Effect of Different Colour Plastic Mulches on Growth and Yield of Banana Crop

A Thesis submitted to the

Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722,
Dist. Ahmednagar, Maharashtra, (India)

by

Mr. Vinayak Digambar Paradkar
B. Tech. (Agril. Engg.)
Reg. No. 2014/13

in partial fulfillment of the requirements for the degree

of

Master of Technology
(Agricultural Engineering)

in

Irrigation and Drainage Engineering

Department of Irrigation and Drainage Engineering,
Dr. Annasaheb Shinde College of Agricultural Engineering,
Mahatma Phule Krishi Vidyapeeth,
Rahuri, Dist. Ahmednagar, M. S. (India)

June, 2016

Dedication

Affectionately Dedicated to

My Beloved

Parents, Respected Teachers and Friends

…….Mr. Vinayak Digambar Paradkar

Candidate's Declaration

I hereby declare that this thesis entitled**, "Effect of Different Colour Plastic Mulches on Growth and Yield of Banana Crop"** or any part thereof has not been previously submitted by me or any other person to any other University or Institute for a degree or diploma.

Place: MPKV, Rahuri **(V. D. Paradkar)**

Date : / /2016

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Certificate

This is to certify that the thesis entitled **"Effect of Different Colour Plastic Mulches on Growth and Yield of Banana Crop"** submitted to the Faculty of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (M.S.) in the partial fulfillment of the requirement for the award of degree of **Master of Technology (Agricultural Engineering)** in **Irrigation and Drainage Engineering,** embodies the results of a piece bonafide research work carried out by **Mr. Vinayak Digambar Paradkar** under my guidance and supervision and no part of thesis has been submitted to any other University or Institute for Degree or Diploma.

The assistance and help received during the course of this investigation have been duly acknowledged.

Place: M.P.K.V. Rahuri.

Date: / /2016 **(N. N. Firake)**

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This is to certify that the thesis entitled **"Effect of Different Colour Plastic Mulches on Growth and Yield of Banana Crop"** submitted by **Mr. Vinayak Digambar Paradkar** has been checked by us and we found it to be of sufficient standard for submission for the degree **of Master of Technology (Agricultural Engineering)** in **Irrigation and Drainage Engineering,** of Mahatma Phule Krishi Vidyapeeth, Rahuri.

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Date: / /2016 **(P. A. Turbatmath)**

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Place: MPKV, Rahuri

Date: / /2016 **(V. D. Paradkar)**

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List of Abbreviations

@	:	At the rate
%	:	Per cent
AVHRR	:	Advanced Very High Resolution Radiometer
BBPM	:	Blue Black Plastic Mulch
B: C ratio	:	Benefit cost ratio
C. D.	:	Critical Difference
cm	:	Centimetre
DAT	:	Days After Transplanting
Dept.	:	Department
dS m^{-1}	:	Deci Siemens per metre
EC	:	Electrical Conductivity
Eq.	:	Equation
ETc	:	Crop evapotranspiration
ETo	:	Reference evapotranspiration
Ep	:	Pan evaporation
EU	:	Emission Uniformity
et al.	:	And others
etc	:	Etcetera
Fig.	:	Figure
FUE	:	Fertilizer Use Efficiency
g	:	Gram
GWP	:	Ground Water Project
ha	:	Hectare
HP	:	Horse Power
hr	:	Hour
IDE	:	Irrigation and Drainage Engineering
i.e.	:	That is
K	:	Potassium (Kelium)
Kc	:	Crop coefficient
Kg	:	Kilogram

Kg ha^{-1}	:	Kilo gram per hectare
Km hr^{-1}	:	Kilo meter per hour
lit	:	Litre
m	:	Metre
M. S.	:	Maharashtra State
mm	:	Millimetre
MPKV	:	Mahatma Phule Krishi Vidyapeeth
N	:	Nitrogen
NM	:	No Mulch
NDVI	:	Normalized Difference Vegetative Index
NOAA	:	National Oceanic and Atmospheric Administration
PPM	:	Pervious Plastic Mulch
P	:	Phosphorus
PFDC	:	Precision Farming Development Center
pH	:	Negative logarithm of hydrogen ion
PVC	:	Polyvinyl Chloride
RBPM	:	Red Black Plastic Mulch
R	:	Replication
₹ ha^{-1}	:	Rupees per hectare
RDF	:	Recommended dose of fertilizer
SBPM	:	Silver Black Plastic Mulch
S. E.	:	Standard Error
t ha^{-1}	:	Tonnes per hectare
TM	:	Landsat Thematic Mapper
Var.	:	Variety
viz.	:	Namely
WBPM	:	White Black Plastic Mulch
WSF	:	Water Soluble Fertilizer
WUE	:	Water Use Efficiency
YBPM	:	Yellow Black Plastic Mulch

Abstract

Effect of Different Colour Plastic Mulches on Growth and Yield of Banana Crop

by

Vinayak Digambar Paradkar
Master of Technology
(Agricultural Engineering)
in

Irrigation and Drainage Engineering
Mahatma Phule Krishi Vidyapeeth, Rahuri,
Dist – Ahmednagar (Maharashtra)
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Irrigated agriculture has played a vital role in supporting a dramatic increase in global food production over recent decades. However, current irrigation practices such as furrows are inefficient, causing environmental hazards. Optimum irrigation can improve crop production, reduce yield variability, and increase profits. Plastic mulches are being used widely for many years, are known to effectively modify soil temperature. The greater marketable yield is observed with the use of plastic mulches (upto 24 to 65%) compared to bare soil, which is because of conservation of moisture, improved microclimate both beneath and above the soil surface, light reflection and great weed control.

Banana (*Musa paradisica* L.) is the fourth most important food crop in the world after rice, wheat and maize. The major hurdle in quality banana production is lack of professional outlook towards its production and mismanagement of available resources. The state of the land vegetative condition can be explained with the help of vegetative parameters such as Normalized Difference Vegetative Index (NDVI). Healthy vegetation will have higher value of the NDVI. The NDVI values ranges from -1 to +1 (pixel values 0 to 255). NDVI values vary with leaf characteristics.

In view of this, the present investigation was planned and executed at the Research cum Demonstration farm of PFDC, Dr. A. S. College of Agril. Engg., Mahatma Phule

Krishi Vidyapeeth, Rahuri during the period 2014-15. The present investigation aimed with specific objectives, to find out the effect of different colour plastic mulches on growth, yield and quality of banana crop, to compare the yield of banana under drip irrigation and surface irrigation, to determine the water requirement and water use efficiency of banana, to find out NDVI values of banana over its growth period and to study the economic viability of banana production under different colour plastic mulches. The soil of the experimental field was clay type. The field capacity, permanent wilting point, bulk density was 40.09%, 17.37% and 1.24 gm cm^{-3}, respectively.

The field experiment was laid out in a randomised block design which comprised of nine treatments with three replications. First seven treatments comprised of six coloured plastic mulches namely yellow- black, blue- black, silver- black, white- black, red- black, pervious mulch and one control treatment. For these seven treatments irrigation was given at the rate of 48% of pan evaporation. Eighth treatment was control treatment with irrigation at 100% crop evapotranspiration and ninth treatment was of surface irrigation with 1.00 IW/CPE ratio. Irrigation for first eight treatments was scheduled through drip on daily basis.

It was observed that the average emission uniformity was in the range of 94 to 97 %. The total quantity of water applied for each of first seven treatments was 1114 mm, 1130, 1015, 1087, 1081, 1060 and 1142 mm, respectively. For eighth treatment the quantity of water applied was 1323 mm and for ninth treatment it was 2204 mm. The maximum and significantly superior yield (84.45 t ha^{-1}) was obtained with treatment T_3 (silver- black plastic mulch with drip irrigation at 48% Ep) which was at par with the treatment T_6 (pervious mulch with drip irrigation at 48% Ep). The minimum yield of (53.00 t ha^{-1}) was obtained with surface irrigation treatment T_9. The maximum water use efficiency (83.18 kg ha^{-1} mm^{-1}) was obtained with treatment T_3, followed by treatment T_6. The minimum water use efficiency (24.04 kg ha^{-1} mm^{-1}) was observed with treatment T_9 (surface irrigation treatment with 1.00 IW/CPE ratio).

The maximum plant height (266.74 cm) at harvest (320 DAT) was observed with treatment T_3 (silver- black plastic mulch with daily drip irrigation at 48% Ep), followed by treatment T_6 (pervious plastic mulch with daily drip irrigation at 48%

Ep), that was 252.59 cm. The minimum plant height (194.72 cm) at 320 DAT was observed with treatment T_9 (surface irrigation with 1.00 IW/CPE ratio). Similar trend as plant height was observed with stem girth and number of functional leaves of banana.

The maximum absorbed photosynthetically active radiation (1060.78 μmol m^{-2} s^{-1}) was observed at 240 DAT with treatment T_3 (silver- black plastic mulch with drip irrigation at 48% Ep), followed by treatment T_4 (white- black plastic mulch with drip irrigation at 48% Ep), that was 1040.47 μmol m^{-2} s^{-1}. The minimum absorbed photosynthetically active radiation (826 μmol m^{-2} s^{-1}) at 240 DAT was observed with treatment T_9 (surface irrigation with 1.00 IW/CPE ratio). Similarly photosynthesis rate was maximum (29.33 μmol CO_2 m^{-2} s^{-1}) at 300 DAT for treatment T_3, followed by treatment T_4, that was 29.02 μmol CO_2 m^{-2} s^{-1} and minimum (23.38 μmol CO_2 m^{-2} s^{-1}) for treatment T_9.

From the NDVI values obtained for banana crop, the maximum NDVI value (0.8943) at 300 days after transplanting was observed for treatment T_6 (pervious plastic mulch with daily drip irrigation at 48% Ep), followed by treatment T_3 (silver- black plastic mulch with daily drip irrigation at 48% Ep), that was 0.8918. The minimum NDVI value (0.8104) at 300 days after transplanting was observed with treatment T_9 (surface irrigation at 1.00 IW/CPE ratio).

The study revealed that, the adoption of silver- black plastic mulch with daily drip irrigation at 48% Ep has resulted in 37.24% increase in yield of banana over surface irrigation with 1.00 IW/CPE ratio. From the economic point of view, the adoption of silver-black plastic mulch was found to be the best amongst all other treatments, having maximum B: C ratio of 2.34 and maximum net income of ₹ 3, 86,286 /- per hectare.

1. Introduction

The contribution of irrigation to agricultural production is very significant for the world's food supply. However, current irrigation practices such as furrows and borders are inefficient, causing environmental hazards such as salinity, runoff and contamination of water bodies. Irrigated agriculture has played a vital role in supporting a dramatic increase in global food production over recent decades. While only 20% of the world's agricultural land is irrigated, it produces 39% of the world's food supply (FAO, 2011). Optimum irrigation can improve crop production, reduce yield variability, and increase profits. But choosing and buying an irrigation system are both expensive and complex to the farmers. Drip irrigation is one of the most efficient methods of watering the crops. It eliminates water channel, brings more area under irrigation and reduces the use of purchased inputs. The drip irrigation system requires heavy initial investment and preferably used in wide spaced crops. As a result, the cultivators are becoming more conscious about cost of installation of this system and economic analysis of different fruit crops for their profitable production.

The per capita availability of water in the country is 1545 cubic meters as per the 2011 census. The per capita water availability in the country is reducing progressively due to increase in population. The share of agriculture in real GDP has fallen, indicating its lower growth rate relative to industry and services. During the current Five Year Plan, agriculture growth is estimated at 3.28% against a target of 4%. Without incremental productivity gains and technology diffusion across regions, achieving this higher growth may not be feasible and has implications for the macroeconomic stability given the rising demand of the people for food.

Banana (*Musa paradisica* L.) is the fourth most important food crop in the world after rice, wheat and maize with a world production of around 80 million metric tonnes in 2006 and in the world India is the largest producer of banana with an annual production of 23.205 million metric tonnes from an area of 0.647 million ha. Banana belongs to the genus *Musa* of the family *Musaceae*. It ranks next to mango in both area and production in India. Besides being a cheap and easily produced source of energy, it is rich in vitamins A, C, B_6 and is a good source of minerals. Banana is a tropical plant that requires an ample and frequent supply of water. Many earlier workers have reported that water deficit adversely affects the crop growth and yield (Mahmoud, 2006).

Modern bananas and plantains originated in the South East Asian and West Pacific regions where their inedible, diploid ancestors can be found in the natural forest vegetation. Later *Musa* was introduced in the western hemisphere and into other parts of the world. Nearly 90% of the total banana and plantain produced worldwide are consumed locally in the producing countries leaving only 10% for export (Dadzie and Orchard, 1997). Banana cultivation continues to be one of the principal agricultural activities for many developing countries. The banana industry has been designed and oriented almost exclusively towards the export markets. Export of fresh banana fruit demands high standard of quality (Bakhiet, 2006). The major hurdle in quality banana production is lack of professional outlook towards its production and improper management of available resources.

Banana has wide adaptability to soil conditions but its performance varies with soil types, lime concentration, nutrient status and drainage. In heavy soils, time taken for harvesting is longer as compared to light soils. The information on the soil factor is vital for the banana production which needs attention for maximizing the production with available resources. Drip irrigation systems are well suited to fertigation because of their frequency of operation and because water application can be easily controlled by the manager (Lewis, 2001). In today's perspectives, it is essential to study the crops like banana, which is a heavy feeder of the nutrients with respect to most efficient method of fertilizer application to get maximum fertilizer use efficiency and net profit.

The cycle time of Grandnaine variety of banana is slightly shorter, bunches are slightly heavier and fingers slightly longer. These advantages add up to a higher annual yield of extra-large fruit with Grandnaine. Worldwide Grandnaine is regarded as the most popular Cavendish dessert banana in both tropical and subtropical localities (Ahmed, 2006). The overall mean temperature for an optimum balance between growth and development of banana is about 27 °C.

Plastic mulches are being used widely for many years, are known to effectively modify the soil temperature. Mulching is the practice of covering the soil to make more favourable conditions for plant growth, development and efficient production of crops.

The term ‘mulch’ is derived from the Germanic word ‘molsh’, which means soft. Though all mulches are not soft, for many the word denotes the soft, spongy layer found in forest ecosystems. Mulches are defined as materials that are applied to, or grow upon, the soil surface, as opposed to materials that are incorporated into the soil profile (amendments). Therefore, any material laid or grown over the soil surface can be considered a mulch, though some materials are more beneficial than others.

The different types of mulch affect the vegetative growth and soil moisture regulation. While natural mulches such as leaf, straw, dead leaves and compost have been used for centuries, during the last 60 years the advancement of synthetic materials has altered the methods and benefits of mulching. The greater marketable yield is observed with the use of plastic mulches (upto 24 to 65% increase) compared to bare soil, which is because of conservation of moisture, improved micro climate both beneath and above the soil surface, light reflection and great weed control. Because of imperviousness of plastic mulches, it prevents direct evaporation of moisture from the soil and thus limits the water losses and soil erosion over the surface.

Besides the advantages stated above there are several other advantages of mulches such as improved soil moisture, maintenance of optimal soil temperatures, reduced soil erosion and compaction, increased binding of heavy metals, increased soil nutrition, improved plant establishment and growth, improved seed germination and seedling survival, reduction of salt and pesticide contamination, enhanced root establishment and transplant survival, increased overall plant growth performance, reduction of weeds, reduction of disease, reduced pesticide use.

Traditionally, plastic mulches are black and white. Black plastic mulch is often used to warm soil early in the season. The use of black polyethylene mulch in vegetable production has been reported to control the weed incidence, reduces nutrient losses and improves the hydrothermal regimes of soil. The silver/black and black plastic mulch controls weeds by 95 to 98%. White light is reflected back into the atmosphere or the plant canopy from a white plastic mulch, resulting in slightly cooler (-2 ºF at 1 inch depth) soil temperatures. Hence, white plastic mulches can be used to establish crops in the summer, when a reduced soil temperature might be beneficial. Reflective silver mulches also give cooler soil temperatures (Singh, 2009). The different colour mulches like yellow, grey, blue reflect different radiation patterns back into the canopies of various crops affect plant growth and development in many ways. Some colours attract certain insects, such mulches might be used in a field to grow "catch crops" to pull insects away from other crops. Thus there is need to adopt specific colour mulch for particular crop.

The state of the land vegetative condition can be explained with the help of vegetative parameters such as Normalized Difference Vegetative Index (NDVI). NDVI is a numerical indicator that uses the visible and near-infrared bands of the electromagnetic spectrum, and is adopted to analyse remote sensing measurements and assess whether the target being observed contains live green vegetation or not. The NDVI is a calculation based on spectral bands of photosynthetic output and it measures the amount of green vegetation area. Healthy vegetation will have higher value of the NDVI. But from the bare soil or rocks same levels of red and near-infrared light will be reflected and hence they will show the value of NDVI as zero. Clouds, water and snow are opposite to that of vegetation reflecting more visible energy hence they show NDVI value negative. The NDVI values ranges from -1 to +1 (pixel values 0 to 255). NDVI values vary with leaf characteristics. The present study is aimed to find NDVI values for banana crop at its different growth stages using the spectroradiometer.

