many sugar phosphates involved in photosynthesis, respiration, and other metabolic processes, and it is also part of nucleotides, as in RNA and DNA, and of the phospholipids present in membranes (Salisbury and Ross, 2005) which might be involved in increasing the size of the fruit.

Similar increase in banana finger size was observed with the foliar application of urea in cv. Nanjangudu Rasabale (Nandan *et al*., 2011), sulphate of potash (1.5%) in cv. Ney Poovan (Kumar and Kumar, 2007), 2% K_2SO_4 in ber cv. Banarasikaraka (Singh and Shailendra, 2011), KNO_3 in Patharnakh pear (Gill *et al*., 2012), 4% KNO_3 in Washington Navel Oranges (Abd *et al*., 2011) and Monopotassium phosphate in Star Ruby grape fruit (Lavon *et al*., 1995).

Table 4.2. Influence of different bunch management practices on finger length and finger girth in banana cv. Grand Naine (AAA)

	Treatments	Finger length (cm)	Finger Girth (cm)
T_1.	Spraying of 1.0% Urea	21.65	13.76
T_2.	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	21.56	13.67
T_3.	Spraying of 0.5%Potassium nitrate (PN)	20.71	13.70
T_4.	Spraying of 0.5% Potassium sulphate (PS)	21.16	13.33
T_5.	Spraying of 0.5% Ammonium sulphate (AS)	21.33	13.23
T_6.	Spraying of 0.25% PN + 0.25% PDP	21.11	13.57
T_7.	Spraying of 0.25% PS + 0.5% Urea	21.47	13.39
T_8.	Spraying of 0.25% AS+ 0.25% PDP	19.48	13.18
T_9.	Spraying of 0.25% PDP + 0.5% Urea	21.90	13.81
T_{10}.	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	21.49	13.79
T_{11}.	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	20.30	12.47
T_{12}.	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	20.58	13.60
T_{13}.	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	19.76	12.92
T_{14}.	Control (without any spray and bunch feeding)	19.45	12.14
	SEm (±)	0.255	0.116
	CD (P=0.05)	0.745	0.339

Fig.2. Influence of different bunch management practices in Finger length and girth in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 % PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

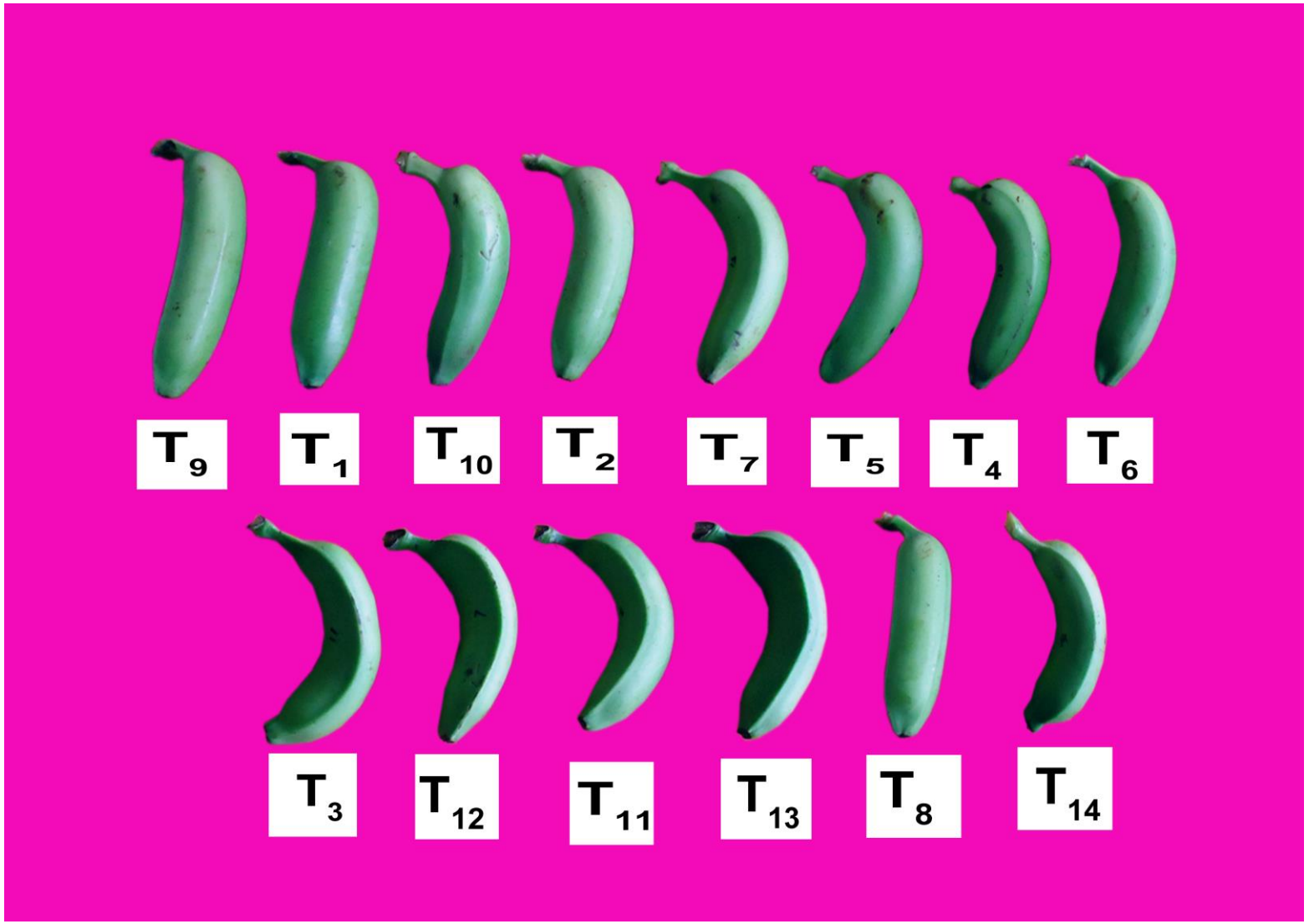


Plate 3:Influence of different bunch management practices on finger length of banana

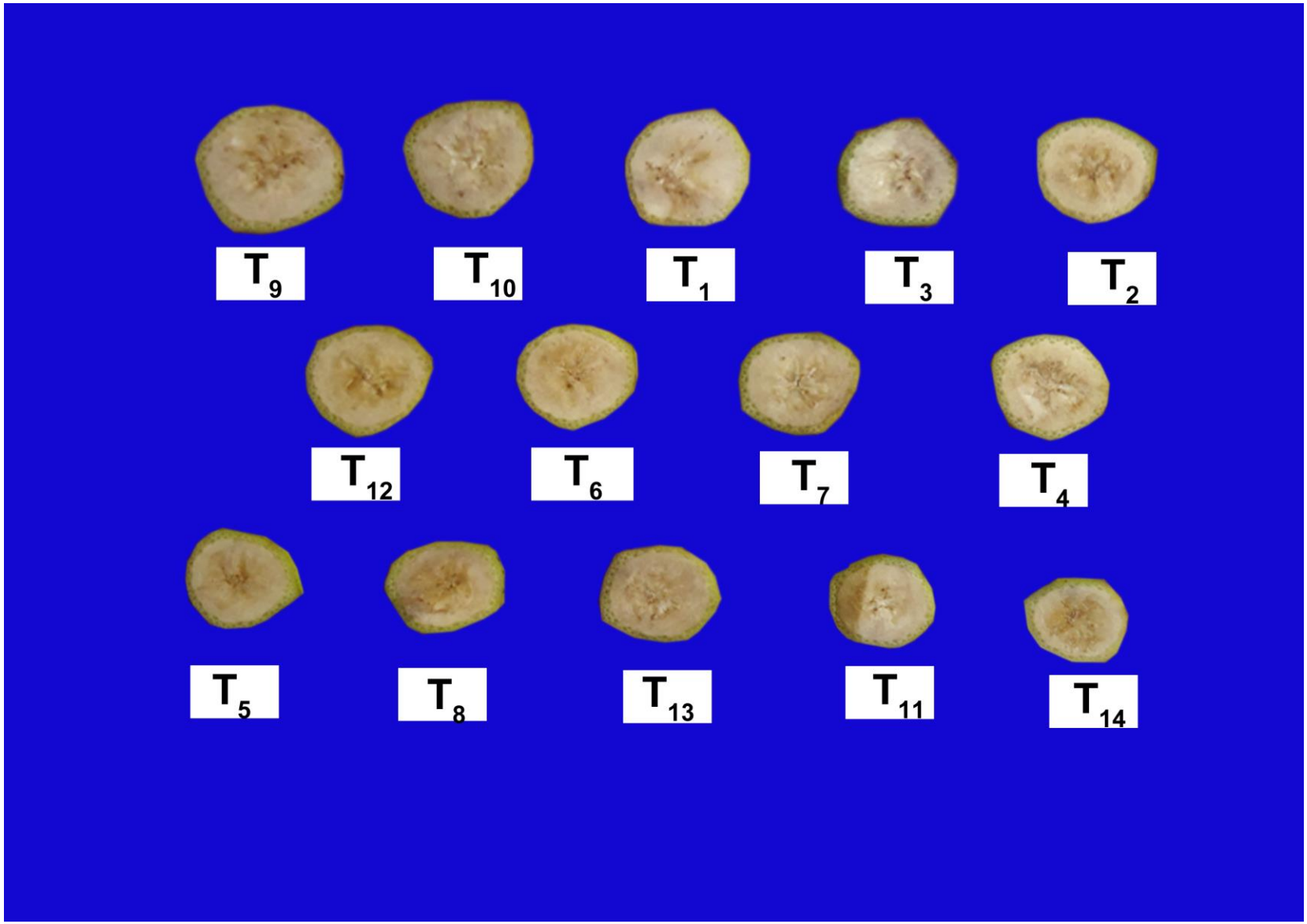


Plate 4: Influence of different bunch management practices on finger girth of banana

4.1.6 Weight of finger at harvest (g)

Significant differences among the treatments were observed with respect to weight of a finger at harvest are presented in Table 4.3 and Fig 3. The finger weight at harvest ranged from 98.55g (T_{14}) to 153.55g (T_9).

The treatment with 0.25% potassium dihydrogen phosphate + 0.5% urea has recorded significantly higher finger weight at harvest (153.55g) and it was on par with spraying of 0.5% potassium dihydrogen phosphate (151.55g), spraying of 1.0% urea (151.33g), bunch feeding with cow dung slurry containing 0.5% potassium nitrate + 0.5% potassium dihydrogen phosphate (148.22g) and spraying of 0.5% potassium sulphate + 0.5% urea (147.80g). However, least finger weight at harvest has registered in control (98.55g).

Exogenous application of all the major nutrients *viz.,* nitrogen, potassium and phosphorus either in foliar form or as bunch feeding along with cow dung improved the finger weight over control. The combined foliar application of 0.25% potassium dihydrogen phosphate + 0.5% urea might be attributed to hastened availability of nitrogen in the plant system, more chlorophyll synthesis, greater accumulation of protein in plants and efficient translocation of assimilates to reproductive parts there by increased the finger weight.

The foliar supplied N and K are effectively absorbed as anion and cation by plants which might have delayed the synthesis of abscisic acid and promoted cytokinin activity (Brevadan and Hodges, 1973), causing higher chlorophyll retention. This may secure higher photosynthetic activity in effective leaves and supplied developing fingers with current photosynthatates for proper increase in finger size, resulting in higher finger weight.

Similar results in increasing the weight of the fruit were reported by Ancy *et al*. (1998) with foliar application of 5% urea in banana, Kumar *et al*. (2008) with foliar application of 1.5% sulphate of potash in banana cv. Robusta, Kumar and Kumar (2009) with foliar application of 0.5% potassium dihydrogen phosphate + 1% urea + 20ppm 2,4-D in banana cv. Nendran, Anju *et al*. (2008) with foliar application of 2% urea in guava cv. Sardar and Singh and Sailendra (2011) by application of 1% potassium sulphate as foliar spray in ber cv. Banarasikaraka.