Now-a-days, a lot of emphasis is being given on adoption of micro-irrigation systems for various crops. In order to increase the productivity and production of banana with efficient water use, there is a need to generate information on irrigation scheduling, water requirement and water saving due to different colour plastic mulches in respect of banana.

Keeping all these points in view, the present study entitled "Effect of different colour plastic mulches on growth and yield of banana crop" was undertaken with the following specific objectives.

1. To study the effect of different colour plastic mulches on growth, yield and quality of banana.
2. To compare the yield of banana under drip irrigation and surface irrigation.
3. To determine the water requirement and water use efficiency of banana.
4. To find out NDVI values of banana over its growth period.
5. To study the economic viability of banana production under different colour plastic mulches.

2. Review of Literature

As the crop like banana has huge water requirement, many workers have stated the effectiveness of use of mulching and drip irrigation for banana. Valuable research has been carried out in respect of irrigation management of banana crop to increase the water use efficiency and productivity. Efforts have been made to review the literature available on these aspects.

2.1 Effect of different colour plastic mulches on growth, yield and quality of banana

Many workers studied effect of different mulches on various parameters of banana crop. The findings of various workers on these aspects are cited below.

Decoteau *et al.* (1990) conducted an experiment to evaluate the effect of surface colour of mulch on growth of bell pepper (*Capsicum annuum* L.) plants, the amount and quality of upwardly reflected light and soil temperatures under the mulch. Of the surface colour evaluated (black, red, yellow and white), plants grown over red mulch were tallest. The darker (black and red) mulches reflected less total light and more far-red (FR) relative to red (R) light and soil temperatures recorded afternoon and evening were warmer than under yellow and white mulches. Plant growth response to surface colour of mulch were also observed when the soil temperature differences among mulch colour treatments were minimized by placing insulation boards between the mulch surface and soil. Plants that received FR (high FR: R ratio) were 51% taller than plants exposed to R (low FR: R ratio) light treatments. The similar response of pepper plants to differences in FR: R ratios associated with mulch colour and end-of-day light treatment provided evidence that pepper plant growth is affected by relatively small changes in light environment induced by surface colour of mulch.

Csizinszky *et al.* (1995) conducted an experiment to evaluate the effect of six mulch colors: blue, orange, red, aluminum, yellow, and white (fall) or black (spring), on fruit yields and on insect vectors of sunny tomato *(Lycopersicon esculentum* Mill.). Plant growth and yields were inconsistent with mulch colors during the three seasons. In fall 1988, in once-over harvest, extra-large ($\geq$ 70 mm diameter) and marketable fruit yields were higher ($P \leq 0.05$) on blue than on the conventional white mulch. In Spring 1989, early marketable yields on red mulch were higher than on black mulch, and in Fall 1989, under high stress from tomato mottle virus (TMoV) transmitted by silverleaf whitefly [*Bemisia argentifolii* (Bellows and Perring)], seasonal yield of extra-large fruit was better on orange than white mulch. In fall 1988 and 1989, fruit size and marketable yields were reduced on yellow mulch. Aphids (Aphididae), thrips (Thripidae), and whiteflies were counted monthly in traps placed on the mulched beds. Aphids were least numerous on the aluminum and yellow and most numerous on the blue mulch. Where differences occurred, the fewest thrips were captured on aluminum and the fewest whiteflies were captured on the yellow, aluminum and orange mulches. Although differences were not always significant, the fewest adult whiteflies also were observed on foliage of tomato plants grown on these latter three mulches. Later in the seasons, as plant foliage covered the mulch, differences in the number of insects captured were similar for all mulch colors. Low numbers of whiteflies on the orange and aluminum mulches early in fall 1989 delayed virus symptom development and increased yields. Virus symptom development was not delayed and yields were low on the yellow mulch, in spite of the low number of whiteflies. When averaged over all mulch colors, extra-large and marketable fruit yields increased linearly with delayed symptom development.

Feng *et al.* (1999) conducted field experiment to compare three mulching treatments viz. for 20 d (M_1), 40 d (M_2), and 60 d (M_3) after sowing (DAS), with a non-mulch control (CK). Mulching increased temperature and moisture in the upper 5 cm of soil, and shoots emerged 8 d earlier than in CK. Mulching also increased number of tillers, length of the growing period, spikelet and grain numbers per spike, and the duration from flowering to harvest. In the mulched treatments, photosynthesis rate and soluble sugar content were higher in the vegetative period, but soluble sugar content was lower in the grain filling period relative to CK. Grain yield following 20 d mulching was greatest (8207 kg ha^{-1}), and decreased gradually as the mulching period increased (7847 and 6702 kg ha^{-1} for M_2 and M_3, respectively). Plastic film removed after 20 d maximizes yield and minimizes soil pollution.

Agrawal (2005) conducted an experiment to study the effect of drip irrigation and mulches on the growth and yield of banana. The experiment comprised of eight drip-irrigated and two surface irrigated treatments. Results showed that drip irrigation increased banana yield as compared to surface method of irrigation along with good water saving. It was observed that drip alone could save water considerably without any reduction in banana production, while drip coupled with mulches could simultaneously increase the crop yield in addition to water savings. Application of plastic mulch along with drip irrigation system was found better. The maximum yield of 498.68 q ha^{-1} was recorded under 60% water through drip with plastic mulch, which did not differ significantly from other treatments with same combination, but significantly better than basin irrigation. All drip treatments either alone or in combination with mulches resulted in higher return than surface method of irrigation. The benefit: cost ratio was also observed higher in drip irrigation with plastic mulch as compared to control.

Gordon *et al.* (2008) conducted an experiment to evaluate effect of mulches on summer Squash. It consisted of 12 treatments including: (1) Black plastic mulch (BPM) +spun-bonded row cover (RC). (2) BPM alone. (3) White plastic mulch (WPM) +RC, (4) WPM alone. (5) Red plastic mulch (RPM) +RC, (6) RPM alone. (7) Bare soil (BS) +RC, (8) BS alone, (9) Silver plastic mulch (SPM) +RC. (10) SPM alone, (11) Blue plastic mulch (BLUPM) +RC, and (12) BLUPM alone. Year and mulch color affected all variables, row cover affected plant height and stem diameter, and the mulch colour row cover interaction affected yield variables. Mulch color and year significantly affected air and soil temperatures and row cover significantly affected air temperature. Soil temperatures were more than 5°C lower than air temperatures in all treatments and air temperatures were 2 to 5°C higher with row covers than with-out. Increased soil and air temperatures did not always result in yield increases. Colored plastic mulch with or without row covers did not increase early fruit yield in squash. Lack of a mulch/row cover induced temperature effect on yield was attributed to the relatively high mean air temperatures that may have masked treatment temperature effects.

Juan (2009) carried out field experiment to determine the effects of colored plastic mulches on root zone temperature, broccoli plant growth and yield of broccoli (‘Packman’) plants were grown using plastic film mulch and drip irrigation. The treatments consisted of plastic film mulch (black, blue, gray on black, red, silver on black, and white on black mulches) and bare soil. Mean daily RZT, maximal daily RZT and degree day accumulation in the soil were highest in dark-colored mulches (blue, black, red, and gray) and lowest in light-colored mulches (silver and white), while minimal daily RZT was highest in silver mulch and lowest in white mulch. Silver mulch showed the smallest diurnal fluctuations in RZT among plastic mulches, with the highest RZT during the night and among the lowest in the afternoon. Colored plastic mulches also affected broccoli plant growth and yield, although the effect of mulches was more dramatic in the spring than in the fall seasons. Broccoli yield was linearly related to both the vegetative top dry weight and root dry weight of mature plants. Broccoli yield was little affected at mean RZT of < 21 ˚C but increased with increasing mean RZTs above 21 ˚C up to 25 ˚C. Thus, broccoli plant growth and yield responded more favorably to dark-colored mulches than to light-colored mulches, suggesting that broccoli benefited from increased soil warming. No high RZT stress effects on broccoli plant growth or yield were observed in this study.

Ashrafuzzaman *et al.* (2011) conducted an experiment to evaluate the effect of coloured plastic mulch on growth and yield of chili. The plastic mulches were transparent, blue, and black and bare soil was the control. Different mulches generated higher soil temperature and soil moisture under mulch over the control. Transparent and blue plastic mulches encouraged weed population which were suppressed under black plastic. Plant height, number of primary branches, stem base diameter, number of leaves and yield were better for the plants on plastic. At the mature green stage, fruits had the highest vitamin-C content on the black plastic. Mulching produced the fruits with the highest chlorophyll-a, chlorophyll-b and total chlorophyll contents and also increased the number of fruits per plant and yield. However, mulching did not affect the length and diameter of the fruits and number of seeds per fruit. Plants on black plastic mulch had the maximum number of fruits and highest yield.

Kumar (2011) conducted field experiment for two consecutive years under sub-temperate climatic conditions at Nauni in district Solan of Himachal Pradesh on loamy sand Inceptisols to investigate the effect of different mulches (hay: HM, black polyethylene: BP) on root growth, nutrient uptake, water use efficiency (WUE) and yield of strawberry under drip (DI) and surface irrigation (SI) systems. Unmulch (UM) and rainfed treatments were kept as control. Higher soil moisture content was registered under both the mulch materials during entire crop growth period. However, it was greater under BP mulch as compare to HM. The moisture conservation increased by 2.80 to 12.80% under BP mulch as compared to UM. HM treatment, irrespective of irrigation method increased the minimum soil temperature (2.8 to 5.2 ˚C) and reduced the maximum soil temperature (2.7 to 5.8 ˚C) as compared to UM. BP mulch increased the minimum soil temperature from 0.4 to 2.5 ˚C. Application of irrigation moderated the soil (minimum 2.6 and maximum 1.4 ˚C) temperature. Both the mulch materials were effective in enhancing root growth, nutrient uptake, WUE and yield. Application of mulch enhanced the root growth (63%), nutrient uptake (179.20%), WUE (84.40%) and yield (343%) under DI. However, respective increase under SI was 23.60, 83.80, 109.40 and 219.20 %. Under DI, 51% of irrigation water was saved and about 19% higher fruit yield was obtained as compared with SI treatment.

Jagandi (2012) conducted an experiment on red loamy soil, to assess the depth of irrigation, mulching effects and requirement of water for banana production. Among the treatments 2.5 cm depth of irrigation with 10 kg paddy straw as surface soil mulch at 6 days interval registered higher number of hands bunch^{-1} (9.495). Bunch length (88.495 cm), bunch weight (29.55 kg) and minimum water use (3766 cm). The results clearly indicated that even with the maximum number of irrigation (63) given during the crop period, it is possible to save up to 35 to 40% water using paddy straw as surface soil mulch with 2.5 cm depth of irrigation at 6 days intervals.

Rajablariani (2012) reported that tomato (*Lycopersicon esculentum* L.) grown on polyethylene mulch films and bare soil to evaluate the effect of coloured plastic mulches on weed and crop yield. The plastic mulches were blue, black, clear, red and silver on black. Black and silver/black plastic mulches suppressed weeds which were encouraged under clear, blue and red mulches. Results indicated that soil temperature increased under the various colored plastic mulches about 3 to 6 ˚C more than it in bare soil. Number of branches and leaves were better for the plants grown over plastic compared to bare soil. The highest early yield was obtained in clear plastic likely due to light entrance and raising soil temperature. Mulching increased marketable yield relative to bare soil as the plants grown on silver/black plastic mulch indicated 65% increase in marketable yield compared to control treatment. The plastic mulches resulted in an 84 to 98% reduction in weed biomass.

Ahmed *et al.* (2013) conducted field trials at the National Cereals Research Institute, Badeggi to assess the effect of mulching and harvesting time on the agronomic performance of a sugarcane variety named NCS 008. The treatments consisted of three-coloured polyethylene mulches (black, red, and green) with one treatment without mulch as a control and two harvesting stages (10 and 12 months after planting). The experiment was laid out as a randomized complete block design in a factorial arrangement and replicated three times per treatment. Sugarcane setts planted on plots mulched with black polyethylene sheet established significantly ($P < 0.05$) faster than those planted on plots mulched with red and green coloured polyethylene sheet as well as those planted on plots without mulch. Plants in the control plots had the least performance for all parameters measured during the experiment. Coloured polyethylene significantly ($P < 0.05$) increased the stalk length, stalk girth, number of tillers, chewable stalk and yield of NCS 008 for the main, as well as, the ratoon crops. Harvesting stage significantly influenced the stalk length, stalk girth and yield. Plots harvested 12 months after planting performed better than plots harvested 10 months after planting.

Mutetwa and Mtaita (2014) conducted an experiment to investigate the effect of different colors of plastic mulch on growth performance and yield of cucumber (*Cucumis sativus*). The microclimate condition improved by the mulches have provided a suitable condition for producing superior branch characteristics, number of fruits plant^{-1}, fruit size and total yield in the plants. Marketable fruit yield significantly improved by the use of a silvery-grey colored plastic mulch (37.9 t ha^{-1}) compared to the blue colored mulch (15.3 t ha^{-1}) and wheat straw mulch (26.4 t ha^{-1}). Also, the significant results were observed in growth parameters by mulching with silver-grey colored mulch. Fewer insect pests (thrips, aphids, cucumber moths and whiteflies) were noted on plants on silvery grey colored mulch compared to other colored mulches. The effectiveness of the colored mulches to suppress both aphids and cucumber moth after the peak period was non-significant due to the increased vine/plant size which covered the colored mulches. In areas where thrips and cucumber moth are likely to infest cucumber, blue colored mulch were not suggested. Where aphids and whiteflies are high, yellow colored mulches should be discouraged. This study explored the possibility of improving yield of cucumber by using the plastic mulches in which silvery-grey gave the most effective influence as compared to other color mulches.

From the literature, it was clear that, the plastic mulching significantly influenced the growth and yield of various crops. It was observed that, soil temperature improved by use of plastic mulching helped the plant for better growth. Plastic mulching also improved microclimate under crop canopy by altering amount of light reflected from its surface. There was also evidence of reduction in insects and pests because of use of colour plastic mulching. It was also observed that moisture conservation because of mulches helped plant for better growth and more yield.

2.2 Scheduling of irrigation to banana through drip and surface irrigation methods

Micro irrigation is one of the recent innovation proved its effectiveness to enhance productivity with high water use efficiency. The results obtained by various workers on these aspects are cited below.

Hedge and Srinivas (1990) studied growth, yield and water use of plant and ratoon crops of banana cv. Robusta under drip and basin irrigation with different levels of evaporation replenishment (20, 40, 60, 80, 100 and 120% of USWB Class-A pan). The effects of irrigation method and evaporation replenishment on growth, flowering, dry matter production, yield components, yield, quality and water use were tabulated. Drip irrigation resulted in earlier flowering, and significantly higher dry matter production, bunch weight and yield compared with basin irrigation. Banana yield increased significantly in both plant and ratoon crops with increasing evaporation replenishment up to 80% under basin irrigation and up to 60% under drip irrigation. At the optimum evaporation replenishment for drip (60%) and basin (80%) irrigation, the field water use efficiency was 64.4 and 53.7 kg ha^{-1} mm^{-1} under drip and 54.0 and 40.1 kg ha^{-1} mm^{-1} under basin irrigation, for plant and first ratoon crops, respectively.

Table 2.1. Summary of literature cited for effect of different colour plastic mulches on growth, yield and quality of banana crop

Author (s)	Location	Year	Crop	Aspect of study	Results
Decoteau D. R., M. J. Kasperbaur and P. G. Hunt	USA	1990	Capsicum	Colour mulches: Red, black, silver and white	(1) The plants which received high FR:R ratio were 51% taller than those received low FR:R ratio. (2) The darker colour mulches reflected more far red (FR) and less total light.
Csizinszky A. A., D. J. Schuster and J. B. Kring	USA	1995	Tomato	Colour mulches: Red, blue, orange, yellow, aluminium, and white	(1) Marketable and early fruit yield was higher on blue and red mulch respectively. (2) Lowest whiteflies, aphids and thrips on aluminium and yellow mulch.
Feng Min Li, An Hong Guo and Hong Wei	China	1999	Wheat	Mulching for 20 d (M_1), 40 d (M_2), 60 d (M_3) DAS and control treatment	(1) Mulching increased temperature and moisture in upper 5 cm of soil. (2) In mulching treatments shoots emerged 8 days earlier than non-mulching treatments.
Agrawal N. and S. Agrawal	Raipur, India	2005	Banana	Drip irrigation with plastic mulch, without mulch and surface irrigation	(1) Drip irrigation treatment given better yield than surface method. (2) Drip irrigation coupled with mulching given better yield than drip alone.
Gordon G. G., W. G. Foshee and S. T. Reed	USA	2008	Squash	Colour mulches and row covers: Black, blue, red, white and silver	(1) Plants grown on mulch with row covers given better yield. (2) Soil temperatures were more than 5 ^{o}C lower than air temperatures in all treatments.
Jaun C.	USA	2009	Broccoli	Colour mulches: Black, blue, grey, red, silver, white and bare soil	(1) Mean root zone temperature was highest in dark colour mulches (black, blue and red). (2) Broccoli yield increased with increasing root zone temperature from 21^{o}C up to 25 ^{o}C.
Ashrafuzzaman M. and M. Abdul Halim	Bangladesh	2011	Chili	Colour mulches: Black, transparent, blue and no mulch	(1) Plants on black plastic mulch had maximum number of fruits and yield. (2) Mulching increased vitamin C and chlorophyll content in fruits.

Kumar Sushil and P. Dey	Himachal Pradesh, India	2011	Strawberry	Mulches: Black polyethylene, hay mulch and no mulch I_1: 100% ETc I_2: 80% ETc I_3: 60% ETc	(1) Moisture conservation increased by 2.8 to 12.8% under black polyethylene mulch than hay mulch. (2) Application of mulch enhanced the root growth (63%), nutrient uptake (179.20%), WUE (84.40%) and yield (343%) under drip irrigation.
Jagandi Sharanappa	Bangalore	2012	Banana	Different depths of irrigation with paddy straw mulch	(1) The highest yield obtained under treatment 2.5 cm depth of irrigation with 10 kg paddy straw as surface mulch. (2) Water saving up to 35 to 40% obtained with paddy straw as surface mulch.
Rajablariani H. R. and F. Hassankhan	Iran	2012	Tomato	Colour mulches: Blue, black, clear, red, silver and bare soil	(1) Soil temperature increased under various colour mulches about 3 to 6 ^{o}C more than it in bare soil. (2) Mulching increased 65% increase in marketable yield compared to bare soil. (3) The plastic mulch resulted 84 to 98% reduction in weed biomass.
Ahmed M., K. P. Baiyeri and B. C. Echezona	Nigeria	2013	Sugarcane	Colour mulches: Black, red and green Harvesting stages: 10 and 12 months after planting	(1) Sugarcane sets planted on black polyethylene mulch established faster than red and green mulches. (2) Plots harvested 12 months after planting performed better than those harvested 10 months after planting.
Mutetwa Moses and Tuarira Mtaita	Zimbabwe	2014	Cucumber	Mulches: Silver, blue and wheat straw mulch	(1) Highest marketable yield obtained in silver colour plastic mulch than blue and wheat straw mulch. (2) Fewer insects observed with silver colour plastic mulch.

Berad (1996) conducted an experiment to study yield response of banana to drip and surface irrigation methods. The experiment was conducted at the farm of Water Management Project, M.P.K.V., Rahuri, Dist. Ahmednagar. The experiment was carried out in randomised block design with eight treatments and four replications. Total water applied in drip irrigation was 99.6 cm as against 197 cm and 172 cm in T_1 (NP+ RDF+ SI) and T_3 (PRP+RDF+SI). The effective rainfall was also less in drip (25.85 cm) than surface (44.74 cm) irrigation treatments. Ultimately total seasonal water requirement was also less in drip (125.45 cm) in drip as compared to surface irrigation treatments (241.74 cm and 216.74 cm, respectively in treatment T_1 and T_3.). The water use efficiency was almost double in drip irrigated treatments as compared surface irrigated treatments. The highest field water use efficiency was 539.18 kg ha^{-1} cm^{-1} observed under treatment T_2 (NP+ RDF+DI). The highest yield (67.64 t ha^{-1}) was observed under treatment T_2 (NP+ RDF+DI) followed by the treatment T_5 (PRP+125%RDF+DI) that was 67.19 t ha^{-1}.

Goenaga and Irizarry (1998) conducted an experiment on an ultisol to determine the water requirement, yield and fruit quality traits of three ratoon crops (R_1, R_2, R_3) of Grandnaine banana subjected to four levels of irrigation. The irrigation treatments were based on class-A pan factors ranging from 0.0 (rainfed) to 1.0 in increments of 0.25. When needed, drip irrigation was supplied three times a week on alternate days. Results showed significant ($p < 0.01$) irrigation treatments and crop effects on bunch weight, yield, bunch mean hand weight, weight and fruit diameter of third and last hands and length of fruits of third hand. Highest marketable yield (47.9 t ha^{-1}) was obtained from R_2 crop with water application according to pan factor of 1.0. It was concluded that irrigating the crop according to pan factor of 1.0 was sufficient to justify investment of drip irrigation system for a farm in the mountain region.

Bharambe *et al.* (2001) carried out a field experiment to study the effect of moisture regimes applied through drip on spatial distribution of soil moisture, salts, nutrient availability and water use efficiency of banana under different planting patterns revealed that highest water content was found below the dripper and it followed a decreasing trend with increasing spatial distance, lateral as well as vertical. Irrigation at 0.8 and 1.00 ETc maintained soil moisture content near to field capacity. The salt content was low near the dripper and increased with water front, laterally. More salt spreading was observed from the trickle source with higher application rate of water and maximum salt accumulation was at periphery of wetted zone of soil. However, more salt accumulation was observed in the root zone under surface irrigation in check basin as compared to irrigations applied through drip. The availability of P and K in soil was highest in the surface layer. Application of irrigation to banana at 1.0 ETc through drip with normal planting (1.5 x 1.5 m) recorded significantly higher bunch yield as well as water use efficiency. Drip irrigation saved 41% water over surface irrigation in check basin.

Ahmed *et al.* (2010) conducted an experiment to determine the effect of drip irrigation system on growth, yield and quality of banana cv. Grandnaine in comparison with farmer practice. Five different quantities of irrigation were applied at 2 days interval compared with farmers practice every 5 to 7 days; these were 40, 60, 80, 100 and 120% of crop evapotranspiration (ETc) under drip irrigation. A drip irrigation system was designed and installed on the area of 2145 m^2 and two emitters per plant were used; the discharge of one emitter was 8 L hr^{-1}. The preliminary results of mother plant crop indicated that the amount of applied irrigation water with drip irrigation system was lower than that of surface irrigation. Irrigation regimes had significant effect on growth parameters at flowering, yield and yield components. The highest irrigation productivity efficiency was obtained with 120% of crop evapotranspiration (ETc) under drip irrigation. The best nutrient use efficiency (partial factor productivity) was also obtained with the 120% of ETc.

Mahendran *et al.* (2013) carried out a field experiment using banana as test crop. Subsurface drip fertigation of 100 per cent recommended dose of fertilizers (50% P and K as basal, remaining N, P and K as water soluble fertilizers) plus liquid bio fertilizers and subsurface drip fertigation of 100% recommended dose of fertilizers (Urea, 13:40:13, KNO_3) plus liquid bio fertilizers were equally effective in increasing growth and physiological parameters of banana. The highest bunch yield, quality parameters and water use efficiency of banana were recorded in subsurface drip fertigation of 100% recommended dose of fertilizers (Urea, 13:40:13, KNO_3) plus liquid bio fertilizers compared to surface irrigation with soil application of recommended dose of fertilizers.

Husameldin and Fatima (2013) conducted an experiment to evaluate the effect of different levels of planting distances, irrigation and fertigation levels on growth characters of the banana main crops cv. Grandnaine. Main and ratoon crops grown at the widest planting distance 1.75 × 1.75 m showed significantly better growth and shortened the total crop duration. Application of irrigation at a rate of 764.30 mm $year^{-1}$ during main crops substantially improved growth and shortened crop duration. In the ratoon crops, irrigation at a rate of 1187.10 mm $year^{-1}$ was observed to be most economical and effective in decreasing number of days to shooting that subsequently reduced the total crop duration. In the both main and ratoon crops, 80% of the recommended fertigation dose (160 N: 32 P: 192 K g $plant^{-1}$ $year^{-1}$) performed well in respect of growth parameters and shortened the total crop duration. Hence, fertigation with 80% of the recommended dose was found to be optimum and economical.

From the literature, it was clear that, drip irrigation helped the crop for better growth with optimum quantity of water. Higher water use efficiency was observed under drip irrigation leads to considerable water saving. Drip irrigation coupled with plastic mulching gave better results than drip alone. The better growth and yield was observed under drip irrigation than surface irrigation. Fertilizer use efficiency was observed to be improved due to use of drip irrigation than surface irrigation.

2.3 Water requirement and water use efficiency of banana crop

Micro irrigation method proved its effectiveness in improving water and fertilizer use efficiency. The findings of some workers are cited below.

Salvin *et al.* (2000) conducted a field experiment in Jorhat, India to compare the growth, yield and water use efficiency (WUE) of banana cv. Barjahaji under the trickle and basin methods of irrigation. There were six treatments in total. Four treatments were on trickle irrigation at different levels of evaporation replenishment viz., 50, 75, 100 and 125% of USWB Class-A pan evaporation. The fifth treatment was basin irrigation applied at fortnightly intervals on the basis of available soil moisture depletion. The studies indicated that there was improved growth, early shooting, higher productivity and increased WUE under trickle irrigation compared to basin irrigation. The yield and yield attributing characters were significantly influenced by the different treatments and were

Table 2.2. Summary of literature cited for scheduling of irrigation to banana through drip and surface irrigation methods

Author (s)	Location	Year	Crop	Aspect of study	Results
Hedge D. M. and K. Srinivas	India	1990	Banana	Drip and basin irrigation with 20, 40, 60, 80, 100 and 120% of USWB Class-A pan evaporation	At optimum evaporation replenishment for drip (60%) and basin (80%) irrigation WUE was 64.4 and 53.7 kg ha^{-1} mm^{-1} under drip and 54.0 and 40.1 kg ha^{-1} mm^{-1} under basin irrigation.
Berad S. M.	Maharashtra, India	1996	Banana	I_1 : Drip irrigation with full irrigation volume I_2 : Surface irrigation with 1.00 IW/CPE ratio P_1 : Normal planting P_2 : Paired row planting	Highest yield and water use efficiency was observed in drip irrigation (full irrigation volume) with normal planting (1.5x1.5 m). Yield in all drip irrigation treatments was higher than surface irrigation with 1.0 IW/CPE ratio.
Goenaga R. and H. Irizarry	Puerto Rico	1998	Banana	Drip irrigation with 25, 50, 75 and 100% of USWB Class-A pan evaporation	Highest marketable yield and quality was obtained with water application according to pan factor of 1.0.
Bharambe P. R. and M. S. Mungal	Maharashtra, India	2001	Banana	I_1 : 80% ETc I_2 : 100% ETc P_1 : Normal planting P_2 : Paired row planting	Application of irrigation at 1.0 ETc through drip and normal planting recorded higher bunch yield and water use efficiency.
Ahmed A. B., M. A. Ali and M. I. Ihsan	Sudan	2010	Banana	Drip irrigation with 40, 60, 80, 100 and 120% of crop evapotranspiration (ETc)	The highest irrigation efficiency as well as nutrient use efficiency was obtained with 120% of crop evapotranspiration.
Mahendran P. P. and M. Yuvaraj	Tamil Nadu, India	2013	Banana	Surface irrigation and subsurface drip fertigation with 100% and 75% RDF	The highest bunch yield and water use efficiency were recorded in subsurface drip fertigation of 100% recommended dose of fertilizers compared to surface irrigation with soil application of recommended dose of fertilizers.

Husameldin M. and Fatima Gaffer	Sudan	2013	Banana	Planting distances: D_1: 1.75 x 1.75 m D_2: 1.5 x 1.5 m D_3: 1.25 x 1.25 m Irrigation levels: I_1 : 0.4 Ep I_2 : 0.6 Ep I_3 : 0.8 Ep Fertigation levels: F_1: 120% RDF F_2: 100% RDF F_3: 80% RDF	Application of irrigation at the rate of 764.30 mm year^{-1} improved growth and shortened crop duration. In ratoon crops irrigation the rate of 1187.10 mm year^{-1} observed most economical. Also in both main and ratoon crops 80% of RDF performed well. D_1 x I_1 x F_3 resulted in higher growth and yield of banana crop.

superior in plants under trickle irrigation compared with those under basin irrigation. The highest bunch weight (14.26 kg) and yield (44.0 t ha^{-1}) were observed under trickle irrigation at 75% evaporation replenishment, while the lowest bunch weight (8.46 kg) and yield (26.12 t ha^{-1}) were observed in the rainfed plants. WUE was considerably higher under trickle irrigation than under basin irrigation. Trickle irrigation at 75% evaporation replenishment recorded the highest WUE (300.01 kg ha^{-1} cm^{-1}), while it was lowest (146.09 kg ha^{-1} cm^{-1}) under basin irrigation.

Thomas (2001) carried out a field experiment to find out water and fertilizer use efficiency of banana Musa (AAB) Nendran, at Banana Research Station, Kannara and at college of Horticulture, Vellanikkara. Response of banana var. Nendran to different methods of fertilizer application (drip fertigation and basin application), to different frequencies of fertigation (six and twenty four fertilizer splits) and to five different levels of fertilizer at regular intervals (50 to 250% of present recommendation in the first year and 25 to 200% in the second year) were tested. Drip fertigation could register significant improvement in productivity and response to fertilizer levels over conventional means of fertilizer application and irrigation when frequency of application was enhanced. The yield obtained from basin application of the present recommended fertilizer level viz., 200-115-300 g NPK $plant^{-1}$ in six splits was comparable with that obtained from drip fertigation at 100-60-150 g NPK $plant^{-1}$ suggesting an improved fertilizer use efficiency under drip fertigation. Methods of irrigation included surface drip, subsurface drip and conventional method, while levels of irrigation were 8, 12 and 16 lit day^{-1} in the first year and 50, 75 and 100% pan evaporation compensation in the second year. The efficiency of drip fertigation was enhanced by placing the emitters below the surface (subsurface drip) as evidenced by higher moisture content in the root zone and a larger production of roots in the limited wet zone. Water use efficiency of 570 kg ha^{-1} mm^{-1} of water could be obtained under subsurface drip fertigation as against 470 kg ha^{-1} mm^{-1} in conventional method resulted in an increased efficiency of 21% in the second year.

Yaghi *et. al.* (2013) conducted an experiment to study the effect of two types of plastic mulch (transparent and black) with drip irrigation on water requirement and cucumber (*Cucumis sativus* L.) yield, in addition to their effect on maturity time. Trials were carried out at Teezen Research Station, Hama Agricultural Research Center, GCSAR, Syria, during 2009- 2010 growing seasons using complete randomized block design with three replicates. Treatments were transparent mulched drip irrigation (DI + TM), black mulched drip irrigation (DI + BM), drip irrigation without mulching (DI) and surface furrow irrigation (SI). The results of the study indicated that (DI + TM) treatment excelled all other treatments at yield and water use efficiency (WUE), where its yield was 63.9 t ha^{-1}, and (WUE) was 0.262 t $ha^{-1}mm^{-1}$, while (DI + BM) treatment produced 57.9 t $ha^{-1,}$ with a (WUE) of 0.238 t $ha^{-1}mm^{-1}$. However cucumber yield and WUE declined in the remaining treatments of no mulch (DI) and (SI) to 44.1 t ha^{-1} with 0.153 t $ha^{-1}mm^{-1}$ and 37.7 t ha^{-1} with 0.056 t $ha^{-1}mm^{-1}$, respectively. The results showed that (DI + TM) treatment gave the highest soil temperature and moisture during both of the seasons in comparison to (DI + BM). This enhanced its vegetative growth and almost doubled its productivity compared to the SI treatment.

From the literature, it was clear that, drip irrigation enhanced the water use efficiency as well as fertilizer use efficiency than surface method of irrigation. Drip irrigation also enhanced productivity and improved yield of crop.

2.4 NDVI values over growth period of banana crop

The results obtained by various researchers on the aspect of Normalized Difference Vegetation Index (NDVI) are cited below.

Ruiz *et al.* (2004) used the NOAA AVHRR images for crop monitoring using NDVI. They analyzed changes in the cultivated landscapes and also used it to measure the crop density and vigour throughout the crop period. Vegetation growth and NDVI showed the qualitative positive relationship. Therefore, these satellite images proved to be a very useful tool in analysis of crop related phenological phenomena.

Johnson and Thomas (2012) studied that the remote sensing of CC has been studied in several major crops, but not in most horticultural crops. They measured CC of 11 different annual and perennial horticultural crops in various growth stages.

Table 2.3. Summary of literature cited for water requirement and water use efficiency of banana crop

Author (s)	Location	Year	Crop	Aspect of study	Results
Salvin S. and K. Baruah	Assam, India	2000	Banana	Drip irrigation with 50, 75, 100 and 125% of USWB Class-A pan evaporation	(1) The highest yield (44 t ha^{-1}) was observed under trickle irrigation at 75% evaporation replenishment. (2) The highest water use efficiency (300 kg ha^{-1} cm^{-1}) was observed under trickle irrigation at 75% evaporation replenishment.
Thomas Deepa	Kerala, India	2001	Banana	Surface and subsurface drip fertigation with (50, 75 and 100% Ep) and conventional irrigation method with RDF	(1) Water use efficiency 570 kg ha^{-1} mm^{-1} obtained with subsurface drip fertigation as against 470 kg ha^{-1} mm^{-1} with conventional method (2) Subsurface drip fertigation resulted in an increased efficiency of 21% over conventional method .
Yaghi T., A. Arslan and F. Naoum	Syria	2013	Cucumber	T_1: Transparent mulch with drip irrigation T_2: Black mulch with drip irrigation T_3: No mulch with drip irrigation T_4: Surface irrigation	(1) The treatment transparent mulch with drip irrigation given highest yield (63.9 t ha^{-1}) and water use efficiency (0.262 t ha^{-1} mm^{-1}). (2) The same treatment gave highest soil temperature and moisture. (3) This treatment enhanced vegetative growth and almost doubled the productivity compared to surface irrigation treatment.