4.1.7 Weight of finger after ripening (g)

The data presented in Table 4.3 and Fig 3. showed that all bunch management treatments had significant effect on finger weight after ripening.

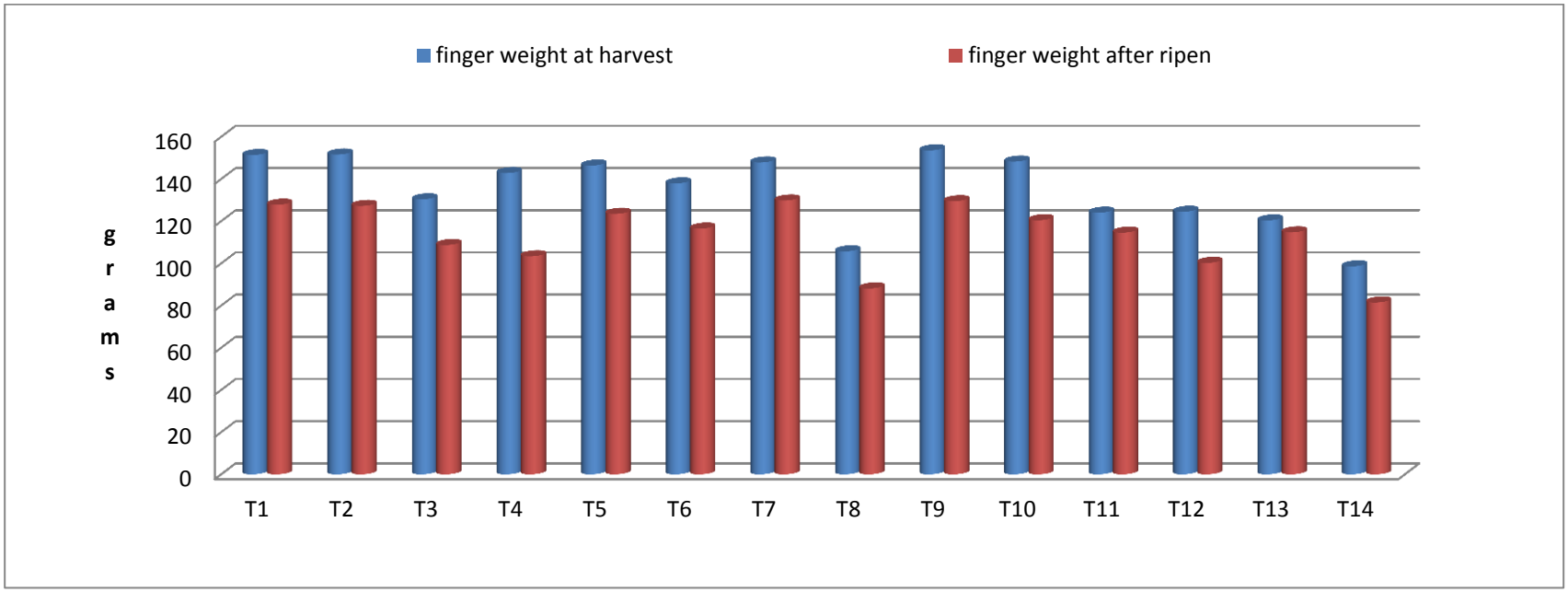
The data indicated that higher finger weight after ripening was observed in treatment with spraying of 0.5% potassium sulphate + 0.5% urea (129.77g) which was statistically on par with 0.25% potassium dihydrogen phosphate + 0.5% urea (129.44g), spraying of 1.0% urea (127.77g) and spraying of 0.5% potassium dihydrogen phosphate (127.20g). While, least finger weight after ripening was observed in control (81.44g).

The decrease in banana finger weight from harvest to ripening might be due to the increase in respiration rate. Presence of sulphur in potassium sulphate has a synergistic effect with zinc which is essential for carbondioxide absorption and utilization which increased the rate of respiration results in loss of moisture from the finger which finally decrease the fruit weight (Mustaffa *et al.*, 2004).

Table 4.3. Influence of different bunch management practices on finger weight at harvest and after ripening in banana cv. Grand Naine (AAA)

	Treatments	Finger Weight at harvest (g)	Finger Weight after ripening(g)
T_1.	Spraying of 1.0% Urea	151.33	127.77
T_2.	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	151.55	127.20
T_3.	Spraying of 0.5%Potassium nitrate (PN)	130.33	108.68
T_4.	Spraying of 0.5% Potassium sulphate (PS)	142.78	103.32
T_5.	Spraying of 0.5% Ammonium sulphate (AS)	146.33	123.44
T_6.	Spraying of 0.25% PN + 0.25% PDP	137.89	116.44
T_7.	Spraying of 0.25% PS + 0.5% Urea	147.80	129.77
T_8.	Spraying of 0.25% AS+ 0.25% PDP	105.67	88.09
T_9.	Spraying of 0.25% PDP + 0.5% Urea	153.55	129.44
T_{10}.	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	148.22	120.42
T_{11}.	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	124.00	114.55
T_{12}.	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	124.44	100.22
T_{13}.	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	120.33	114.68
T_{14}.	Control (without any spray and bunch feeding)	98.55	81.44
	SEm (±)	2.265	2.116
	CD (P=0.05)	6.620	6.184

Fig.3. Influence of different bunch management practices on Weight of finger at harvest and after ripen in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 % PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

4.1.8 Weight of hand (kg)

The data on hand weight in a bunch was recorded and presented in Table 4.4 and Fig 4. The differences among the treatments were significant.

The highest hand weight in a bunch was noticed in the treatment with spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea (3.08kg) which was observed to be on par with spraying of 0.5% potassium dihydrogen phosphate (2.94 kg), spraying of 1.0% urea (2.83 kg), spraying of 0.25% potassium sulphate + 0.5% urea (2.75 kg) and bunch feeding with cowdung slurry containing 0.5% potassium nitrate + 0.5% potassium dihydrogen phosphate (2.75 kg). Whereas, the least hand weight in a bunch was recorded in control (1.83 kg).

Foliar application of chemicals recorded high percentage increase of hand weight over control and bunch feeding treatments. This might be due to availability of nutrients to the whole plant in case of bunch spray treatments compared to bunch alone in bunch feeding treatments. Highest percent increase of hand weight over control was observed in spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea (68.30%).

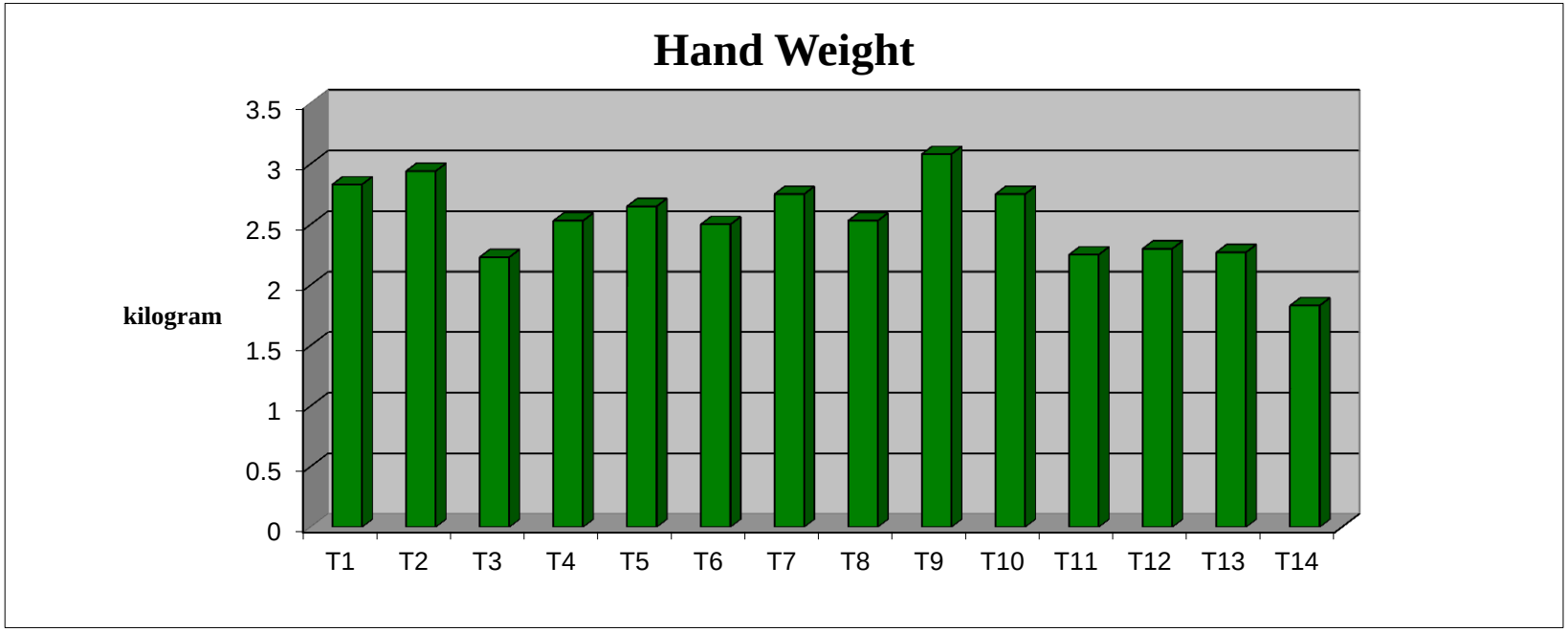
The increase in weight of hand was obviously due to increase in finger size and more finger weight with the application of urea and potassium dihydrogen phosphate which resulted in more accumulation of photosynthetic assimilates into the fingers.

Similar increase in hand weight with foliar application of 2% urea in Dwarf Cavendish and Giant Cavendish banana (Venkatarayappa *et al.*, 1979) and by feeding the bunch with 500g fresh cowdung blended with 20g urea in banana cv. Martman (Shira *et al.*, 2012)

Table 4.4. Influence of different bunch management practices on hand weight and their % increase over control in banana cv. Grand Naine (AAA)

	Treatments	Hand weight (kg)	% increase over control
T_1.	Spraying of 1.0% Urea	2.83	54.64
T_2.	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	2.94	60.65
T_3.	Spraying of 0.5%Potassium nitrate (PN)	2.23	21.86
T_4.	Spraying of 0.5% Potassium sulphate (PS)	2.53	38.25
T_5.	Spraying of 0.5% Ammonium sulphate (AS)	2.65	44.81
T_6.	Spraying of 0.25% PN + 0.25% PDP	2.50	36.61
T_7.	Spraying of 0.25% PS + 0.5% Urea	2.75	50.27
T_8.	Spraying of 0.25% AS+ 0.25% PDP	2.53	38.25
T_9.	Spraying of 0.25% PDP + 0.5% Urea	3.08	68.30
T_{10}.	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	2.75	50.27
T_{11}.	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	2.25	22.95
T_{12}.	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	2.30	25.68
T_{13}.	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	2.27	24.04
T_{14}.	Control (without any spray and bunch feeding)	1.83	-
	SEm (±)	0.131	-
	CD (P=0.05)	0.384	-

Fig.4. Influence of different bunch management practices on Hand weight in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

Plate 5: Influence of different bunch management practices on hands of banana (T_1-T_6)

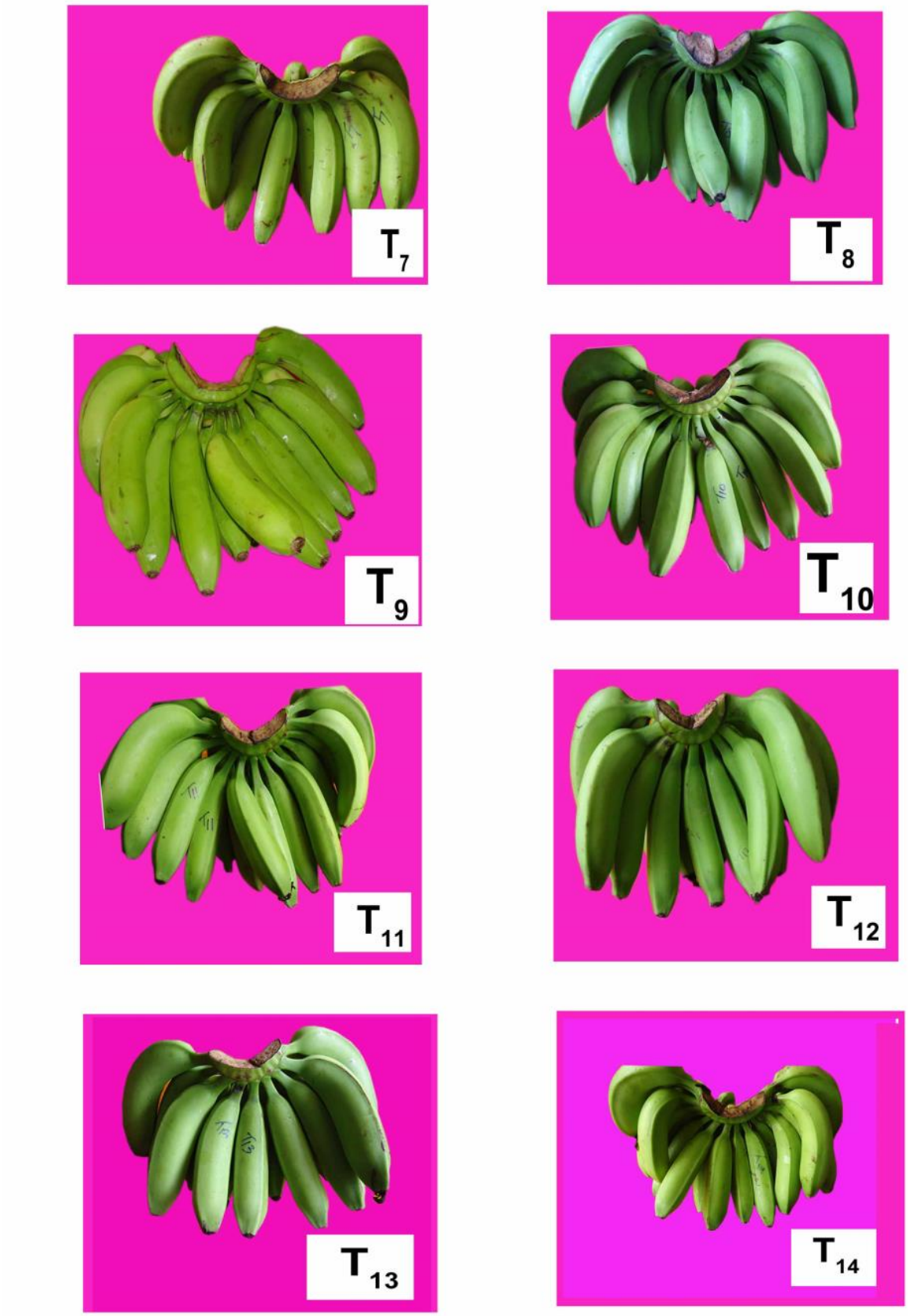


Plate 6: Influence of different bunch management practices on hands of banana (T_7-T_{14})

4.1.9 Weight of a bunch (kg)

Bunch weight was significantly influenced by different treatments (Table 4.5. and Fig 5.). Significantly the highest bunch weight was recorded with the spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea (22.84 kg) which was observed to be on par with spraying of 0.5% potassium dihydrogen phosphate (21.97 kg).Whereas, the lowest bunch weight was noticed from control (18.18 kg).

Among bunch management treatments high percentage increase of bunch weight was recorded in foliar treatments when compared to bunch feeding treatments and control. This might be due to availability of nutrients to the whole plant in case of bunch spray treatments compared to bunch alone in bunch feeding treatments. Highest percent increase of bunch weight over control was observed in spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea (25.63%).

This increase in bunch weight was due to the increase in fruit characters, such as, finger length, finger girth, finger weight and hand weight in plants receiving supplemental foliar urea and Potassium dihydrogen phosphate at post shooting stage which have close bearing on general appeal of the hands tending to increase its marketable value.

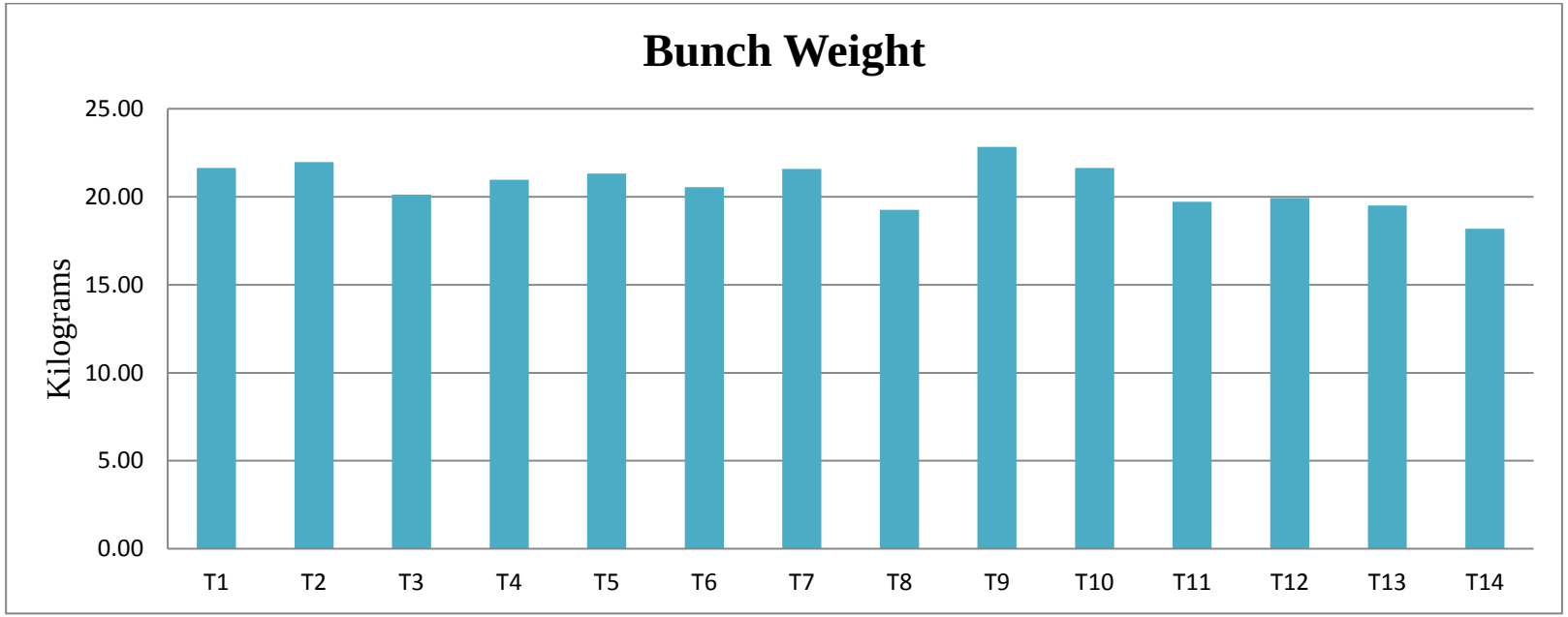
Baruah and Mohan (1991) indicated that the reduced longevity of banana leaves was due to high mobility of potassium from old leaves to other parts and as a result the leaf duration was severely hampered by low K content. In banana, retention of higher chlorophyll pigment in leaves and developing fruits during post shooting stage reflects the efficiency of photosynthesis results in maintaining a better photosynthetic status in plants which helps the bunch to accumulate more photosynthates, thus reflecting in bunch size and yield. Post shooting foliar supplementation of major nutrients might have helped in enhanced the longevity of the leaves in banana.

Similar increase in bunch weight with foliar application of sulphate of potash was observed in banana by Kumar *et al*. (2008) in cv. Robusta, Kumar and Kumar (2009) in cv.Nendran , Buragohain and Shanmugavelu (1986) in cv. Vayal vazhai and Nandan *et al.* (2011) in cv. Nanjangudu Rasabale.

Table 4.5. Influence of different bunch management practices on bunch weight and their % increase over control in banana cv. Grand Naine (AAA)

	Treatments	Bunch weight (kg)	% increase over control
T_1.	Spraying of 1.0% Urea	21.64	19.03
T_2.	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	21.97	20.85
T_3.	Spraying of 0.5%Potassium nitrate (PN)	20.12	10.67
T_4.	Spraying of 0.5% Potassium sulphate (PS)	20.97	15.35
T_5.	Spraying of 0.5% Ammonium sulphate (AS)	21.32	17.27
T_6.	Spraying of 0.25% PN + 0.25% PDP	20.54	12.98
T_7.	Spraying of 0.25% PS + 0.5% Urea	21.59	18.75
T_8.	Spraying of 0.25% AS+ 0.25% PDP	19.25	5.86
T_9.	Spraying of 0.25% PDP + 0.5% Urea	22.84	25.63
T_{10}.	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	21.63	18.98
T_{11}.	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	19.71	8.42
T_{12}.	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	19.92	9.57
T_{13}.	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	19.50	7.26
T_{14}.	Control (without any spray and bunch feeding)	18.18	-
	SEm (±)	0.343	-
	CD (P=0.05)	1.004	-

Fig.5. Influence of bunch management practices on Bunch weight in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

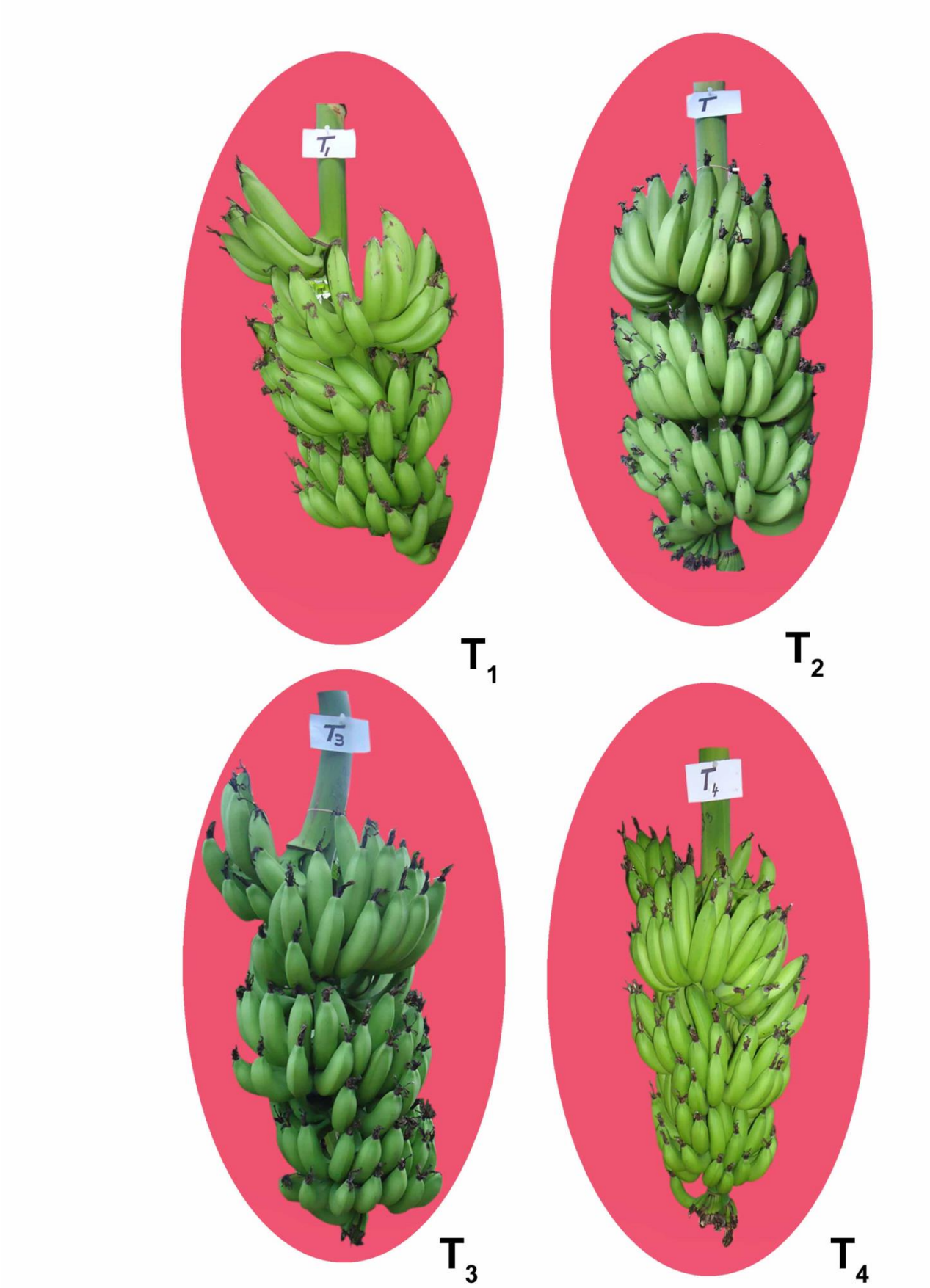


Plate 7: Influence of different bunch management practices on bunches of banana (T_1-T_4)