Canopy cover was compared with normalized difference vegetation index (NDVI) values calculated from Landsat 5 satellite imagery. The NDVI was highly correlated and linearly related with measured CC across the wide range of crops, canopy structures, and growth stages ($R^2 = 0.95$, $P < 0.01$) and predicted CC with mean absolute error of 0.047 up to effective full cover. These results indicated that remotely sensed NDVI may be an efficient way to monitor growth stage, and potentially irrigation water demand, of horticultural crops.

Hangbin *et al.* (2011) studied that the Normalized difference vegetation index (NDVI) is an important index characterizing the growth dynamics of plants. During the growth process of plants, NDVI value gradually increases, reaching its maximum at a certain stage of its growth period and then gradually dwindle. The variation curve of NDVI varies for different plants. Due to its high time resolution, Moderate Resolution Imaging Spectrometer–Normalized difference vegetation index (MODIS-NDVI) data can be applied to the study on the NDVI's variation of agro-ecosystem. The analysis on the NDVI's variation characteristics in different cropping systems of the agro-ecosystem of south bank Hangzhouwan Bay (Southeast Shanghai, China with north latitude of 30°02′ to 30°24′ and east longitude of 121°02′ to 121°42′) was conducted by employing the field investigation data and remote sensing data of 23 time sequences synthesized by MODIS-NDVI 16d in 2002. The results indicated that NDVI curves of different cropping systems were characterized by specific variation law. NDVI feature model extracted from different cropping systems based on MODIS-NDVI data can be used for the analysis of the cropping system of the agro-ecosystem, providing basic data for remote sensing yield estimation.

Kadam (2014) developed the spectral signatures for sorghum, chickpea and wheat crops during *rabi* season, Developed different relationships and functions for the estimation of canopy parameters *viz.* normalized difference vegetation index (NDVI), leaf area index (LAI) and crop coefficients (Kc) using the field and remote sensing data for different growth stages.

Table 2.4. Summary of literature cited for NDVI values over growth period of banana crop

Author (s)	Year	Crop	Aspect of study	Results
Ruiz	2004	-	Crop monitoring using NDVI	Vegetation growth and NDVI showed quantitative positive relationship. Also NOAA AVHRR satellite images proved very useful tool in analysis of crop related phenomena.
Jhonson and Thomas	2012	Horticultural crops	Comparison of canopy cover and NDVI using Landsat 5 satellite imagery	The NDVI was highly correlated and linearly related with crop canopy across wide range of crops, canopy structures and growth stages.
Hangbin Zhao, Yang Xiaoping and Li Jialin	2011	-	Relation between NDVI and growth dynamics of the plant	NDVI feature model extracted from different cropping systems based on MODIS- NDVI data can be used for analysis of cropping system of the ecosystem.
Kadam S.A.	2014	Wheat, Sorghum and Chickpea	Development of spectral signatures and different relationships and functions for the estimation of canopy parameters	Developed linear, exponential, logarithmic, power and 2nd order polynomial type of relationships between Kc, and NDVI by considering the growth and decline phases independently during total crop growth period.

2.5 Cost economics of banana production

The results obtained by various researchers on the aspect of economic viability of banana production under various colour mulches and irrigation methods are cited below.

Tiwari *et al.* (1998) conducted field experiments on the lateritic sandy loam soils of Kharagpur, West Bengal, India to evaluate the economic feasibility of drip irrigation in combination with different types of mulches for an okra crop. Actual evapotranspiration for okra crop was estimated using modified Penman method. The net irrigation volume (V) was determined after deducting the effective rainfall. The net average seasonal water requirement of crop was estimated to be 665 mm. The effect of three irrigation levels *viz*. VD, 0.8 VD and 0.6 VD with drip in conjunction with black plastic mulch were studied on biometric and yield response. Effect of two organic mulches (rice husk and rice straw) were also studied with drip irrigation. The results of furrow irrigation either alone or in conjunction with black plastic mulch conditions were compared with drip irrigation in terms of growth and yield of the crop. The study indicated that 100% irrigation requirement met through drip irrigation along with black plastic mulch (VD.PM) gave the highest yield (14.51 t ha^{-1}) with 72% increase in yield as compared to furrow irrigation. The net seasonal income, benefit cost ratio and the yield per unit depth of water used, were found to be highest for drip irrigation with black plastic mulch (VD.PM), drip irrigation alone (VD) and drip irrigation with black plastic mulch (0.6 VD.PM), respectively.

Singh *et al.* (2009) conducted an experiment to investigate the effect of drip irrigation and black polyethylene mulch compared with surface irrigation, on growth, yield, water-use efficiency and economics of tomato (*Lycopersicon esculentum*). Drip irrigation at 80% evapotranspiration (ET) crop based on pan evaporation applied gave higher fruit yield (45.57 t ha^{-1}) compared to the surface irrigation (29.43 t ha^{-1}). Use of black polyethylene mulch plus drip irrigation further raised the fruit yield to 57.87 t ha^{-1}. Plant height, leaf area index, dry matter production, fruit weight and yield increased significantly with the use of drip irrigation alone and in conjunction with polyethylene mulch compared to surface irrigation alone or with mulch. Water-use efficiency under drip irrigation alone, drip irrigation with polyethylene mulch and surface irrigation was

0.97, 1.23 and 0.42 tonnes ha^{-1} cm^{-1}, respectively. Among different irrigation levels, drip irrigation at 80% ET resulted in higher net returns (34431 ₹ ha^{-1}) and benefit cost ratio (1.76) in tomato. However, maximum net returns (51386 ₹ ha^{-1}) and benefit cost ratio (2.03) was found with drip irrigation at 80% ET coupled with polyethylene mulch compared to other treatments. Drip irrigation besides giving a saving of 38% water resulted into 55% higher fruit yield compared to surface irrigation.

Paul *et al.* (2013) reported that the yield, water-use- efficiency and economic feasibility of capsicum grown under drip and surface irrigation with non-mulch and black Linear Low Density Poly Ethylene (LLDPE) plastic mulch. Actual evapotranspiration for capsicum crop was estimated using modified pan evaporation method. The net irrigation volume (V) was determined after deducting the effective rainfall. Effect of three irrigation levels viz. VD, 0.8 VD and 0.6 VD (VD = full irrigation volume with drip) in conjunction with LLDPE mulch and no mulch were studied on biometric and yield response of capsicum crop. The highest yield (28.7 t ha^{-1}) was recorded under 100% net irrigation volume with drip irrigation (VD) and plastic mulching as compared to other treatments. This system increased the yield and net seasonal income by 57% and 54% respectively as compared to conventional surface irrigation without mulch with a benefit cost ratio of 2.01. The benefit cost ratio was found to be the highest (2.44) for the treatment VD without mulch. Drip irrigation system could increase the yield by 28% over surface irrigation even in the absence of mulch. Similarly, LLDPE mulch alone could increase the yield by 13% even in the absence of drip irrigation system.

Pramanik *et al.* (2014) conducted an experiment to evaluate the economic viability of drip-fertigation system in banana cultivation in West Bengal. The main factor was irrigation at 3 levels (I_1= 50% CPE, I_2= 60% CPE and I_3= 70% CPE) and sub-factor was fertilizer at 3 levels (F_1= 50% RDF, F_2= 60% RDF and F_3= 80% RDF). It has been found that the variations in fertilizer and irrigation levels provide different yields of banana. The highest yield was obtained for both plant (49.2 t ha^{-1}) and ratoon (44.1 t ha^{-1}) crops of banana with combined application of irrigation at 60% CPE and 80% RDF. The water-use efficiency has been found higher under drip fertigation and was highest under 60% CPE and 80% RDF, resulting in a considerable saving of water (41.7% in plant crop and

40.4% in ratoon crop). The drip fertigation has been found economically-viable because of higher gross returns, net returns and return per rupee investment as compared to conventional method of irrigation.

From the literature, it was observed that, yield, seasonal income and benefit cost ratio was higher in drip irrigation with plastic mulching than drip alone and surface method of irrigation.

Table 2.5. Summary of literature cited for cost economics of banana production

Author (s)	Location	Year	Crop	Aspect of study	Results
Tiwari K. N. and K. Y. Reddy	West Bengal, India	1998	Okra	Treatments: T_1: Drip irrigation with full volume and plastic mulch (VD.PM) T_2: Drip irrigation with 80% volume and plastic mulch (0.8VD. PM) T_3: Drip irrigation with 60% volume and plastic mulch (0.6VD. PM)	(1) The study indicated that 100% irrigation requirement met through drip irrigation along with black plastic mulch (VD.PM) gave the highest yield (14.51 t ha^{-1}) with 72% increase in yield as compared to furrow irrigation. (2) The net seasonal income, benefit cost ratio and the yield were found to be highest for drip irrigation with black plastic mulch (VD.PM),drip irrigation alone (VD) and drip irrigation with black plastic mulch (0.6VD.PM), respectively.
Singh R., Satyendra Kumar, D. D. Nangare and M. S. Meena	Punjab, India	2009	Tomato	Irrigation levels: I_1: 100% ETc I_2: 80% ETc I_3: 60% ETc Mulches: Black polyethylene mulch and bare soil (no mulch)	(1) Drip irrigation at 80% evapotranspiration (ETc) gave significantly higher fruit yield (45.57 t ha^{-1}). (2) Maximum net returns (51386 ₹ ha^{-1}) and Benefit: cost ratio (2.03) was found with drip irrigation at 80% ETc coupled with polyethylene mulch compared to other treatments.
Paul J. C., J. N. Mishra, P. L. Pradhan and B. Panigrahi	Bhubaneswar, India.	2013	Capsicum	Irrigation levels: I_1: Drip irrigation with 100% volume (VD) I_2: Drip irrigation with 80% volume (0.8 VD)	(1) The highest yield (28.7 t ha^{-1}) was recorded under 100% net irrigation volume with drip irrigation (VD) and plastic mulching. (2) The benefit cost ratio was found to be the highest (2.44) for the treatment VD without mulch.

				I_3: Drip irrigation with 60% volume (0.6 VD) Mulches: Black polyethylene mulch and bare soil (no mulch)	(3) Drip irrigation system could increase the yield by 28 % over surface irrigation even in the absence of mulch. (4) LLDPE mulch alone could increase the yield by 13 % even in the absence of drip irrigation system.
Sanjit Pramanik, S.K. Tripathi, R. Ray and Hirak Banerjee	West Bengal, India	2014	Banana	Irrigation levels: I_1: 50% CPE I_2: 60% CPE I_3: 70% CPE Fertigation levels: F_1: 50% RDF F_2: 60% RDF F_3: 80% RDF	(1) The highest yield was obtained for both plant (49.2 t ha^{-1}) and ratoon (44.1 t ha^{-1}) crops of banana with combined application of irrigation at 60% CPE and 80% RDF. (2) The water use efficiency was highest under 60 % CPE and 80% RDF, resulting in a considerable saving of water (41.7% in plant crop and 40.4% in ratoon crop).

3. Materials and Methods

The present investigation entitled "Effect of different colour plastic mulches on growth and yield of banana crop" was carried out during the year 2014-2015. The details of the materials used and methodologies adopted for conducting this experiment are presented in this chapter.

3.1 Materials

3.1.1 Location of study area

The field experiment was carried out at the Research cum Demonstration Farm of Precision Farming Development Centre (PFDC), Department of Irrigation and Drainage Engineering, Dr. Annasaheb Shinde College of Agricultural Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri during the period from December, 2014 to December, 2015. Geographically, the farm lies at 74^0 38' 00" E longitudes and 19^0 20' 00" N latitude at 557 m above the mean sea level, in the central campus of Mahatma Phule Krishi Vidyapeeth, Rahuri.

3.1.2 Climatic conditions of study area

3.1.2.1 General climatic conditions

Climatically, the region falls under the semi-arid and sub-tropical zone with average annual rainfall of 566.48 mm. The annual mean maximum and minimum temperature ranges between 28.22 to 39.04 ^{0}C and 10.10 to 22.9 ^{0}C, respectively. The distribution of rain is uneven and it is distributed over 15 to 37 rainy days. The annual mean pan evaporation ranges from 3.7 to 12.4 mm day^{-1}. The annual mean wind speed ranges from 3.2 to 13.09 km hr^{-1}. The annual mean maximum and minimum relative humidity ranges from 59 to 90% and 21 to 61%, respectively.

3.1.2.2 Climatological data

The meteorological data on important weather parameters during the crop growth period (9th December, 2014 to 15th December, 2015) were collected on daily basis from the Auto Weather Station (AWS) situated at the Instructional Farm of Department of Irrigation and Drainage Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri. The data includes maximum and minimum temperature, minimum and maximum relative humidity, actual sunshine hour and daily wind speed etc.

3.1.3 Experimental setup

The experimental set up consisted of different treatments of coloured mulching along with drip and surface irrigation method in open field. The topography of the experimental field was uniform and levelled.

3.1.3.1 Soil type

Type of soil was predominantly clay. The information related to soil properties was determined at Micronutrient Research Scheme, Department of Soil Science & Agril chemistry, MPKV, Rahuri. Generally deep, well drained loamy soil with adequate organic matter is ideal for banana cultivation.

3.1.3.2 Soil analysis

The physio-chemical properties of the soil for the study area were determined by adopting the standard methods given in Tables 3.1 and 3.2. The representative samples of soil were collected from the field. The samples were mixed thoroughly and air dried in the shed. The stones, roots and other debris were separated out from the soil samples. A composite sample weighing 1 kg was obtained and powdered in wooden mortar and pestle, sieved through 2 mm sieve and analysed for its physical and chemical properties by using standard methods.

Table 3.1. Methods to determine physical properties of soil

Sr. No.	Details	Methods
1.	Soil texture a) Sand, % b) Silt, % c) Clay, %	Sieve analysis
2.	Textural class	Triangular diagram
3.	Bulk density, g cm^{-3}	Core cutter method
5.	Field capacity, %	Pressure plate apparatus
6.	Permanent wilting point, %	Pressure plate apparatus

Table 3.2. Methods to determine chemical properties of soil

Sr. No.	Details	Methods
1.	pH	Potentiometric method (Jackson, 1973)
2.	EC, dS m^{-1}	Conductometric method (Jackson, 1973)
3.	Available N	Alkaline permanganate (Subhiah and Asija, 1956)
4.	Available P	Modified Olsen (Olsen, 1965)
5.	Available K	Neutral N ammonium acetate of flame photometer (Knudsen and Peterson,1982)

3.1.4 Water source

The source of water for the experiment was an open dug well situated at the Instructional Farm of Department of Irrigation and Drainage Engineering.

3.1.4.1 Analysis of water

The chemical properties of irrigation water were determined by adopting standard procedure as shown in Table 3.3.

Table 3.3. Methods to determine chemical properties of irrigation water

Sr. No.	Chemical properties	Method adopted
1.	pH	Potentiometric (Jackson, 1973)
2.	EC	Conductometric (Jackson, 1973)

3.1.5 Mulch details

Six different colour plastic mulches were used for the experiment viz. yellow- black, blue- black, silver- black, white- black, red- black and pervious plastic mulch. These mulches used for different treatments were 30 micron in thickness, 7.5 m in length and 2.1 m in width. The covering of raised bed by colour mulch for banana plantation is shown in Plate 3.1.

Plate 3.1. Covering raised bed by colour mulch for banana plantation

3.1.6 Irrigation system

Drip irrigation and surface irrigation methods were adopted to meet the irrigation requirement of the crop as per the treatments. The drip control head consisted of a suction pipe, screen filter, sand filter with back flush assembly, electric power source, control valves and by-pass assembly. The system was operated by electric motor pump-set.

3.1.6.1 Details of pump-set

An electrical pump set was used for pumping water into the drip irrigation system. The pump having capacity of 3 HP for drip irrigation system and 7.5 HP for surface irrigation. The operating pressure of drip irrigation system was measured by pressure gauge and maintained at 1 kg cm^{-2}.

3.1.6.2 Details of drip irrigation system

The details of drip irrigation system installed for application of water to the experiment field plot was as below:

Main and submain pipe	: PVC
Size of main pipe	: 50 mm diameter
Size of sub main/manifold pipe	: 50 mm diameter
Lateral pipe	: LLDPE material
Size of lateral	: 16 mm
Type of dripper	: Non- pressure compensating
Discharge of emitter	: 4 lit hr^{-1} (On line drippers)
Spacing between lateral	: 1.75 m
Spacing between emitter	: 1.75 m
Operating pressure	: 1 kg cm^{-2}
No. of drippers per plant	: 2

3.1.6.3 Agronomical details of the crop

The agronomical details of the crop are given below:

Local name	:	*Keli*, Banana
Common name	:	*Kela*
Botanical name	:	*Musa paradisica* L.

Variety	:	Grandnaine
Crop duration	:	360-390 days
Crop spacing	:	1.75 m X 1.75 m
Planting date	:	9th December, 2014
Recommended dose	:	160:32:160 g N: P: K plant^{-1} year^{-1}

3.1.6.4 Layout of the experiment

The experiment was carried out on open field with different mulching treatments. The size of the open field was 43.5 m x 27 m. The experiment was laid out in randomized block design with nine treatments and three replications. The size of each plot was 7 m × 3.5 m. A 1.5 m buffer strip was provided between two beds to avoid lateral movement of water from one bed to another.

The schematic layout of an experiment and single plot is shown from Fig. 3.1 and 3.2, respectively.

3.1.7 Experimental details

3.1.7.1 Experimental layout

Design	: Randomised Block Design
Number of treatments	: 9
Number of replications	: 3
Bed Dimensions	: 7 x 3.5 m with 0.3 m height
Size of Field	: 43.5 × 27 m
Total number of plants	: 216

3.1.7.2 Treatment details

The experiment was carried out in randomised block design with nine treatments based on different colour mulches and irrigation methods.

Table 3.4. Details of treatments and symbol used

Sr. No.	Symbol used	Treatment details
1.	T_1	a. Yellow black plastic mulch. b. Drip irrigation with 48% of pan evaporation.
2.	T_2	a. Blue black plastic mulch. b. Drip irrigation with 48% of pan evaporation.
3.	T_3	a. Silver black plastic mulch. b. Drip irrigation with 48% of pan evaporation.
4.	T_4	a. White black plastic mulch. b. Drip irrigation with 48% of pan evaporation.
5.	T_5	a. Red black plastic mulch. b. Drip irrigation with 48% of pan evaporation.
6.	T_6	a. Pervious (weed mat) plastic mulch. b. Drip irrigation with 48% of pan evaporation.
7.	T_7	a. No mulch (control treatment). b. Drip irrigation with 48% of pan evaporation.
8.	T_8	a. No mulch. b. Drip irrigation with 100% of crop evapotranspiration.
9.	T_9	a. No mulch. b. Surface irrigation with 1 IW/CPE ratio.

Treatment T_1 to T_7 was consisted of different colour mulches and daily drip irrigation was given with 48% of pan evaporation. This was based on recommendation of irrigation for banana crop as 60% of pan evaporation, which was for non-mulched treatment. Thus, considering average water saving of mulch as 20%, drip irrigation was scheduled as 48% of pan evaporation. Treatment T_8 was given daily drip irrigation with 100% of crop evapotranspiration based on Kc (crop coefficient) values. Treatment T_9 was given surface irrigation with 1.00 IW/CPE ratio.

3.1.8 Cultural operations

The land used for this experiment was used for banana cultivation in the previous year 2013-2014. Thus, various operations were carried out prior to further cultivation of same crop. The various operations carried out for the experimental plot are as given in Table 3.5.

Table 3.5. Cultural operations followed during crop growth period

Sr. No.	Field operations	Frequency	Date
1.	Ploughing	2	3-11-2014, 6-11-2014
2.	Harrowing	2	10-11-2014, 15-11-2014
3.	Cleaning of the field	1	17-11-2014
4.	Layout of the field	1	19-11-2014
5.	Preparation of raised beds	1	27-11-2014
6.	Installation of drip irrigation system (Laying laterals, fixing drippers etc.)	1	30-11-2014
7.	Covering coloured mulches on beds	1	5-12-2014
8.	Preparation of furrows	1	7-12-2014
9.	Transplantation of tissue culture plants of banana	1	9-12-2014
10.	Sowing of Shevari plant seeds for purpose of vegetative barriers (wind breaks) all around the field.	1	10-12-2014
11.	Weeding		
	a. In raised beds	3	10-03-2015, 18-06-2015, 30-09-2015
	b. In furrows		Bimonthly
12.	Desuckering up to flowering and then keeping one follower at each plant.		Daily supervision

3.1.9 Fertilizer application

3.1.9.1 Fertigation

Electric pump of 0.5 HP was used for injecting the fertilizers into the drip irrigation system. Fertigation was given in ten equal splits at monthly interval.

Table 3.6. Scheduling of fertilizer application for banana through drip irrigation

Total fertilizer dose	Split	Date	Quantity of fertilizer applied		
			Urea(kg)	19:19:19(kg)	0:0:50(kg)
160:32:160 g N:P:K plant^{-1} year^{-1} (Recommended)	1	09/01/2015	6	3.6	5.5
	2	09/02/2015	6	3.6	5.5
	3	03/03/2015	6	3.6	5.5
	4	03/04/2015	6	3.6	5.5
	5	04/05/2015	6	3.6	5.5
	6	04/06/2015	6	3.6	5.5
	7	05/07/2015	6	3.6	5.5
	8	05/08/2015	6	3.6	5.5
	9	05/09/2015	6	3.6	5.5
	10	06/10/2015	6	3.6	5.5

3.1.10 Plant protection measures

Bavistin, chlorpyriphos, sticker (micustick), hexacunazole etc. were used for spraying and drenching as an effective measure against the occurrence of disease and pests like panama wilt, leaf spot, anthracnose, and other fungal diseases. The plants affected by bunchy top virus was killed by using kerosene. The plant protection measures undertaken throughout the growth period of banana crop is shown in Table 3.7.

Table 3.7. Insecticides/pesticides used for pest control in banana

Sr. No.	**Date**	**Type of spray/drenching**	**Quantity (per 10 lit of water)**
1	02/01/2015	Drenching of bavistin and chlorpyriphos	10 ml, 20 ml
2	03/02/2015	Spraying of Hexacunazol and micustick	10 ml, 10 ml

3.2 Methods

3.2.1 Scheduling of drip irrigation

Irrigation was given on daily basis over the entire crop period of banana by drip irrigation method. The roots of banana plant can spread vertically upto only 1 metre and most of the times confined to only 70 cm from the surface (World Meteorological Organization Report, 1988). The plant therefore needs frequent irrigation. The depth of irrigation was applied to banana on the basis of crop evapotranspiration and pan evaporation as per different treatments. Climatological data *viz.* daily maximum and minimum temperature, daily maximum and minimum relative humidity, wind speed at 2 m height, actual sunshine hour and rainfall etc. was collected from the Auto Weather Station (AWS) located at the Instructional Farm of Department of Irrigation and Drainage Engineering.

3.2.1.1 Reference crop evapotranspiration

The reference crop evapotranspiration (ETo) was estimated by using FAO based Penman-Monteith method (Allen *et al.*, 1998). The equation for estimating the ETo is given below (Eq. 3.1).

$$ETo = \frac{0.408.\Delta(R_n - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34 u_2)} \quad .. \ (3.1)$$

where,

ETo = Reference evapotranspiration, mm day^{-1}

Rn = Net radiation at the crop surface, MJ m^{-2} day^{-1}

G = Soil heat flux density, MJ m^{-2} day^{-1}

T = Mean daily air temperature at 2 m height, ^{o}C

u_2 = Wind speed at 2 m height, m s^{-1}

e_s = Saturation vapour pressure, kPa

e_a = Actual vapour pressure, kPa

(e_s – e_a) = Saturation vapour pressure deficit, kPa

Δ = Slope vapour pressure curve, kPa $^{o}C^{-1}$

γ = Psychometric constant, kPa $^{o}C^{-1}$

3.2.1.2 Daily crop coefficient

The daily crop coefficient values required for computing the daily crop evapotranspiration (ETc) shall be estimated using best fit fifth order polynomial equation based on Kc values adopted from the FAO bulletin and as shown in Fig. 3.1.

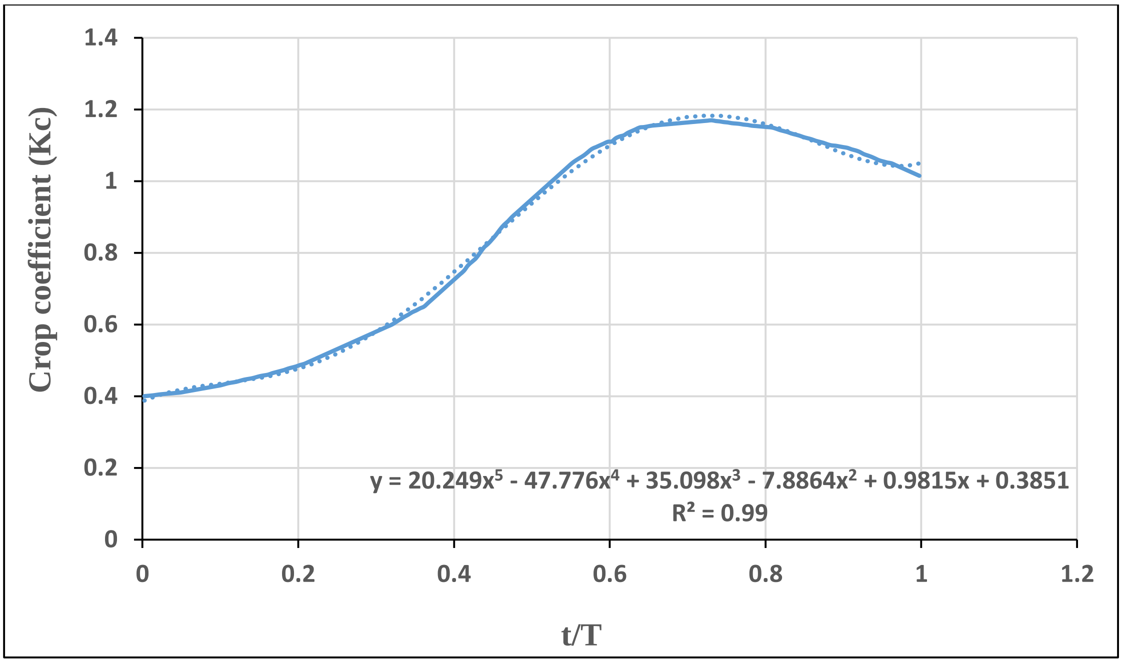

Fig. 3.1. Crop coefficient curve showing best fit polynomial equation for obtaining daily crop coefficient values

$$Kc_t = 20.249[t/T]^5 - 47.776[t/T]^4 + 35.098[t/T]^3 - 7.8864[t/T]^2 + 0.9815[t/T] + 0.3851 \quad .....(3.2)$$

where,

Kc_t - Crop Coefficient on t^{th} day

t - Day considered

T - Total period of crop growth from sowing to harvesting, days

This best fit polynomial equation was obtained by using Kc values and crop period of initial, mid and late/end season for banana crop from FAO Irrigation and Drainage Paper No. 24 and 56. A plot of Kc values against crop period for initial, mid and late/end season given the above best fit polynomial equation which was used for estimation of daily crop coefficient (Kc) values.

3.2.1.3 Crop evapotranspiration (ETc)

The crop evapotranspiration will be estimated using equation (3.3),

$$ETc = ETo \times Kc \quad ...(3.3)$$

where,

ETo = Reference evapotranspiration, mm day^{-1}

Kc = Crop coefficient

3.2.1.4 Emission uniformity

The emission uniformity of each drip irrigated plot shall be computed by collecting water from selected emitters in catch cans for twenty minutes. The operating pressure of 1 kg cm^{-2} shall be maintained throughout the period of irrigation. The emission uniformity shall be computed by the equation (3.4),

$$\mathrm{EU} = \frac{1}{2} \times \left(\frac{\mathrm{qmin}}{\mathrm{qavg}} + \frac{\mathrm{qavg}}{\mathrm{qmax}}\right) \times 100 \qquad \text{..... (3.4)}$$

where,

EU = Absolute Emission uniformity, %

$qmin$ = Average discharge of minimum quarter of emitter, lit hr^{-1}

$qavg$ = Average discharge of all emitter, lit hr^{-1}

$qmax$ = Average discharge of maximum 1/8 th of emitter, lit hr^{-1}

The emission uniformity (EU) was used to calculate time of operation of drip irrigation system.

Total volume of water to be applied to banana crop through the drip irrigation system:

$$\mathrm{Vi} = \frac{(\mathrm{A} \times \mathrm{Di})}{\mathrm{Ea}} \qquad \text{....(3.5)}$$

where,

Vi - Volume of water to be applied during i^{th} irrigation, lit

A - Area of plot, m^2

Di - Depth of irrigation to be applied during i^{th} irrigation, mm

Ea - Application Efficiency, fraction

Time of application will calculated by following equation,

$$T = \frac{\text{Amount of water to be applied (lit)}}{\text{Discharge of emitter (lph)} \times \text{No. of emitters}} \qquad \text{.....(3.6)}$$

where,

T - Time of application, hrs

3.2.2 Scheduling of surface irrigation

In case of surface irrigation 1.00 IW/CPE ratio was used to schedule the irrigation, as per the previous studies carried out at this university. For first three months after planting, 4 cm depth of water was applied at 40 mm CPE. Afterwards 5 cm depth of water was applied at 50 mm CPE till end. As furrow available within paired row planting with surface irrigation was capable of accommodating only 4.1 cm of irrigation depth, only that much of water was applied as against 5 cm depth.

3.2.2.1 Water requirement in surface irrigation treatment

The water requirement of the crop was determined by procedure described by Michael (1978). The following formula was used to determine water requirement of banana crop.

$$WR = IR + ER + S \quad \text{……..(3.7)}$$

where,

WR = Water requirement, cm

IR = Irrigation requirement, cm

ER = Effective rainfall, cm

S = Soil moisture contribution, cm

The soil moisture contribution was considered as nil, as water table was deep enough from soil surface.

3.2.2.2 Net depth of irrigation

The net depth of irrigation was determined with the help of formula suggested by Dastane (1972).

$$d = MAD\% \ X \ AWHC \quad \text{……(3.8)}$$

where,

d = depth of irrigation, cm

MAD = Maximum Allowable Depletion, 35 % (FAO-33)

AWHC = Available Water Holding Capacity, cm

$$= \frac{(FC-PWP)}{100} X\ BDX\ RZD$$

FC = Field Capacity, %

PWP = Permanent Wilting Point, %

BD = Bulk Density, g cm^{-3}

Effective root zone depth was considered as 45 cm up to first three months and then 60 cm till end. The depletion of soil moisture was used to estimate depth of water to be applied and further it was used to estimate CPE value in 1.00 IW/CPE ratio selected as a criteria for irrigation scheduling. Any rain received was deducted from CPE; but rain in excess of evaporation was disregarded.

The rainfall equal to or less than cumulative pan evaporation to the day of rainfall was considered as effective (Hegde and Srinivas, 1991).

Total water applied per turn per plot was calculated by following formula:

$$Q = \frac{\text{A X D}}{\text{Ea}} \quad \text{……(3.9)}$$

where,

Q = Total amount of water applied per plot, lit

A = Total area of plot, m^2

D = Net depth of water application, mm

Ea = Application efficiency, (80%) i.e. 0.8

Time of application was calculated as,

$$T = \frac{\text{Amount of water to be applied (Q), lit}}{\text{Discharge of pipe outlet, lph}} \quad \text{….(3.10)}$$

where,

T = Time, hrs

3.2.3 Field water use efficiency

Field water use efficiency (FWUE) is the ratio of economic yield of crop to total water used during its life period. It is given by equation,

$$\text{FWUE (kg } ha^{-1}cm^{-1}) = \frac{\text{Total yield, (kg } ha^{-1})}{\text{Total water used, cm}} \quad \text{….(3.11)}$$

3.3 Observations recorded for experiment

3.3.1 Climatological parameters

The climatological parameters such as minimum temperature, maximum temperature, minimum relative humidity, maximum relative humidity, wind speed, sunshine hours and rainfall were collected during the course experimentation from the observatory available at Instructional farm, Department of Irrigation and Drainage Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri.

3.3.2 Biometric observations

3.3.2.1 Sampling technique

For recording various growth observations, 4 sample plants were selected randomly from each replicated treatment. The sample plants were tagged for identification. The observations viz. height, stem girth, number of functional leaves etc.

3.3.2.2 Height of the plant

Plant height from ground level to the throat of the observation plant was measured with the help of a metallic tape at 60, 120, 180, 240, 300 days after transplanting and at harvest. Then mean height was expressed in cm.

3.3.2.3 Number of functional leaves

The actual number of physiologically active leaves of all the observation plants were noted down at 60, 120 180, 240, 300 days after transplanting and at harvest.

3.3.2.4 Stem girth

The girth of stem of all the observation plants were noted at the base of pseudostem, 15 cm above the ground level at 60, 120 180, 240, 300 days after transplanting and at harvest. Then mean girth was expressed in cm.

3.3.3 Duration

3.3.3.1 Days for flowering

Banana is monocarpic plant i.e. shoots flowers only at once. After planting number of days required, when 15 cm portion of flower bud was visible, were taken as days required for flowering.

3.3.3.2 Total duration

Days from planting to physiological maturity stage or harvesting stage were counted and recorded as total duration.