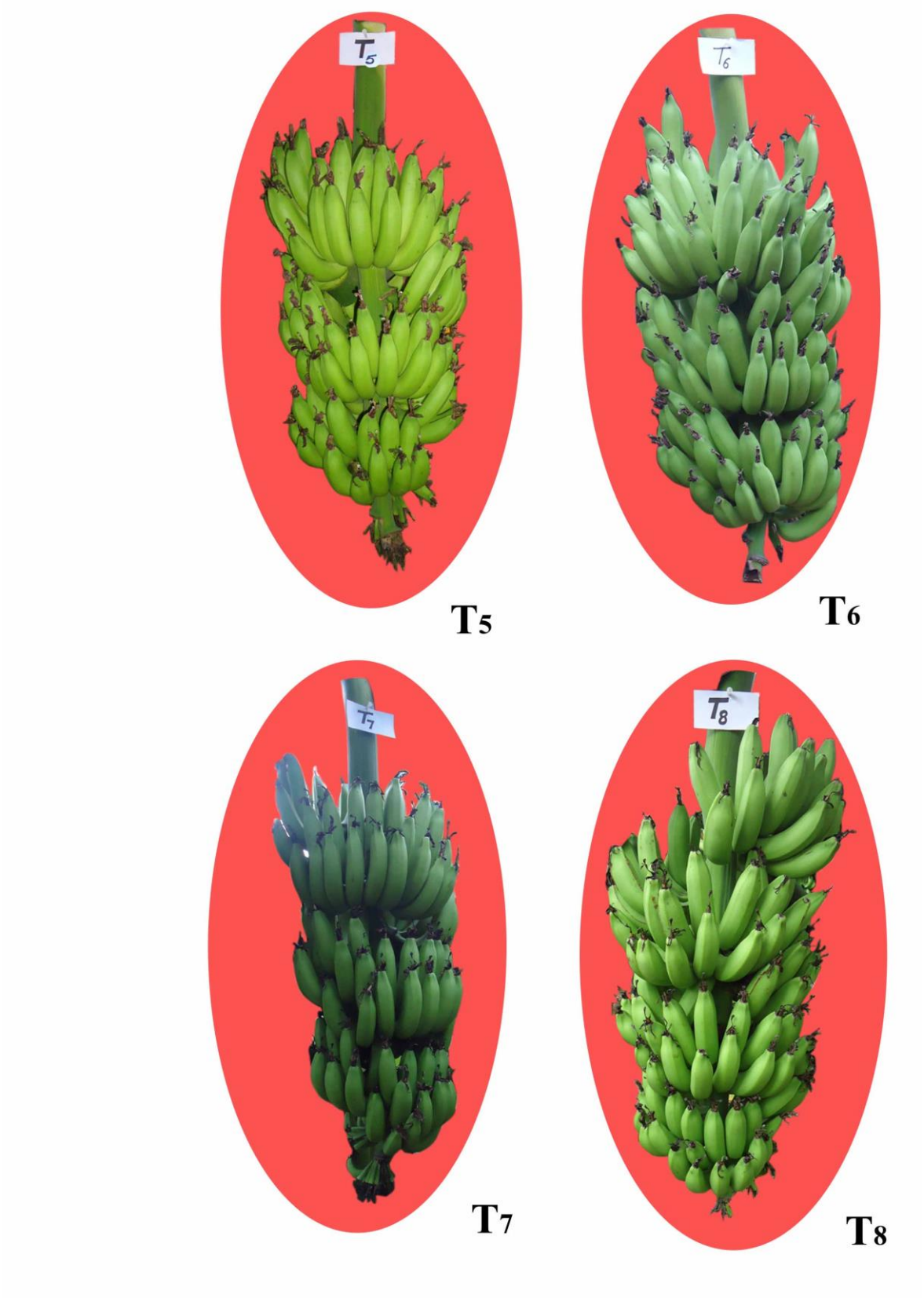


Plate 8: Influence of different bunch management practices on bunches of banana (T_5-T_8)

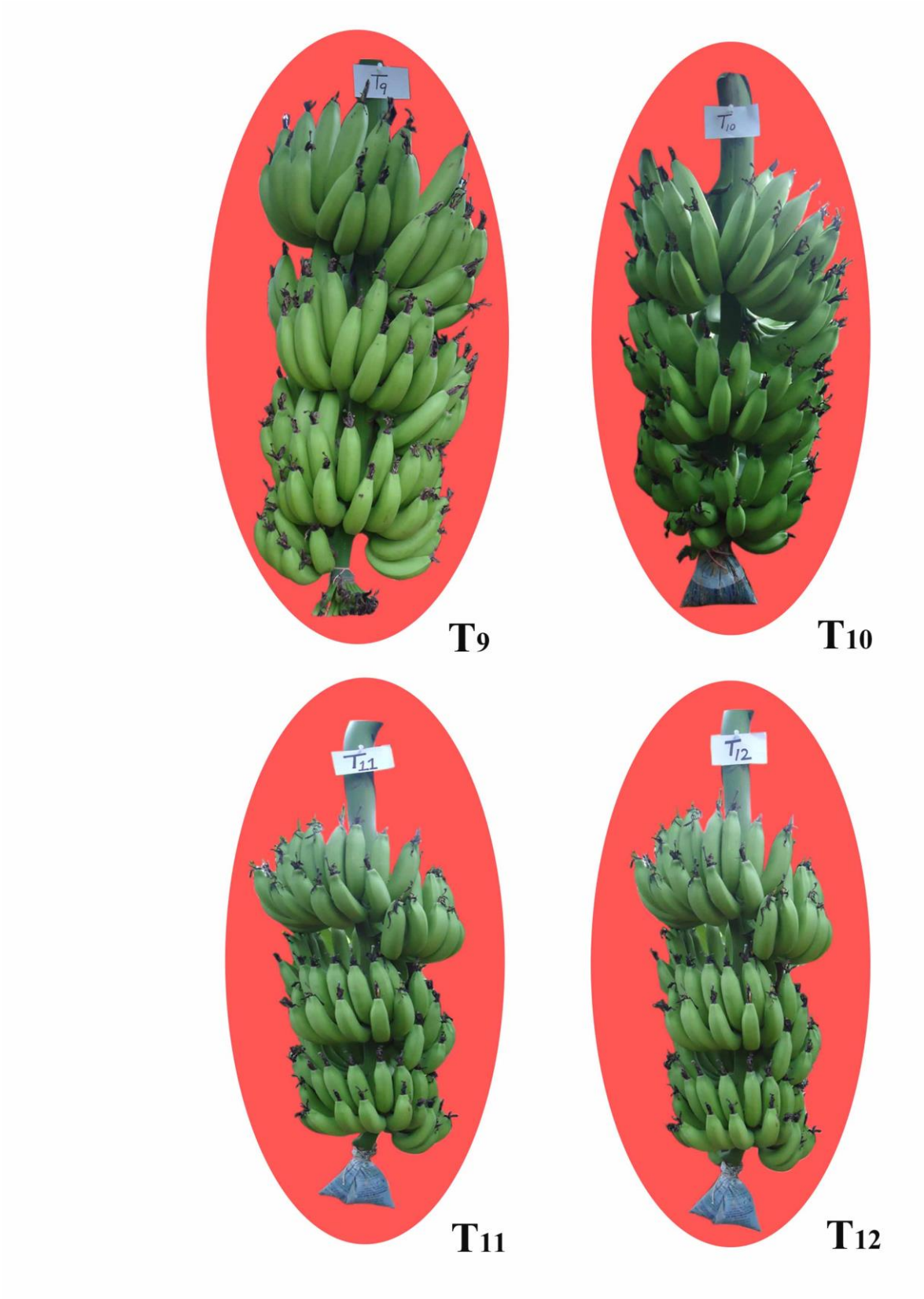


Plate 9: Influence of different bunch management practices on bunches of banana (T_9-T_{12})

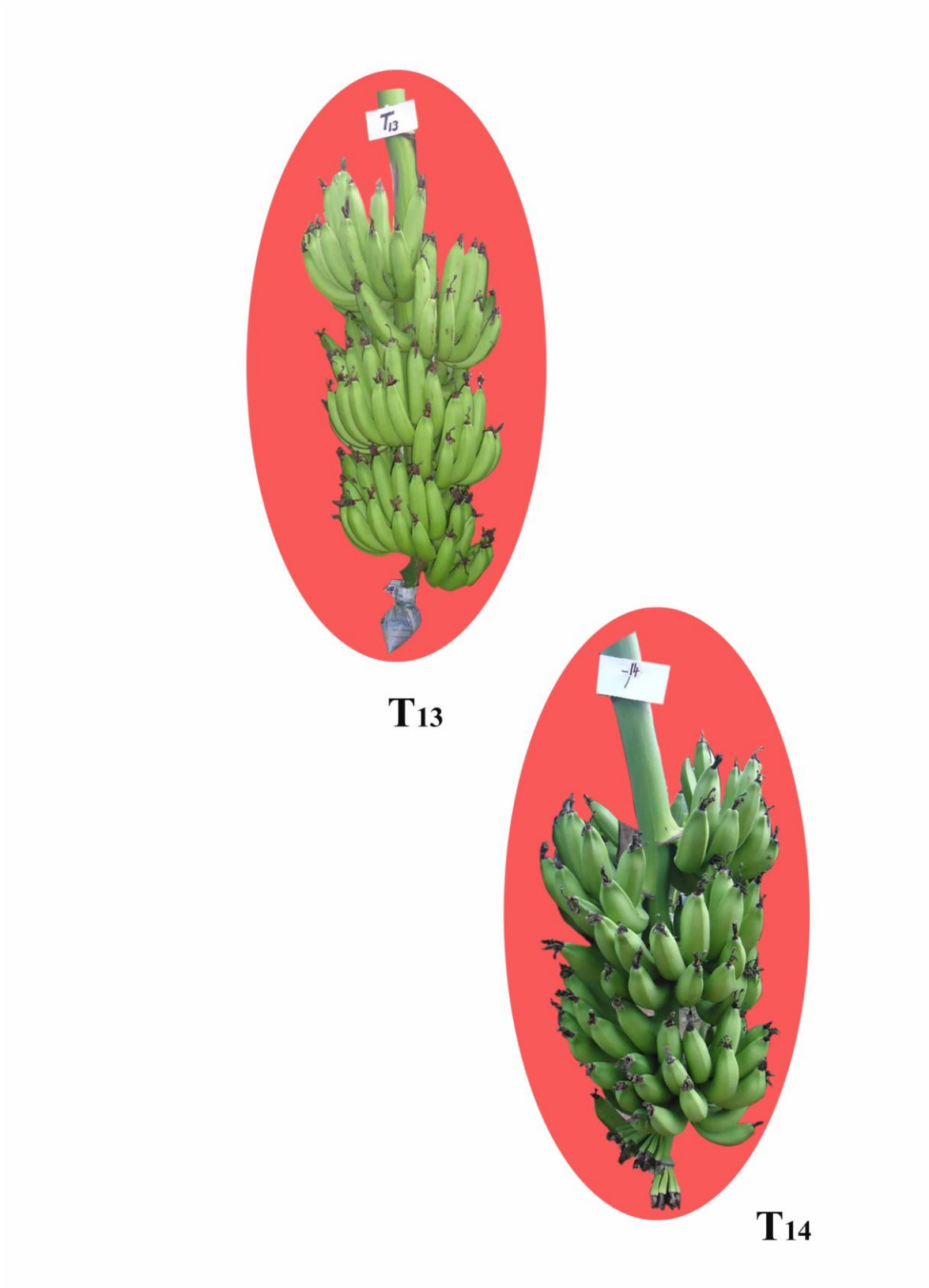


Plate 10: Influence of different bunch management practices on bunches of banana (T_{13}-T_{14})

4.1.10 Weight of peel (g)

The weight of peel influenced by different treatments are presented in Table 4.6 and Fig 6.