3.3.4 Yield parameters

3.3.4.1 Bunch weight

Weight of the bunch from individual plant was measured with the help of weight balance in kg.

3.3.4.2 Number of Hands per bunch

Number of hands from individual bunch of observation plants were counted and recorded.

3.3.4.3 Number of fingers per bunch

Total number of fingers from individual bunch of observation plants were counted and recorded.

3.3.4.4 Average fruit weight

Weight of same selected individual fruit of the observation plants from three replications was taken and calculated the mean weight in grams. This mean is considered as the average weight of fruit for a particular treatment.

3.3.4.5 Fruit yield per plant

The fruit yield from the four, randomly selected observation plants in every treatment was recorded separately and the average yield per plant was worked out.

3.3.4.6 Yield (t ha^{-1})

The overall yield of banana in tonnes per hectare was recorded for each treatment separately.

3.3.4.7 Length of fruit

Middle two fingers of second hand from base of the bunch of observation plants were taken to measure length of fruit. The length was measured from attached portion of pedicel and fruit up to apex along the curved surface in cm.

3.3.4.8 Girth of fruit

Middle circumference of same selected fruits was measured and recorded.

3.3.5 Quality parameters

3.3.5.1 Total soluble solids (TSS) of fruit

The same selected individual fruit from observation plants were taken after ripening for determination of TSS. The pulp of banana fruit was taken in mortar and crushed to prepare a homogeneous paste. Then juice was extracted with the help of muslin cloth and TSS was determined with the help of hand refractometer.

3.3.5.2 Acidity of fruit

The same pulp as used for TSS was used for determination of acidity. 10 gram of pulp was blended with 200 ml of water. It was then filtered and extract was used for titration. 50 ml of above extract was taken in conical flask and titrated against 0.1 N NaOH using phenolphthalein as an indicator. The acidity was expressed as grams of citric acid per 100 gram of pulp.

3.3.6 Micro meteorological studies

3.3.6.1 Photosynthetically active radiation (PAR) (μmol m^{-2} s^{-1})

The photosynthetically active radiation (PAR) is quantum of energy utilized by plants for photosynthesis and is an integrated measurement over spectral range (wavelengths) of 400 to 700 nm. The photosynthetically active radiation (PAR) measured on a clear sky between 11.00 am to 1.00 pm with the LI 191SA Line Quantum Sensor (Li-cor make) at an interval of 15 days. The incident PAR was measured 1 feet above the canopy by line quantum sensor facing toward the sky. The transmitted PAR was measured by placing the line quantum sensor at ground level facing upwards. Reflected PAR by soil and coloured mulches measured at ½ to 1 feet above the ground by facing line quantum sensor towards the mulch and soil. The reflected PAR by canopy + mulch and soil was measured by holding line quantum sensor above the canopy facing toward the canopy. The absorbed photosynthetically active radiation (APAR) calculated by using following formula given by Gallo and Daughtry (1986).

$$APAR = [(Io + Rs) - (Tc + Rc) \qquad ...(3.12)$$

APAR = [(Intercepted + Reflected from soil) – (Transmitted + Reflected from canopy)]

The measurement of absorbed photosynthetically active radiation (APAR) of banana crop with the help of LI 191SA Line Quantum Sensor is shown in Plate 3.2.

3.3.6.2 Soil temperature

Soil temperature was measured by soil thermometer installed in the soil at 10 cm depth. The soil temperature was measured under yellow black plastic mulch, blue black plastic mulch, silver black plastic mulch, white black plastic mulch, red black plastic mulch, pervious mulch and on control treatment (no mulch) daily at the time of 8:30 am and 2:30 pm.

a. Intercepted by canopy (Io) **b. Reflected from soil (Rs)**

c. Transmitted through canopy (Tc) **d. Reflected from canopy (Rc)**

Plate 3.2. Measurement of absorbed photosynthetically active radiation (APAR)

3.3.6.3 Photosynthesis rate

Photosynthesis rate of banana plant leaves measured on a clear sky between 11.00 am to 1.00 pm with the LI 6400 XT Portable Photosynthesis System (PPS) at an interval of 15 days. The LI 6400 XT Portable Photosynthesis System directly gave the reading of photosynthesis rate in the unit μmol CO_2 m^{-2} s^{-1} under various treatments. Plastic mulches affect the plant light environment by altering the wavelength composition and amount of radiation reflected from surface of the mulch up to the plant canopy. The quantification of upwardly reflected light from mulch surface calculated according to amount of photosynthetically active radiation (PAR) and photomorphogenic light (FR: R). Plants responds to increase in FR: R by becoming taller and shifting biomass to aerial portions of the plant in an apparent attempt to grow taller to avoid existing ecological environment and enhance its chance of survival. The light colour mulches reflect more photosynthetic light than dark colour mulches. This affected plant light environment, ultimately affected the rate of photosynthesis (Decoteau *et al*., 1990).

The measurement of photosynthesis rate of banana crop with the help of LI 6400 XT Portable Photosynthesis System (PPS) is shown in Plate 3.3.

Plate 3.3. Measurement of photosynthesis rate of banana crop

3.3.7 Spectral reflectance

The spectral reflectance of the banana crop at different growth stages was measured by using the HR 1024 Spectroradiometer. This spectroradiometer is capable of measuring the light spectrum of different wavelengths reflected from the target ranging from 350 nm to 2500 nm, depending upon calibration of the instrument. The observations on spectral reflectance were recorded fortnightly for every treatment and replication.

3.3.7.1 Estimation of NDVI

The spectroradiometer which was used in the present study is HR 1024 developed by the SVC i.e. Spectra Vista Corporation. This spectroradiometer used in the study is capable of measuring the spectrum of different light sources reflected from the target 350 nm to 2500 nm. The data recorded at the time of field measurements was stored in the form of ASCII file in PDA provided with instrument. The data stored at time of field measurement was then transferred to computer for further processing in 32-bit data processing software of HR 1024. The overlay matching of data was performed and data was exported to excel sheet. NDVI was calculated using the formula given by equation (3.13),

$$\text{NDVI} = \frac{\text{Near Infrared band} - \text{Red band}}{\text{Near Infrared band} + \text{Red band}}$$

….(3.13)

Near infrared band ranges from 700 nm to 1300 nm and red band ranges from 620 nm to 699 nm. By averaging the values of reflectance observed, the NDVI value of the week for particular treatment was calculated. During the field operation the spectral signature were recorded on weekly basis after the irrigation was given. But for the use of NDVI values in computer model and decision support system and better planning, management of irrigation water, daily values of NDVI are required.

The capturing of spectral signatures of banana crop with the help of HR 1024 Spectroradiometer is shown in Plate 3.4.

Plate 3.4. Capturing spectral signature of banana crop

3.3.8 Efficiencies

3.3.8.1 Water use efficiency (kg ha^{-1} mm^{-1})

The field water use efficiency of different treatments was estimated from the banana yield data and the total depth of water applied, using equation (3.14),

$$\text{Water use efficiency} = \frac{\text{Y}}{\text{WR}} \quad .....(3.14)$$

where,

Y = Crop yield, kg ha^{-1}

WR = Total depth of water applied in the field, mm

3.4 Cost economics

3.4.1 Cost of production

The cost of production was worked out for each treatment. The cost includes paid out cost on hired human labour, plants, fertilizers, water charges, interest on working capital, and interest on fixed capital, depreciation, repair and maintenance for drip irrigation system.

3.4.1.1 Depreciation

It was calculated by following formula:

$$\text{Depreciation} = \left[\frac{\frac{OC-JV}{L}}{\text{No. of season}}\right]$$

…..(3.15)

where,

OC = Original cost, ₹

JV = Junk value (10 % of OC), ₹

L = Life span, years

3.4.2 Gross monetary returns

The gross monetary returns per hectare were worked out by considering the fruit yield from different treatments and the prevailing market price of banana.

3.4.3 Net income

The net income was worked out by subtracting the cost of production from the gross monetary returns in each treatment.

3.4.4 Benefit-cost ratio

The benefit-cost ratio was worked out by dividing the cost of production to the gross returns in each treatment under study.

3.5 Statistical analysis

The statistical analysis of data was carried out by statistical method known as “Analysis of variance” (ANOVA) appropriate for the “Random block design”. The standard error (S.E.) for each factor and their interaction was worked out. Wherever the results vary significantly, critical difference (C.D.) at five per cent level of significance was worked out. The data is suitably illustrated with graphs and figures at appropriate places.

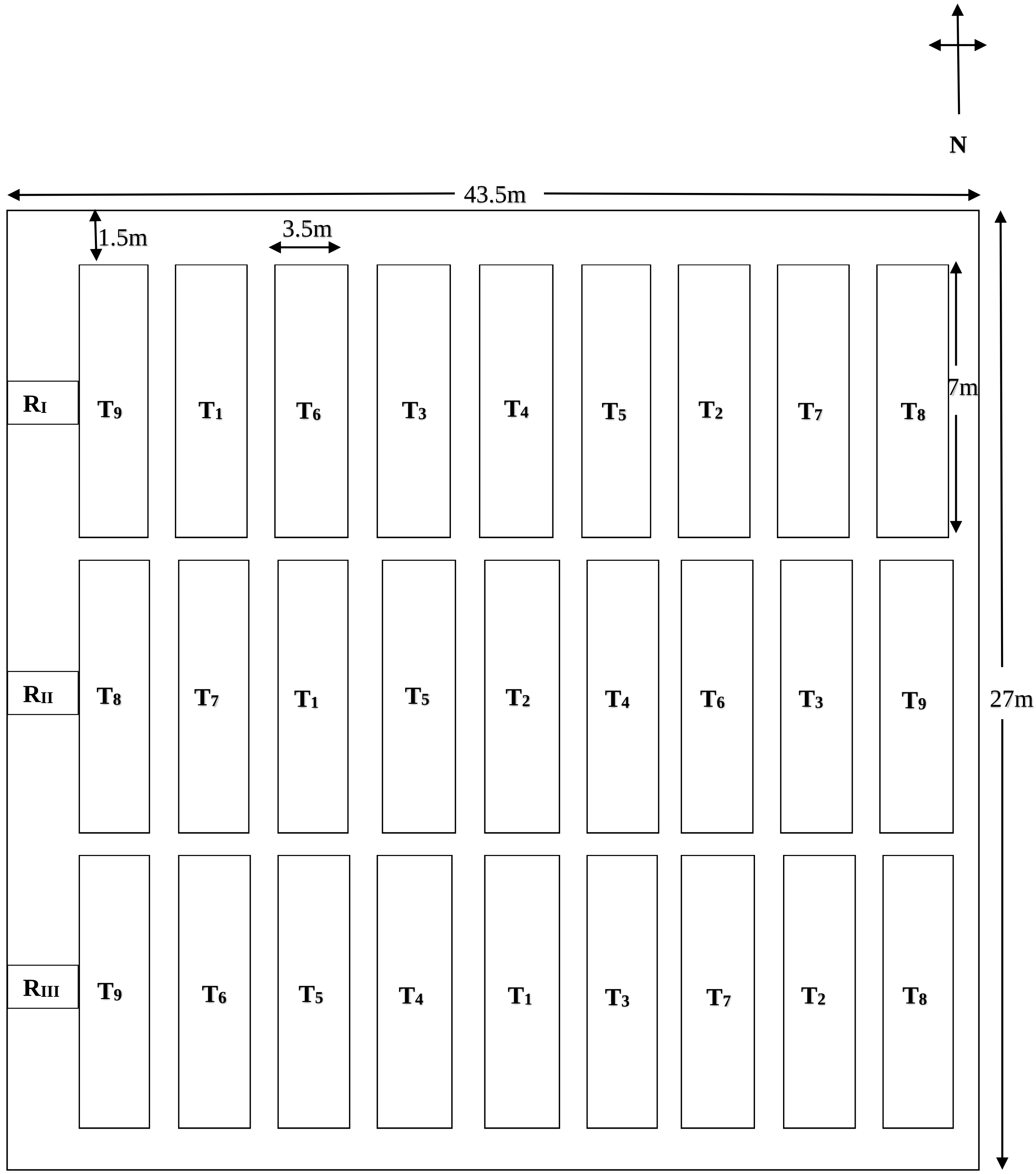

Fig. 3.1 Schematic layout of research experiment on banana

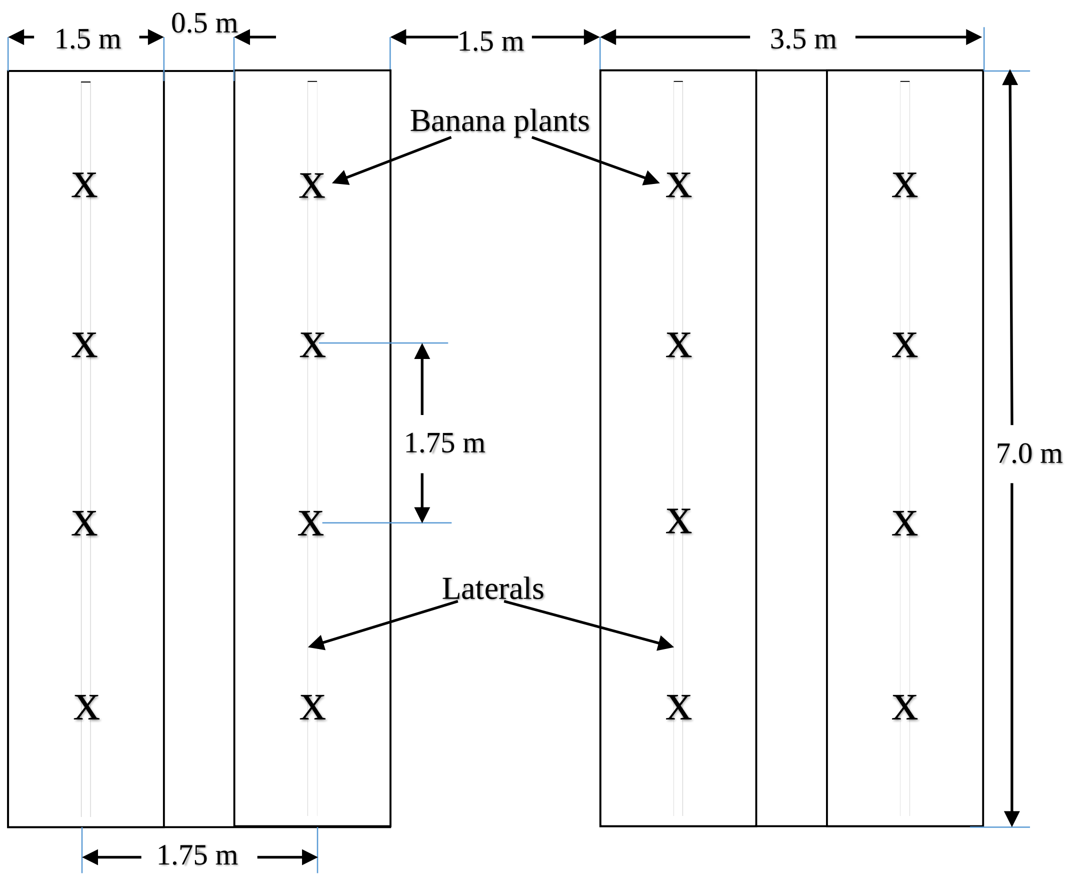

Fig. 3.2. Schematic layout of individual plot of research experiment on banana

4. Results and Discussion

The field experiment entitled "Effect of different colour plastic mulches on growth and yield of banana crop" was conducted at the Research cum Demonstration Farm of Precision Farming Development Centre (PFDC), Department of Irrigation and Drainage Engineering, Dr. A. S. C. A. E., Mahatma Phule Krishi Vidyapeeth, Rahuri. The field experiment was carried primarily to work out, the influence of different colour plastic mulch on growth, yield and quality of banana, to compare the yield of banana under drip and surface irrigation, to determine water requirement and water use efficiency of banana, to find out NDVI values over growth period of banana and to find out economic viability of banana production under various colour mulches. The results of the field experiment are presented and discussed in this chapter.

4.1 Physical and chemical properties of the soil

The soil samples were collected and analyzed by adopting standard procedure as described in Section 3.1.3.2 to determine the physical and chemical properties of soil. The physical and chemical properties of experimental soil were determined before cultivation. The field capacity, permanent wilting point, bulk density, textural class, soil texture were also determined. The chemical properties such as EC, PH, available N, available P and available K were also determined. The physical and chemical properties of experimental soil were determined before sowing and are presented in Table 4.1 and 4.2, respectively.

Table 4.1. Physical properties of soil

Sr. No	Physical properties	Value
1.	Soil texture	
	i) Sand, %	18.76
	ii) Silt, %	23.16
	iii) Clay, %	57.09
2.	Textural class	Clay
3.	Permanent wilting point, %	17.37
4.	Bulk density, g cm^{-3}	1.24
6.	Field capacity, %	40.09
7.	Available soil moisture	22.72

Table 4.2. Chemical properties of soil

Sr. No	Chemical Properties	Values
1.	Soil pH	8.72
2.	EC, dS m^{-1}	0.99
3.	Available N, kg ha^{-1}	81.53
4.	Available P, kg ha^{-1}	7.40
5.	Available K, kg ha^{-1}	302.40

From Table 4.1 and 4.2, it was observed that, the soil of the experimental plot was predominantly clay, with sand, silt and clay percentage of 18.76, 23.16 and 57.09, respectively. The field capacity of the soil was 40.09% and permanent wilting point was 17.37%. It was also observed that, the soil was alkali having pH 8.72 and electrical conductivity 0.99 dS m^{-1}. The soil was deficient in available N (81.53 kg ha^{-1}) and P (7.40 kg ha^{-1}). The available K was found to be sufficient (302.40 kg ha^{-1}).