Significantly the highest peel weight of finger after ripening was observed in bunch feeding treatment with cowdung slurry containing 0.5% potassium nitrate + 0.5% potassium dihydrogen phosphate (44.04 g) which was found to be on par with bunch feeding treatment of cowdung slurry containing 0.5% potassium sulphate + 1.0% urea (42.83g) and spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea (42.18g). Whereas, the least peel weight of a finger after ripening was recorded with spraying of 0.25% potassium nitrate + 0.25% potassium dihydrogen phosphate (30.95g).

The data indicates that bunch feeding treatments recorded maximum peel weight after ripening compared to spraying of nutrients. The differences among treatments for peel weight might be due to differential rate of transfer of water from peel to pulp due to probable change in osmatic pressure between pulp and peel.

4.1.11 Weight of pulp (g)

The data on weight of a pulp recorded after ripening by different treatments are presented in Table 4.6 and Fig 6. The results indicated that post shooting spraying and bunch feeding of different chemicals increased the mean weight of pulp after ripening when compared with the control.

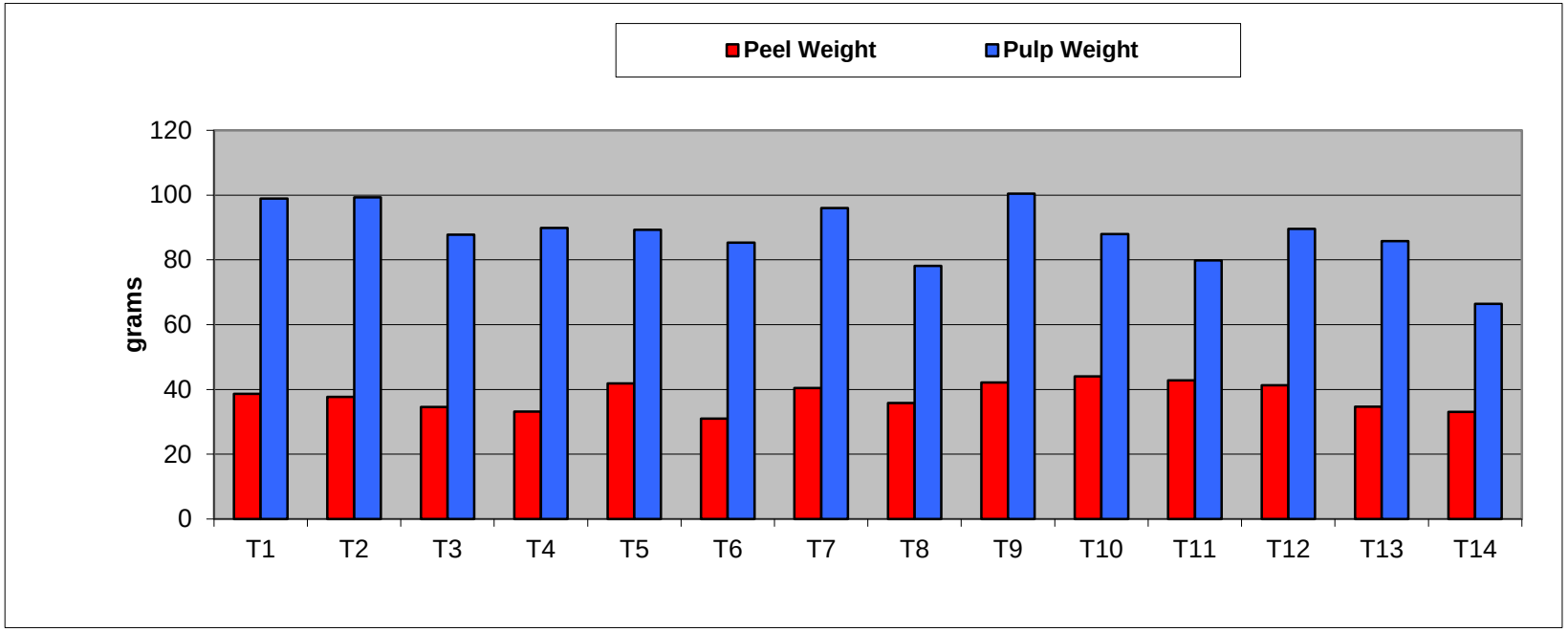
Post shooting spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea produced fingers with high pulp weight (100.46g) which was on par with spraying of 0.5% potassium dihydrogen phosphate (99.30g) and spraying of 1.0% urea (98.93g). Whereas, the lowest pulp weight of finger after ripening was recorded in control (66.48g).

The increase in fruit pulp weight was due to increased fruit size and weight might be due to higher photosynthetic activity in effective leaves and supplied developing fingers with current photosynthates for proper filling of fingers resulting in higher pulp weight by beneficial effect of urea and KH_2PO_4.

Table 4.6. Influence of different bunch management practices on peel weight and pulp weight after ripen in banana cv. Grand Naine (AAA)

	Treatments	Peel weight (g)	Pulp weight (g)
T_1.	Spraying of 1.0% Urea	38.61	98.93
T_2.	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	37.73	99.30
T_3.	Spraying of 0.5%Potassium nitrate (PN)	34.56	87.77
T_4.	Spraying of 0.5% Potassium sulphate (PS)	33.20	89.84
T_5.	Spraying of 0.5% Ammonium sulphate (AS)	41.90	89.35
T_6.	Spraying of 0.25% PN + 0.25% PDP	30.95	85.37
T_7.	Spraying of 0.25% PS + 0.5% Urea	40.43	96.02
T_8.	Spraying of 0.25% AS+ 0.25% PDP	35.80	78.19
T_9.	Spraying of 0.25% PDP + 0.5% Urea	42.18	100.46
T_{10}.	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	44.04	88.03
T_{11}.	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	42.83	79.89
T_{12}.	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	41.32	89.56
T_{13}.	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	34.64	85.83
T_{14}.	Control (without any spray and bunch feeding)	33.09	66.48
	SEm (±)	0.717	1.103
	CD (P=0.05)	2.096	3.225

Fig.6. Influence of different bunch management practices on Weight of pulp and peel in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

4.1.12 Pulp to peel ratio

Significant differences were observed among the treatments regarding pulp to peel ratio (Table 4.7. and Fig 7.). Regarding pulp to peel ratio, results revealed that all the treatments were effective in increasing pulp to peel ratio compared to the control except T_{11} (Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea)

The highest pulp to peel ratio was obtained when 0.25% potassium nitrate + 0.25% potassium dihydrogen phosphate (2.76) was sprayed on whole plant after bunch emergence (T_6) followed by spraying of 0.5% potassium sulphate (2.71). While, the lowest pulp to peel ratio was noticed in bunch feeding with cowdung slurry containing 0.5% potassium sulphate + 1.0% urea (1.87).

Pulp to peel ratio reflects the maximum conversion of starch to sugar. The moisture content of the pulp increases as the fruit ripens, the additional water being derived from the carbohydrates utilized in respiration. Due to this there was drastic reduction in starch content and phenomenal increase in sugar content in the pulp, resulting in an increase in osmotic pressure in the pulp which enables the pulp to draw water from the skin, thereby changing the pulp to peel weight ratio (Gore, 1914).

The increase in pulp to peel ratio in T_6 might be due to beneficial function of nitrate nitrogen and the prevalence of K^+ ions in KNO_3 and KH_2PO_4 might favoured in conversion of starch into simple sugars during ripening activating the sucrose synthatase enzyme thus resulting in osmotic pressure in the pulp.

The favourable effects of potassium in increasing the pulp to peel ratio have also reported by Kumar *et al*. (2008) in banana cv. Robusta and Kumar and Kumar (2009) in banana cv. Nendran.

4.1.13 Thickness of peel (mm)

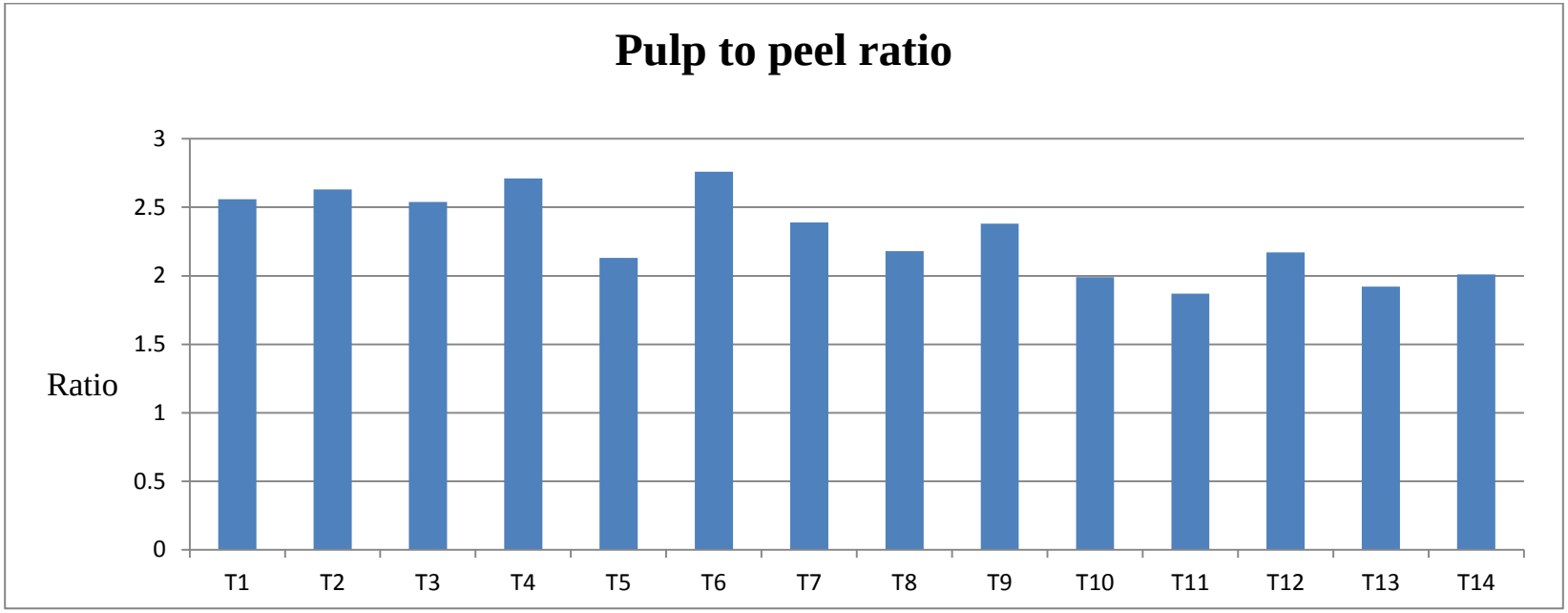
The data presented in the Table 4.7 and Fig 8. Show highly significant variation among the treatments with respect to thickness of peel after ripening.

The lowest peel thickness was noticed in treatment with foliar spraying of 1.0% urea (2.52 mm) after bunch emergence. While, the highest thickness of peel after ripening was noticed in control (3.35 mm). Reduction in the thickness of peel after ripening was due to the movement of photosynthates from peel to the pulp. Increased fruit N and K contents resulting from the supplemental foliar application was accompanied by conversion of starch to sugars which move from peel to pulp resulting in reduction in thickness of peel.

Table 4.7. Influence of different bunch management practices on pulp to peel ratio and thickness of peel in banana cv. Grand Naine (AAA)

	Treatments	Pulp to peel ratio	Thickness of Peel (mm)
T_1.	Spraying of 1.0% Urea	2.56	2.52
T_2.	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	2.63	2.85
T_3.	Spraying of 0.5%Potassium nitrate (PN)	2.54	2.70
T_4.	Spraying of 0.5% Potassium sulphate (PS)	2.71	2.86
T_5.	Spraying of 0.5% Ammonium sulphate (AS)	2.13	2.81
T_6.	Spraying of 0.25% PN + 0.25% PDP	2.76	2.67
T_7.	Spraying of 0.25% PS + 0.5% Urea	2.39	2.67
T_8.	Spraying of 0.25% AS+ 0.25% PDP	2.18	2.83
T_9.	Spraying of 0.25% PDP + 0.5% Urea	2.38	2.88
T_{10}.	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	1.99	2.87
T_{11}.	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	1.87	3.09
T_{12}.	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	2.17	2.61
T_{13}.	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	1.92	3.10
T_{14}.	Control (without any spray and bunch feeding)	2.01	3.35
	SEm (±)	0.050	0.071
	CD (P=0.05)	0.147	0.209

Fig.7. Influence of bunch management practices on Pulp to peel ratio in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

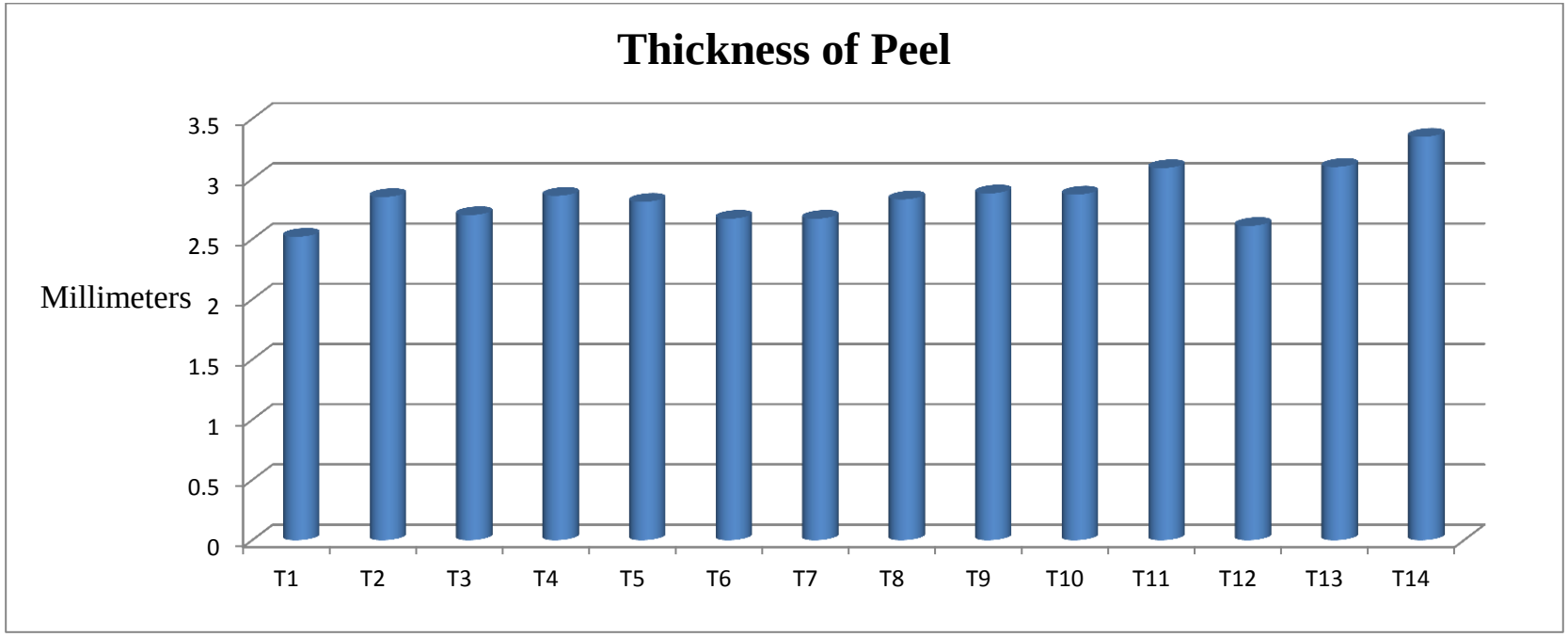
T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

Fig.8. Influence of bunch management practices on Thickness of peel in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

4.2 Fruit quality characters

4.2.1 Total soluble solids (^{0}B)

Total soluble solids content in fruits were significantly influenced by different treatments and are presented in Table 4.8 and Fig 9.

The highest content of total soluble solids was observed in the treatment with foliar application of 0.25% potassium dihydrogen phosphate + 0.5% urea (23.30 ^{0}B) which was found to be on par with spraying of 0.5% potassium nitrate (23.12 ^{0}B), bunch feeding with cowdung slurry containing 0.5% potassium sulphate + 1.0% urea (23.08 ^{0}B), spraying of 0.25% potassium sulphate + 0.5% urea (23.05 ^{0}B), spraying of 0.25% potassium nitrate + 0.25% potassium dihydrogen phosphate (23.00 ^{0}B) and bunch feeding with cowdung slurry containing 0.5% ammonium sulphate + 0.5% potassium dihydrogen phosphate (22.87 ^{0}B). The TSS content was significantly less in fingers obtained from plants in treatment control (18.77 ^{0}B).

An appreciable increase in total soluble solids content was observed with the supplemental application of N and K, through foliar and bunch feeding treatments was accompanied by a higher sugar impact and accumulation. This increase in TSS content of fruits might be due to both nutrients are helpful in photosynthesis which ultimately led the accumulation of carbohydrates which helped in increase of TSS content of the fruit.

Ashok kumar and shanmugavelu (1978) obtained better TSS with increased potassium levels in banana and similar results were observed by Sheela (1982) in Palayankondan banana, Satheesh and Bangaruswamy (2006) in banana cv. Rasthali, Kumar *et al*. (2008) in banana cv. Robusta, Kumar and Kumar (2009) in banana cv. Nendran and Nandan *et al*., (2011) in banana cv. Nanjangudu Rasabale.

4.2.2 Titrable Acidity (%)

Titrable acidity in fruits was significantly influenced by different bunch management treatments (Table 4.8. and Fig 10.).

The data revealed that acid content in fruits reduced under the effect of all treatments in comparison to control. Among the treatments significantly lowest acidity was recorded in the treatment with spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea (0.141%) and it was on par with spraying of potassium dihydrogen phosphate (0.143%). Whereas, maximum acidity was observed in control (0.182%).

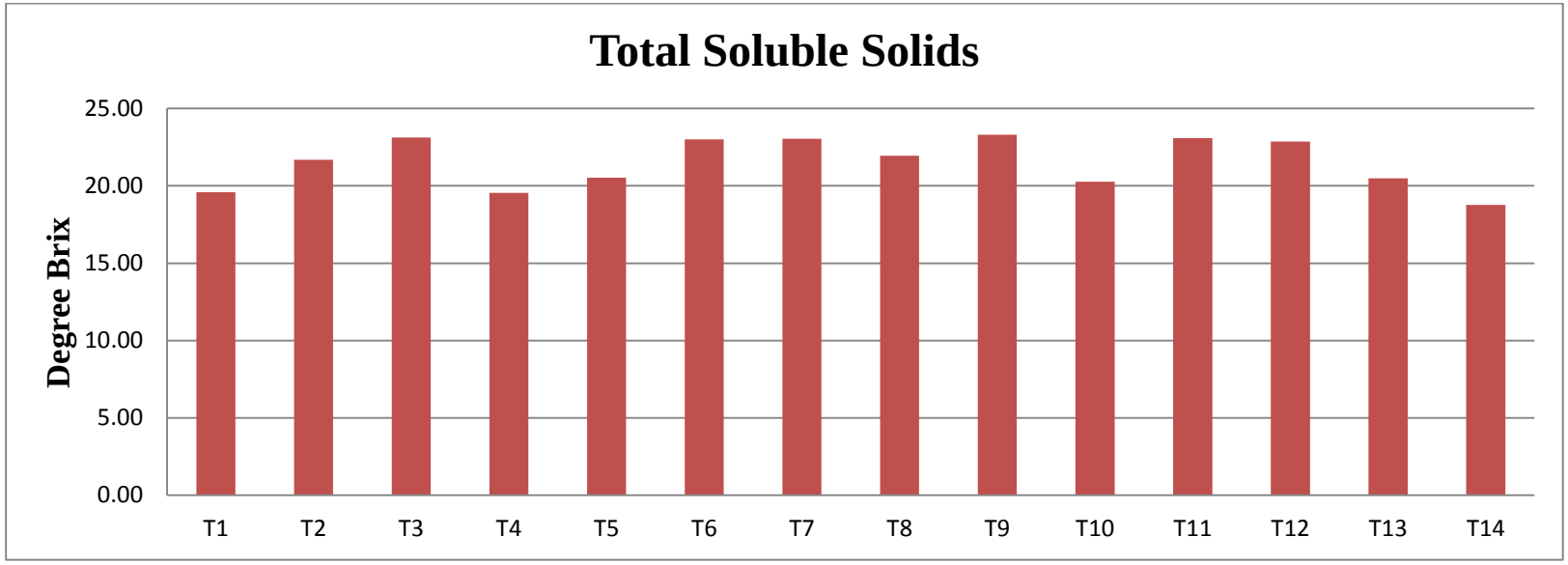
The reason for decrease in acidity due to additional nutrient supply might be due to increased translocation of carbohydrates and increased metabolism due to conversion of acids to sugars, thus bringing about reduction in acid percentage, as sugars and acid are inversely related (Nandan Kumar *et al.*,2011).

Supplemental dose of K as post shooting foliar application resulted in reduced acid content of fruits. Reduced acid content of fruits under low K regimes could be explained by an apparent shunting of phosphoenol pyruvate into alternate pathways resulting in a shortage of acetyl Co-A (Pattee and Teel, 1967). Hence, oxalo acetate appeared to be preferentially formed from PEP in plants with low levels of potassium and this organic acid derivative accumulated. Neutralization of organic acids due to high potassium level in tissues could have also resulted in reduction in acidity (Tisdale and Nelson, 1966). The above results are in line with those reported by Kumar *et al.* (2008) in banana cv. Robusta, Kumar and Kumar (2009) in banana cv. Nendran and Sharma *et al.* (2008) in ber cv. Umran.