4.2 Irrigation water analysis

The source of water was open dug well. The water was analysed for the salts and other related properties such as EC and pH. Adopting the standard procedure as described in Section 3.1.4.1, the class of water obtained C_3S_1 (medium salinity and excellent low hazard alkalization). Table 4.3 shows the chemical properties of the water used for irrigation.

Table 4.3. Chemical properties of irrigation water

Sr. No.	Chemical properties	Values
1	pH	7.95
2	EC, dS m^{-1}	0.62

4.3. Average discharge of emitter

The average dripper discharge for different treatments is reported in Table 4.4 and graphically depicted in Fig. 4.1.

Table 4.4. Average emitter discharge for different treatments

Treatments	Average emitter discharge, lit hr^{-1}
T_1 (YBPM, 48% Ep)	3.89
T_2 (BBPM, 48% Ep)	3.91
T_3 (SBPM, 48% Ep)	3.93
T_4 (WBPM, 48% Ep)	3.87

T_5 (RBPM, 48% Ep)	3.92
T_6 (PPM, 48% Ep)	3.90
T_7 (NM, 48% Ep)	3.89
T_8 (NM, 100% ETc)	3.92

It was revealed from Table 4.4 and Fig. 4.1 that, the average emitter discharge in all treatments ranged from 3.87 lit hr^{-1} to 3.93 lit hr^{-1}.

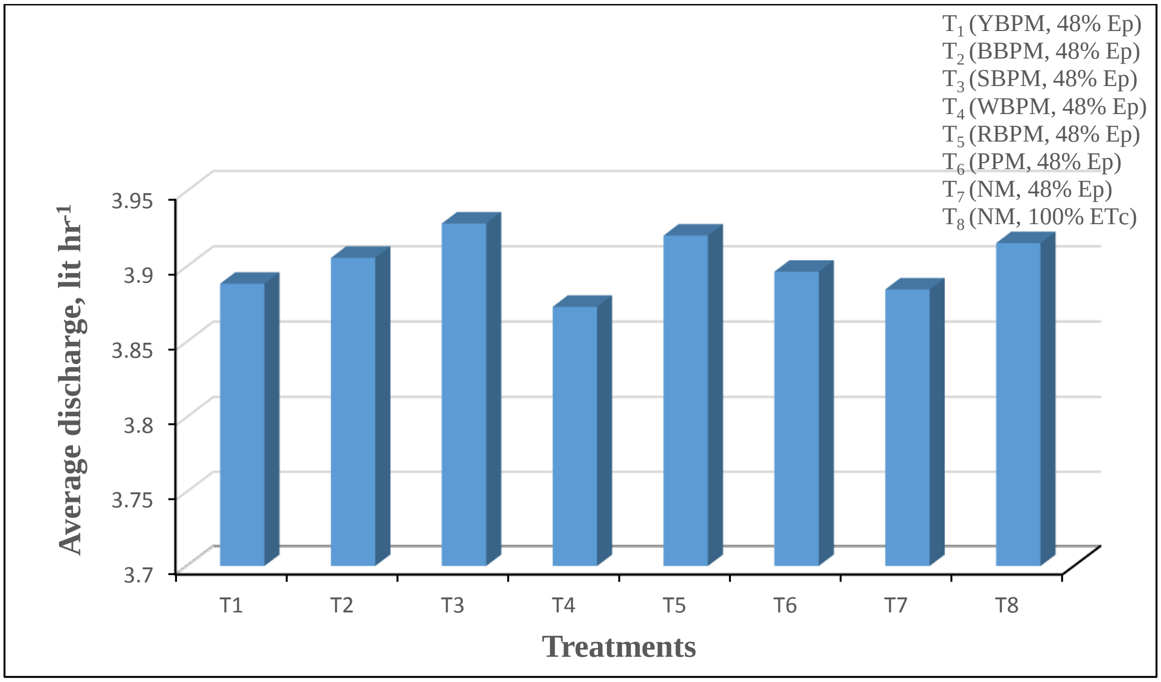

Fig. 4.1. Average discharge of emitter

4.3.1. Average emission uniformity of drip irrigation system

The data of average emission uniformity was computed by adopting the procedure as described in Section 3.2.1.4 for each replication and treatment and given in Appendix-D. The average emission uniformity for different treatments is reported in Table 4.5 and graphically depicted in Fig. 4.2.

Table 4.5. Average emission uniformity of drip irrigation system under different treatments

Treatments	Average emission uniformity, %
T_1 (YBPM, 48% Ep)	96.08
T_2 (BBPM, 48% Ep)	94.81
T_3 (SBPM, 48% Ep)	95.84
T_4 (WBPM, 48% Ep)	95.20

T_5 (RBPM, 48% Ep)	95.76
T_6 (PPM, 48% Ep)	96.34
T_7 (NM, 48% Ep)	95.59
T_8 (NM, 100% ETc)	95.33

It was revealed from Table 4.5 and Fig. 4.2 that, the average emission uniformity in all treatments was ranged from 94.81% to 96.34%. This shows that, the uniformity of water application was excellent throughout the experiment (Bucks and Nakayama, 1982).

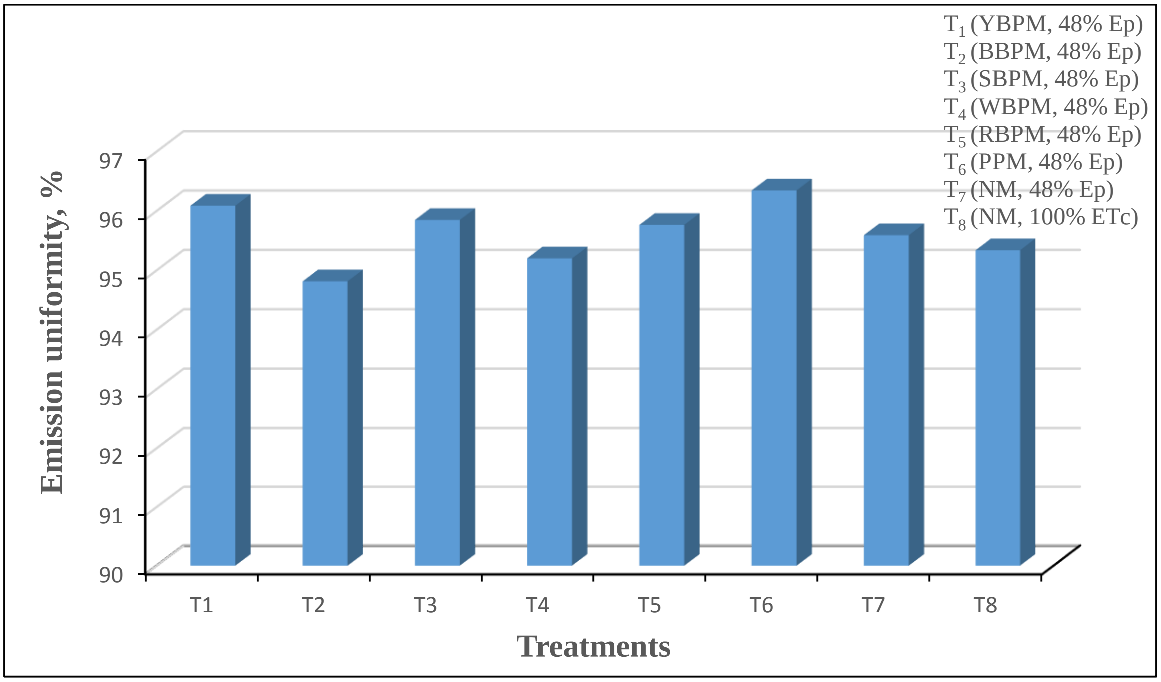

Fig 4.2. Average emission uniformity of drip irrigation system under different treatments

4.4 Irrigation scheduling

In present study drip and surface irrigation method were taken to compare yield of banana in the respective treatments. For first seven treatments i.e. yellow black, blue black, silver black, white black, red black, pervious mulches and control treatment, irrigation was given at the rate of 0.48 Ep (48% of pan evaporation). For eighth treatment irrigation was given at the rate of 100% ETc (100% of crop evapotranspiration) and for ninth treatment surface irrigation was given at the rate of 1.00 IW/CPE ratio. The gross depth of irrigation water applied was calculated by adopting the procedure as described in Section 3.2.1 and given in Appendix-C.

Table 4.6. Total depth of irrigation applied in various treatments for banana crop

Sr. No.	Treatment	Gross depth of water applied, mm
1.	T_1 (Yellow-black plastic mulch, 48% Ep)	1114
2.	T_2 (Blue-black plastic mulch, 48% Ep)	1130
3.	T_3 (Silver-black plastic mulch, 48% Ep)	1015
4.	T_4 (White-black plastic mulch, 48% Ep)	1087
5.	T_5 (Red-black plastic mulch, 48% Ep)	1081
6.	T_6 (Pervious plastic mulch, 48% Ep)	1060
7.	T_7 (No mulch, 48% Ep)	1142
8.	T_8 (No mulch, 100% ETc)	1323
9.	T_9 (Surface irrigation 1.00 IW/CPE ratio)	2204

From Table 4.6 it was revealed that, the maximum depth of irrigation (2204 mm) was applied for treatment T_9, followed by the treatment T_8 (1323 mm) and minimum (1015 mm) in the treatment T_3. Although the irrigation level for first seven treatments was same i.e. 48% of pan evaporation, the variation in depth of irrigation water applied was due to different total duration of plants under various treatments. The plants under treatment T_3 recorded less total duration or completed their life span earlier than those in other treatments, thus recorded less gross depth of water applied.

4.5 Biometric observations of banana

Periodical observations were recorded with an interval of 60 days on the three major growth contributing characters *viz.* plant height, stem girth and number of functional leaves per plant. Periodical data of all these observations given in Appendix-I, Appendix-J and Appendix-K.

In general, each parameter exhibited linear increase during grand growth period and slight decline thereafter. Growth parameters of banana crop discussed under following heads.

4.5.1 Plant height

The data regarding the effect of different treatments on the plant height of banana at harvesting stage (320 DAT) are presented in Table 4.7. The effect of treatments are graphically depicted in Fig. 4.3. From the data, it could be observed that highest plant height (266.74 cm) was recorded at harvest (320 DAT) in treatment T_3, which was at par with T_6 (252.59 cm). The minimum plant height (194.72 cm) was observed in T_9. The rate of increase in plant height was comparatively maximum in same treatments as compared to control treatments. It could also be observed that, the rate of increase in plant height reached its maximum during 90-120 DAP in treatments T_1 to T_8, but in treatment T_9 the same was observed during 120-150 DAP. This might be due to suppressed growth of plants in surface irrigated treatment in early growth period due to periodical water and air stress, but rain started after 5 months after planting the plants might have made up their suppressed growth.

4.5.2 Stem girth

The data regarding the effect of different treatments on the stem girth of banana crop at harvesting stage (320 DAT) are presented in Table 4.7. The data graphically depicted in Fig. 4.4. From the data, it was clear that, as in the plant height, stem girth also followed more or less same trend. The maximum stem girth (63.99 cm) was recorded in treatment T_3, followed by treatment T_6 (63.50 cm), T_1 (59.79) and T_4 (59.07 cm), respectively. The minimum stem girth (51.34 cm) was recorded in the treatment T_9.

4.5.3 Number of functional leaves

The data regarding effect of different treatments on the number of functional leaves of banana crop at harvesting stage (320 DAT) are presented in Table 4.7 and graphically represented in Fig. 4.5. From the periodical data, it could be observed that, number of functional leaves were highest (14.08) in treatment T_3, followed by treatment T_6 (13.42) and T_1 (13.33), respectively. The minimum number of leaves (10.83) were observed under treatment T_9. The rate of increase in functional leaves was maximum during the period 60-90 DAP.

Table 4.7. Growth contributing characters observed at harvesting as influenced by different treatments

Treatments	Plant height, cm	Stem girth, cm	No. of functional leaves per plant
T_1 (YBPM, 48% Ep)	243.78	59.79	13.33
T_2 (BBPM, 48% Ep)	217.54	56.93	12.08
T_3 (SBPM, 48% Ep)	266.74	63.99	14.08
T_4 (WBPM, 48% Ep)	237.19	59.07	12.92
T_5 (RBPM, 48% Ep)	236.32	58.77	12.50

T_6 (PPM, 48% Ep)	252.59	63.50	13.42
T_7 (NM, 48% Ep)	202.70	52.89	11.50
T_8 (NM, 100% ETc)	203.93	54.12	12.00
T_9 (SI, 1 IW/CPE ratio)	194.72	51.34	10.83
S.E.m±	7.00	1.75	1.67
C.D. at 5%	20.99	5.25	7.72