Table 4.8. Influence of different bunch management practices on total soluble solids and acidity in banana cv. Grand Naine (AAA)

	Treatments	Total soluble solids (^{0}B)	Acidity (%)
T_1.	Spraying of 1.0% Urea	19.58	0.150
T_2.	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	21.68	0.143
T_3.	Spraying of 0.5%Potassium nitrate (PN)	23.12	0.164
T_4.	Spraying of 0.5% Potassium sulphate (PS)	19.54	0.155
T_5.	Spraying of 0.5% Ammonium sulphate (AS)	20.53	0.168
T_6.	Spraying of 0.25% PN + 0.25% PDP	23.00	0.148
T_7.	Spraying of 0.25% PS + 0.5% Urea	23.05	0.145
T_8.	Spraying of 0.25% AS+ 0.25% PDP	21.94	0.170
T_9.	Spraying of 0.25% PDP + 0.5% Urea	23.30	0.141
T_{10}.	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	20.27	0.175
T_{11}.	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	23.08	0.157
T_{12}.	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	22.87	0.162
T_{13}.	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	20.49	0.177
T_{14}.	Control (without any spray and bunch feeding)	18.77	0.182
	SEm (±)	0.242	0.002
	CD (P=0.05)	0.708	0.005

Fig.9. Influence of bunch management practices on Total soluble solids in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

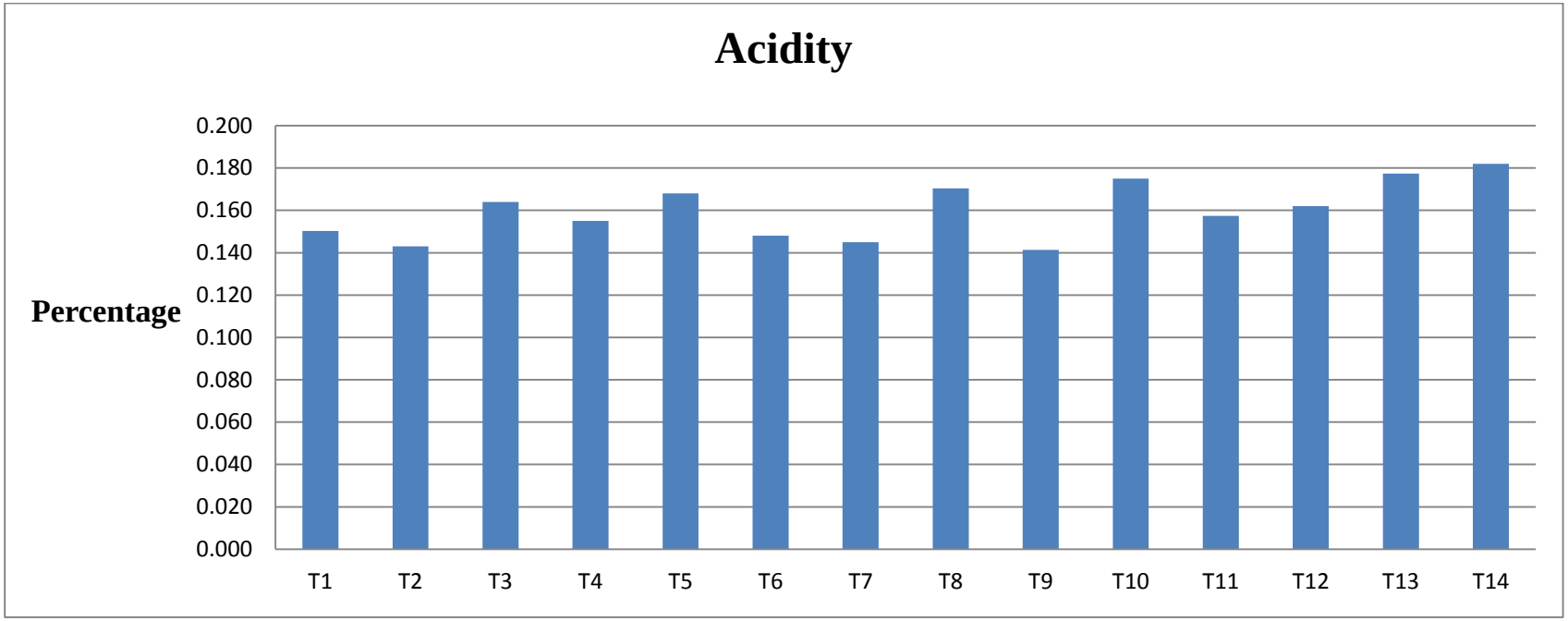
T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

Fig.10. Influence of different bunch management practices on acidity in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

4.2.3 Total sugars (%)

The data presented in Table 4.9 and Fig 11. Showed different bunch management treatments had significant effect on total sugars in banana.

The data indicates that maximum total sugars was observed in fruits obtained from the plants sprayed with 0.25% potassium dihydrogen phosphate + 0.5% urea (18.75%) which significantly superior over all the treatments followed by spraying of 0.5% potassium dihydrogen phosphate (17.02%). Whereas, it was observed to be minimum in control (13.45%).

4.2.4 Reducing sugars (%)

The data presented in Table 4.9 and Fig 11. indicates effect of different chemical spraying and bunch feeding treatments on reducing sugars in banana fruit.

The highest percentage of reducing sugars in fruits was recorded in plants treated by spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea (7.66%) which significantly superior over all the treatments followed by spraying of 0.5% potassium dihydrogen phosphate (7.21%). While, the lowest percentage was noticed in control (5.10%).

4.2.5 Non-reducing sugars (%)

The data pertaining to non-reducing sugars in banana fruits were significantly influenced by different treatments were presented in Table 4.9 and Fig 11.

Foliar spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea (11.09%) on plants recorded maximum non-reducing sugars in fruits of banana, followed by spraying of 0.25% potassium sulphate + 0.5% urea (10.14%). The minimum was observed in control (8.16%).

From the above results it could be inferred that additional dose of potassium as post shooting spray of potassium dihydrogen phosphate resulted in increase the fruit sugar content in banana.

Potassium is often referred as the quality element for crop production (Usherwood, 1985) and it has been widely proven to have a crucial role in many fruit quality parameters like fruit size, soluble solids, total sugars as well as shelf life are significantly influenced by adequate supply of potassium (Ganesh murthy *et al.,* 2011).

The highest fruit quality especially higher sugar content such as reducing, non-reducing and total sugars can be explained by the role of potassium which is involved in carbohydrate synthesis, breakdown and translocation and synthesis of protein and neutralisation of physiologically important organic acids (Tisdale and Nelson, 1966).

Potassium is responsible for energy production in the form of ATP and NADPH in chloroplasts by maintaining balanced electric charges. Besides, K is involved in phloem loading and unloading of sucrose and amino acids and storage in the form of starch in developing fruits by activating the enzyme starch synthase (Mengel and Kirkby, 1987). Post shooting application of potassium also favours the conversion of starch into simple sugars during ripening by activating sucrose synthase enzyme, resulting in higher sugar content in fruits.

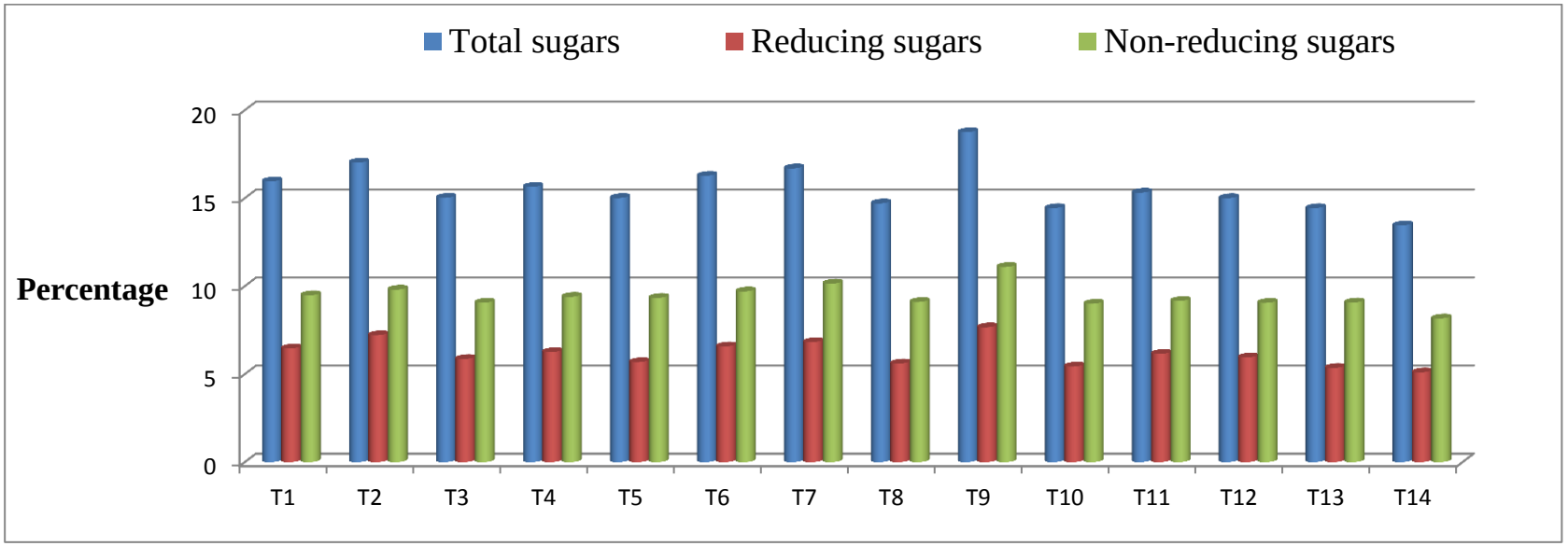
The strong positive correction between fruit K concentration and fruit sugar contents was also observed and suggested that acid invertase activity might be retained longer in fruits with higher K concentrations than low K fruit (Laster *et al*., 2005).

The results are in line with those obtained by Lin *et al.,* 2004 and Laster *et al.,* 2006 who observed that supplemental foliar K spray increased fruit sugar concentration in muskmelon.

Table 4.9. Influence of different bunch management practices on total, reducing and non–reducing sugars in banana cv. Grand Naine (AAA)

	Treatments	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
T_1.	Spraying of 1.0% Urea	15.95	6.46	9.48
T_2.	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	17.02	7.21	9.80
T_3.	Spraying of 0.5%Potassium nitrate (PN)	15.02	5.86	9.06
T_4.	Spraying of 0.5% Potassium sulphate (PS)	15.64	6.25	9.39
T_5.	Spraying of 0.5% Ammonium sulphate (AS)	15.01	5.68	9.33
T_6.	Spraying of 0.25% PN + 0.25 PDP	16.27	6.57	9.70
T_7.	Spraying of 0.25% PS + 0.5% Urea	16.69	6.82	10.14
T_8.	Spraying of 0.25% AS+ 0.25% PDP	14.70	5.60	9.10
T_9.	Spraying of 0.25% PDP + 0.5% Urea	18.75	7.66	11.09
T_{10}.	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	14.43	5.43	9.00
T_{11}.	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	15.31	6.15	9.16
T_{12}.	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	15.00	5.95	9.05
T_{13}.	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	14.43	5.35	9.07
T_{14}.	Control (without any spray and bunch feeding)	13.45	5.10	8.16
	SEm (±)	0.292	0.073	0.283
	CD (P=0.05)	0.854	0.213	0.829

Fig.11. Influence of bunch management practices on Reducing, Non- reducing and Total sugars in banana cv. Grand Naine (AAA).



T_1 - Spraying of 1.0% Urea

T_2 - Spraying of 0.5% Potassium dihydrogen phosphate

T_3 - Spraying of 0.5%Potassium nitrate

T_4 - Spraying of 0.5% Potassium sulphate

T_5 - Spraying of 0.5% Ammonium sulphate

T_6 - Spraying of 0.25% PN + 0.25 PDP

T_7 - Spraying of 0.25% PS + 0.5% Urea

T_8 - Spraying of 0.25% AS+ 0.25% PDP

T_9 - Spraying of 0.25% PDP + 0.5% Urea

T_{10} - Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP

T_{11} - Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea

T_{12} - Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP

T_{13} - Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea

T_{14} - Control (without any spray and bunch feeding)

4.3 Physiological characters

4.3.1 Physiological loss in weight (%)

Physiological loss in weight significantly influenced by different treatments and the data presented in Table 4.10 and Fig 12.

The different bunch management treatments showed their significant effects on physiological loss in weight of fruits. Spraying of 0.5% ammonium sulphate (T_5) recorded the maximum physiological loss in weight of 21.14 percent and it was on par with spraying of 0.25% ammonium sulphate + 0.25% potassium dihydrogen phosphate (20.73 %). While, minimum physiological loss in weight was observed when bunch feeding was done with cowdung slurry containing 0.5% potassium nitrate + 0.5% potassium dihydrogen phosphate (13.34%).

Foliar or bunch feeding of ammonium sulphate either alone or in combination with potassium dihydrogen phosphate appeared to hasten fruit ripening and to accelerate physiological loss in weight. Presence of sulphur in ammonium sulphate has a synergistic effect with zinc which is essential for carbondioxide absorption and utilization which resulted increase in the rate of respiration which directly correlated to loss of moisture from the fruit results in more physiological loss in weight (Mustaffa *et al.*, 2004).

Increased potassium application reduces the post harvest moisture loss by increasing the weight of the harvested organs and maintaining tissue integrity as the storage compounds accumulating in the harvested produce during growth and maturation are consumed in the course of metabolic activities during storage (IPI, 2013). The results were in close conformity with the findings of Kumar *et al*. (2008) in banana cv. Robusta, Kumar and Kumar (2009) in banana cv. Nendran and Rajive *et al*. (2013) in ber also reported reduction in physiological loss in weight percent with either foliar spray treatment or bunch feeding with potassium.

4.3.2 Shelf life (days)

Shelf life of the fruits was significantly influenced by different treatments (Table 4.10. and Fig 13.).

Fruits obtained with the foliar spraying of 0.5% potassium dihydrogen phosphate (11.63 days) had shown significantly higher shelf life and it was on par with spraying of 0.5% potassium sulphate (11.40 days). Shorter shelf life was noticed in fruits obtained from control (9.07 days).

Weight loss from harvested fruits i.e. physiological loss in weight especially under tropical conditions causes severe loss to the producer and seller which also leads to quality deterioration with low consumer preference. Several workers have tried post shooting nutrient treatments to reduce weight loss in fruits (Sweitlik and Faust, 1984). Increased shelf life of potassium treated fruits compared to control, might be an indirect consequence of enhanced phloem transport of calcium to fruits perhaps due to increased osmotic potential in fruit cells due to higher K^+ there by increased uptake of calcium might have enhanced firmness and shelf life of fruits (Laster *et al.*, 2005).

Lester and Grusek (1999) revealed that, inadequate soil K supply also reduces translocation of amino acids and minerals such as magnesium and calcium which are essential for fruit quality and post harvest shelf life in melon. Extension of shelf life with the application of potassium was also observed by Nandan *et al.* (2011) in banana cv. Nanjangudu Rasabale, Kumar *et al.* (2008) in banana cv. Robusta, Kumar and Kumar (2009) in banana cv. Nendran, Dutta *et al.* (2011) in mango and Rajive Kumar *et al.* (2013) in ber.

Table 4.10. Influence of different bunch management practices on physiological loss in weight and shelf life in banana cv. Grand Naine (AAA)

	Treatments	Physiological loss in weight (%)	Shelf life (days)
$T_{1.}$	Spraying of 1.0% Urea	15.96	10.73
$T_{2.}$	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	13.44	11.63
$T_{3.}$	Spraying of 0.5%Potassium nitrate (PN)	14.04	10.42
$T_{4.}$	Spraying of 0.5% Potassium sulphate (PS)	13.95	11.40
$T_{5.}$	Spraying of 0.5% Ammonium sulphate (AS)	21.14	9.96
$T_{6.}$	Spraying of 0.25% PN + 0.25% PDP	13.56	9.86
$T_{7.}$	Spraying of 0.25% PS + 0.5% Urea	14.82	9.10
$T_{8.}$	Spraying of 0.25% AS+ 0.25% PDP	20.73	9.97
$T_{9.}$	Spraying of 0.25% PDP + 0.5% Urea	14.51	10.87
$T_{10.}$	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	13.34	10.10
$T_{11.}$	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	15.85	10.63
$T_{12.}$	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	16.70	9.17
$T_{13.}$	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	15.49	9.73
$T_{14.}$	Control (without any spray and bunch feeding)	18.23	9.07
	SEm (±)	0.275	0.181
	CD (P=0.05)	0.803	0.529

4.4 Economics

The economic analysis (Table 4.11) of bunch management practices indicated that spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea gave maximum gross returns (319000.00) followed by spraying of 0.5% potassium dihydrogen phosphate (318859.40)

Foliar spraying of entire plant with 0.25% potassium dihydrogen phosphate + 0.5% urea thrice after bunch emergence resulted in highest B:C of 1.91 followed by spraying of 0.1% urea (1.70) and spraying of 0.25% potassium sulphate (1.70) compared to all other treatments.

Table 4.11. Economics of banana cv. Grand Naine cultivation per hectare as influenced by different bunch management practices.

	Treatments	Total cost of cultivation ha^{-1}	Gross returns ha^{-1}	Net returns ha^{-1}	Benefit :cost
$T_{1.}$	Spraying of 1.0% Urea	98,891.54	2,67,900.00	1,69,008.46	1.70
$T_{2.}$	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	1,19,925.72	3,18,859.40	1,98,933.68	1.66
$T_{3.}$	Spraying of 0.5%Potassium nitrate (PN)	1,15,759.62	2,92,009.61	1,76,249.99	1.52
$T_{4.}$	Spraying of 0.5% Potassium sulphate (PS)	1,12,473.03	3,04,346.00	1,91,872.97	1.70
$T_{5.}$	Spraying of 0.5% Ammonium sulphate (AS)	98,868.40	2,59,179.00	1,60,310.68	1.62
$T_{6.}$	Spraying of 0.25% PN + 0.25% PDP	1,17,842.67	2,98,105.24	1,80,262.56	1.53
$T_{7.}$	Spraying of 0.25% PS + 0.5% Urea	1,05,682.28	2,70,198.46	1,64,516.18	1.56
$T_{8.}$	Spraying of 0.25% AS+ 0.25% PDP	1,09,397.06	2,51,212.50	1,41,815.44	1.30
$T_{9.}$	Spraying of 0.25% PDP + 0.5% Urea	1,09,409.63	3,19,000.00	2,09,590.37	1.91
$T_{10.}$	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	1,13,297.70	2,85,386.22	1,72,088.52	1.52
$T_{11.}$	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	1,11,532.51	2,46,500.00	1,34,967.68	1.21
$T_{12.}$	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	1,12,313.26	2,49,400.00	1,37,086.74	1.22
$T_{13.}$	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	1,12,242.29	2,45,050.00	1,32,807.71	1.18
$T_{14.}$	Control (without any spray and bunch feeding)	92,512.32	1,96,000.00	1,03,487.68	1.12

Chapter-V

Summary and Conclusions

Chapter V

SUMMARY AND CONCLUSIONS

The present investigation entitled "**Studies on Bunch Management Practices in Tissue culture banana (*Musa spp*.) cv. Grand Naine (AAA)**" was conducted at Horticultural College and Research Institute, Anantharajupet, Y.S.R. Dist. Andhra Pradesh, during 2013-14. The experiment was laid out in Randomized block design (RBD) with fourteen treatments and three replications. The study included spraying of urea, potassium dihydrogen phosphate, potassium nitrate, potassium sulphate, ammonium sulphate. Spraying was done thrice first immediately after last hand had opened second at 30 days after first spray and third at 45 days after first spray to the entire plant including bunch and bunch feeding was done with cowdung with above chemical combinations was done after denavelling. The objectives of investigation was to study the influence of bunch feeding with different chemicals and different chemical sprays on yield, fruit grade and quality of banana.

Early maturity was observed in spraying with 0.25% potassium dihydrogen phosphate and 0.5% urea. No significant differences were noticed in case of both number of hands and fingers in a bunch.

Observations on fruit characters like finger length, finger girth, finger weight at harvest, hand weight, bunch weight and pulp weight were recorded maximum with spraying of 0.25% potassium dihydrogen phosphate and 0.5% urea. Whereas maximum finger weight after ripening were observed in spraying of 0.25% potassium sulphate + 0.5% urea. Bunch feeding with cowdung slurry containing 0.5% potassium nitrate + 0.5% potassium dihydrogen phosphate recorded the highest peel weight. Maximum pulp to peel ratio was observed in spraying of 0.5% potassium dihydrogen phosphate. Thickness of peel was highest in control.

Regarding to fruit quality parameters, the highest total soluble solids, total sugars, reducing sugars, non-reducing sugars and lowest acidity were observed in the treatment with spraying of 0.25% potassium dihydrogen phosphate and 0.5% urea which is significantly superior over all the treatments.

With regard to physiological characters the highest physiological loss in weight was observed in treatment with spraying of 0.5% ammonium sulphate. Maximum shelf life was noticed in the treatments with spraying of 0.5% potassium dihydrogen phosphate.

Economics of different treatments showed that foliar application of 0.25% potassium dihydrogen phosphate + 0.5% urea yielded better return in comparision to other treatments with highest B:C.

Conclusion

On the basis of the results obtained in the present investigation, it can be inferred that spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea has showed a beneficial influence on bunch yield, fruit quality and physiological characters and its attributes along with the highest benefit cost ratio.

Hence, spraying of 0.25% potassium dihydrogen phosphate + 0.5% urea can be recommended for tissue culture banana cv. Grand Naine (AAA) on large scale for getting bunches with quality standards for export and also getting higher yields with best quality fruits of higher shelf life in Rayalaseema region of Andhra Pradesh.

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Appendices

Appendix - I

Monthly meteorological data during the period of study

(2013-14)

MONTH	RELATIVE HUMUDITY (%)		TEMPERATURE (^{0}C)		RAINFALL (mm)	RAINY DAYS
	Morning 8.00 hrs.	Evening 14.00 hrs.	Max.	Min.		
October (2013)	86.7	36.4	30.8	22.4	182.1	9
November	86.6	36.1	28.9	22.1	54.0	3
December	86.8	36.8	26.3	17.9	8.0	1
January (2014)	87.1	38.9	25.8	18.6	NIL	NIL
February	86.1	36.5	28.8	19.0	NIL	NIL
March	85.1	35.7	35.2	25.3	NIL	NIL
April	85.6	36.0	39.6	26.6	25	1
May	85.2	33.0	40.0	26.6	56	2
June	84.8	35.2	36.6	26.1	95	2
July	84.7	34.5	32.6	25.1	46.2	2
August	85.0	34.0	31.8	24.5	166	8
September	83.0	33.3	29.4	23.9	96.9	7

Appendix – II

Cost of cultivation of Tissue culture banana cv.Grand Naine per hectare

S.No.	Particulars	Cost ha^{-1} (Rs/-)
1	Land preparation (Deep ploughing and harrowing)	10,000.00
2	Preparation of channels	2,210.00
3	Digging pits	6,500.00
4	**Cost of fertilizers treatments wise per hectare**	
4.1	Spraying of 1.0% Urea	259.22
4.2	Spraying of 0.5% Potassium dihydrogen phosphate (PDP)	21,293.40
4.3	Spraying of 0.5%Potassium nitrate (PN)	17,127.30
4.4	Spraying of 0.5% Potassium sulphate (PS)	13,840.71
4.5	Spraying of 0.5% Ammonium sulphate (AS)	236.08
4.6	Spraying of 0.25% PN + 0.25 PDP	19,210.35
4.7	Spraying of 0.25% PS + 0.5% Urea	7,049.96
4.8	Spraying of 0.25% AS+ 0.25% PDP	10,764.74
4.9	Spraying of 0.25% PDP + 0.5% Urea	10,777.31
4.10	Bunch feeding with cow dung slurry containing 0.5% PN + 0.5% PDP	14,905.38
4.11	Bunch feeding with cow dung slurry containing 0.5% PS + 1.0 % Urea	13,140.19
4.12	Bunch feeding with cow dung slurry containing 0.5% AS + 0.5% PDP	13,920.94
4.13	Bunch feeding with cow dung slurry containing 0.5% PDP + 1.0% Urea	13,849.97
4.14	Control (without any spray and bunch feeding)	-
5	80% RDF(Inorganic) + 20% RDF (FYM) + *Azospirillum* + PSB + FA	6,120.32
6	Irrigation	7,540.00

7	Weeding	13,200.00
8	Fertilizer application	16,800.00
9	Planting material	21,602.00
10	Planting	2,040.00
11	Labour cost for spraying of chemicals	6,120.00
12	Labour cost for bunch feeding	5,880.00
13	Plant protection	1,500.00
14	Harvesting and loading	5,000.00