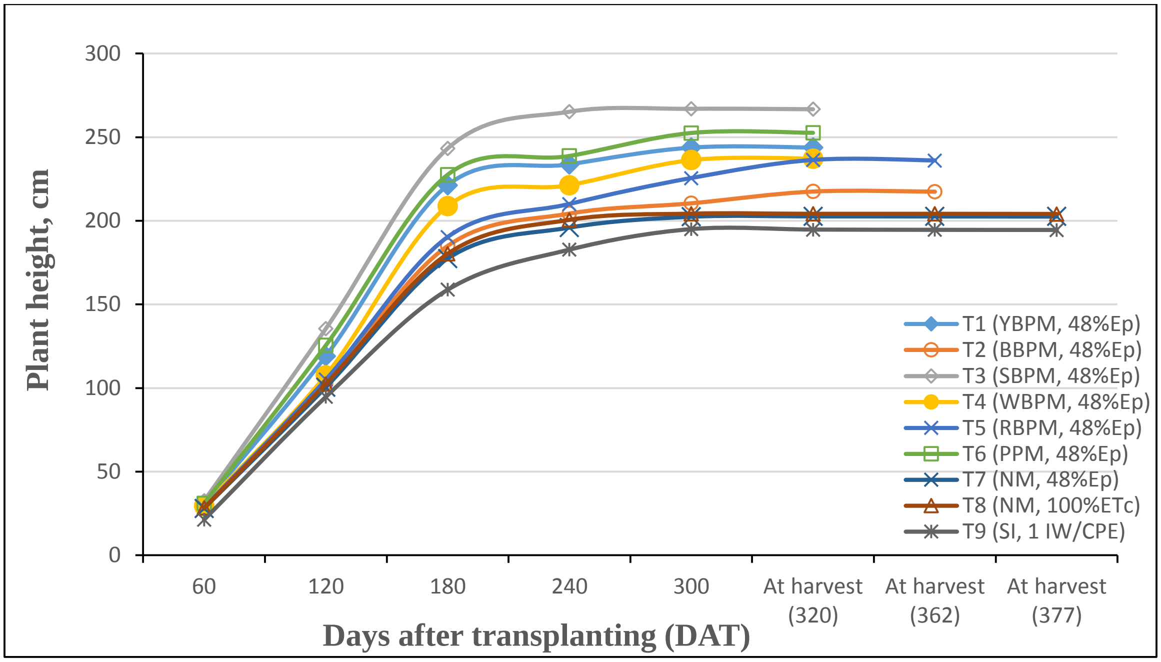

Fig. 4.3. Plant height of banana as influenced by different treatments

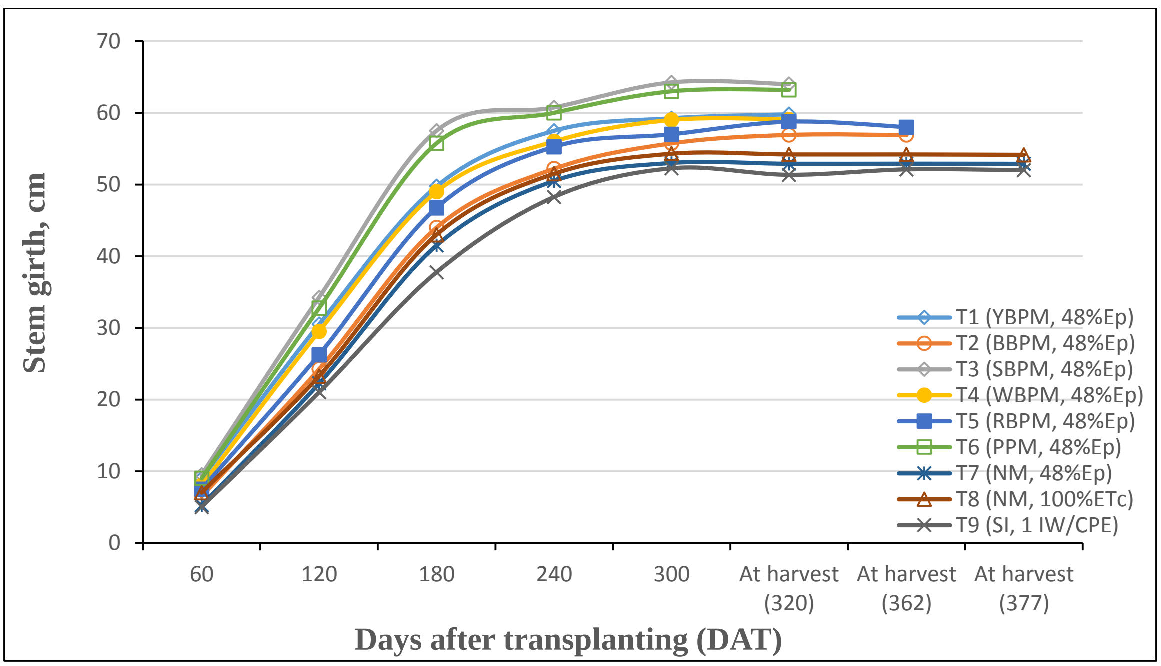

Fig. 4.4. Stem girth of banana plants as influenced by different treatments

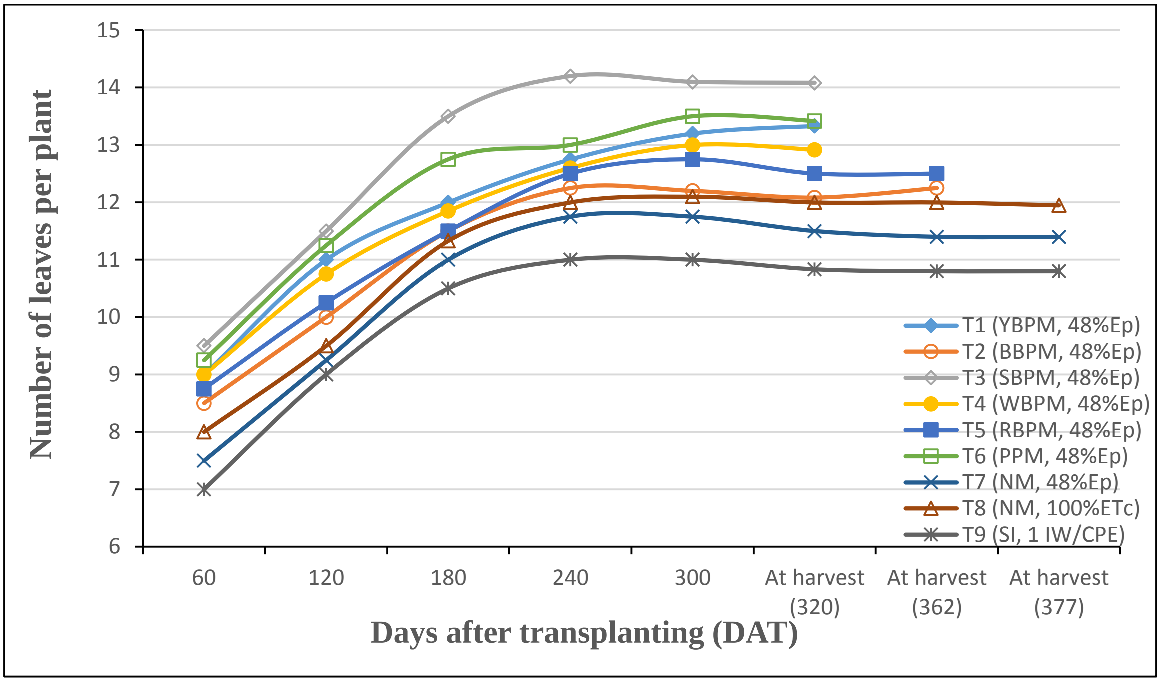

Fig. 4.5. Number of leaves of banana crop as influenced by different treatments

4.5.4 Duration of the crop

4.5.4.1 Days required to flower

The data regarding the days required to flower from date of planting are presented in Table 4.8 and graphically represented in Fig. 4.6. From the data, it was observed that, the treatment T_3 required minimum number of days (220 days) to flower. The earliness in the flowering of plants in treatment T_3 over other treatments could be attributed to better microclimate above and below the mulch with less competition effect resulting in shortening of its vegetative phase and making it to put out earlier flower. Followed by treatment T_3, T_6 (226 days) and T_1 (230 days), respectively showed earliness to flower. The treatments T_1 to T_8 exhibited their earliness over T_9 in this regard.

4.5.4.2 Total duration

The data regarding total duration of plants under various treatments from date of planting are presented in Table 4.8 and graphically represented in Fig. 4.7. From the data, it was observed that, treatment T_3 took minimum number of days (323 days) to complete its life cycle which was at par with T_6 (339 days) and T_1 (347 days), respectively. The treatments T_1 to T_8 observed to be superior over T_9 in this regard also, as they taken less total duration to complete their life cycle than T_9. The plants in the treatment T_9 taken highest 378 days to complete their life cycle among all treatments.

Table 4.8. Duration of banana crop as affected by different treatments

Treatments	Mean days to flower	Total duration, days
T_1 (YBPM, 48% Ep)	230	347
T_2 (BBPM, 48% Ep)	255	368
T_3 (SBPM, 48% Ep)	220	323
T_4 (WBPM, 48% Ep)	239	353
T_5 (RBPM, 48% Ep)	249	362
T_6 (PPM, 48% Ep)	226	339
T_7 (NM, 48% Ep)	264	374
T_8 (NM, 100% ETc)	260	370
T_9 (SI, 1 IW/CPE ratio)	287	378
S.E.m±	6.73	9.35
C.D. at 5%	20.17	28.03

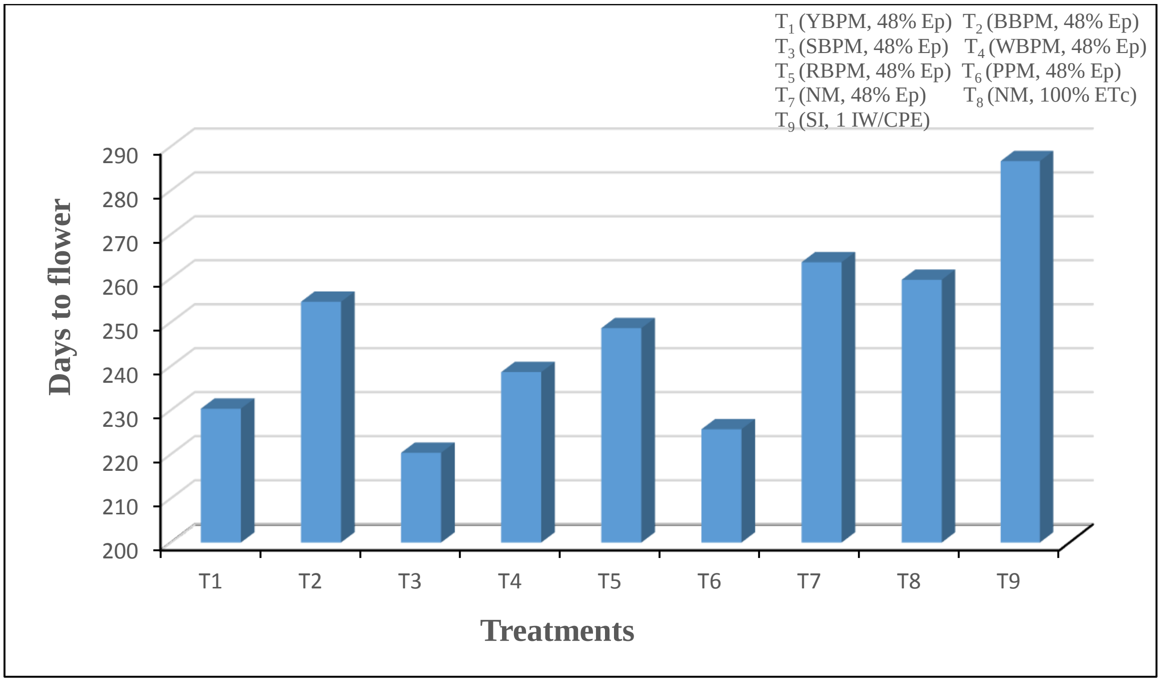

Fig. 4.6. Mean days required for flowering of banana as influenced by different treatments

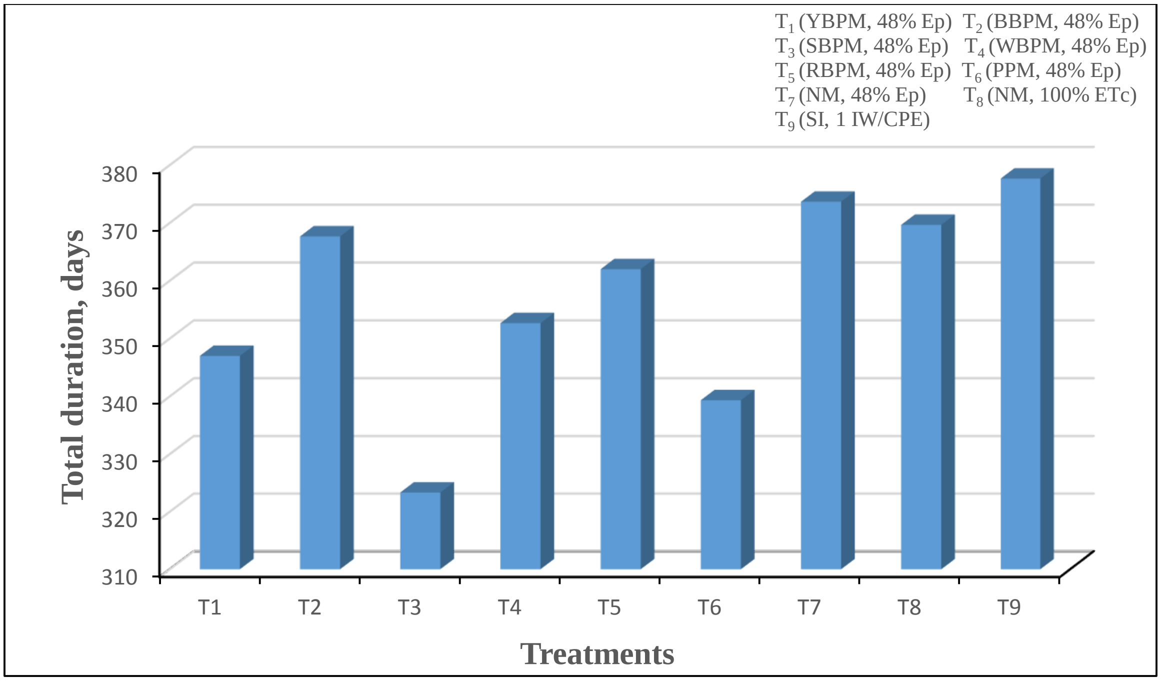

Fig. 4.7. Total duration of banana as influenced by different treatments

4.6 Yield and yield attributes

4.6.1 Number of hands per bunch

The data regarding number of hands per bunch are presented in Table 4.9 and graphically depicted in Fig. 4.8. From the data, it was clear that, the treatment T_3 recorded maximum and significantly superior number of hands per bunch (9.25) among all treatments. This was due to better air water balance in soil and improved microclimate beneath the crop canopy caused due to reflectance from mulch. The number of hands per bunch registered in treatments T_1 to T_8 was significantly higher than that registered in treatment T_9 (5.67).

4.6.2 Number of fingers per bunch

From the data in Table 4.9, it was clear that, the treatment T_3 recorded maximum number of fingers per bunch (130.15), followed by treatment T_6 (126.50) and treatment T_1 (120.52). The number of fingers per bunch registered in treatments T_1 to T_8 was significantly higher than that registered in treatment T_9 (105.33). Significantly less number of fingers per bunch in T_9 was mainly attributed to water stress.

4.6.3 Bunch weight

The data regarding the bunch weight of banana in kg are presented in Table 4.9. The data revealed that, the treatment T_3 registered maximum bunch weight of 25.86 kg, which was at par with T_6 (24.75 kg). This may be due to reason that, the mulch changes microclimate beneath the crop canopy by altering the wavelength composition reflected from mulch surface, which may attributed to improved photosynthesis and improved yield as well. The treatment T_9 recorded lowest bunch weight of 16.23 kg.

4.6.5 Average weight of fruit

The data regarding the average fruit weight of banana in gram are presented in Table 4.9. The data revealed that, the treatment T_3 registered maximum fruit weight (200.33 g), which was at par with T_6 (193.67 g) and T_1 (185.67 g), respectively. The treatment T_9 recorded lowest fruit weight of 145.50 g.

4.6.5 Yield per hectare

The data regarding the yield (t ha^{-1}) of banana are presented in Table 4.9 and graphically depicted in Fig. 4.12. As the yield is function of bunch weight, it also exhibited same trend as bunch weight. The data revealed that, the treatment T_3 registered maximum yield (84.45 t ha^{-1}) which was at par with treatment T_6 (81.67 t ha^{-1}). The treatment T_9 recorded lowest yield of 53.00 t ha^{-1}. The treatments T_1 to T_8 was observed to be superior over treatment T_9 in this regard.

Table 4.9. Yield and yield contributing characters as affected by different treatments

Treatments	No. of hands per bunch	No. of fingers per bunch	Bunch weight, kg	Average fruit weight, g	Yield, t ha^{-1}
T_1 (YBPM, 48% Ep)	8.00	120.52	21.57	185.67	70.67
T_2 (BBPM, 48% Ep)	6.92	114.67	19.19	154.00	63.61
T_3 (SBPM, 48% Ep)	9.25	130.15	25.86	200.33	84.45
T_4 (WBPM, 48% Ep)	7.53	117.57	20.75	174.67	68.10
T_5 (RBPM, 48% Ep)	7.36	115.67	19.84	161.67	65.80
T_6 (PPM, 48% Ep)	8.42	126.50	24.75	193.67	81.67
T_7 (NM, 48% Ep)	6.17	108.67	17.75	150.50	57.73
T_8 (NM, 100% ETc)	6.58	112.50	18.46	153.47	60.12
T_9 (SI, 1 IW/CPE ratio)	5.67	105.33	16.23	145.50	53.00
S.E.m±	0.23	4.15	0.66	5.02	2.04
C.D. at 5%	0.68	12.43	1.99	15.04	6.11

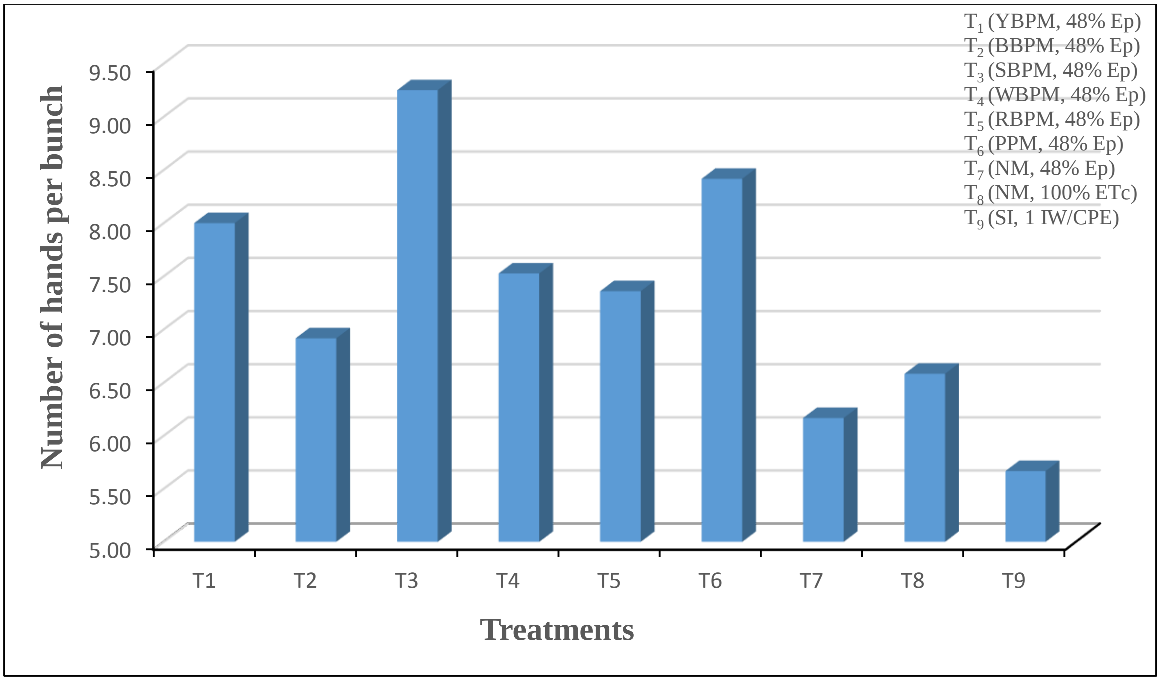

Fig. 4.8. Number of hands per bunch of banana as influenced by different treatments

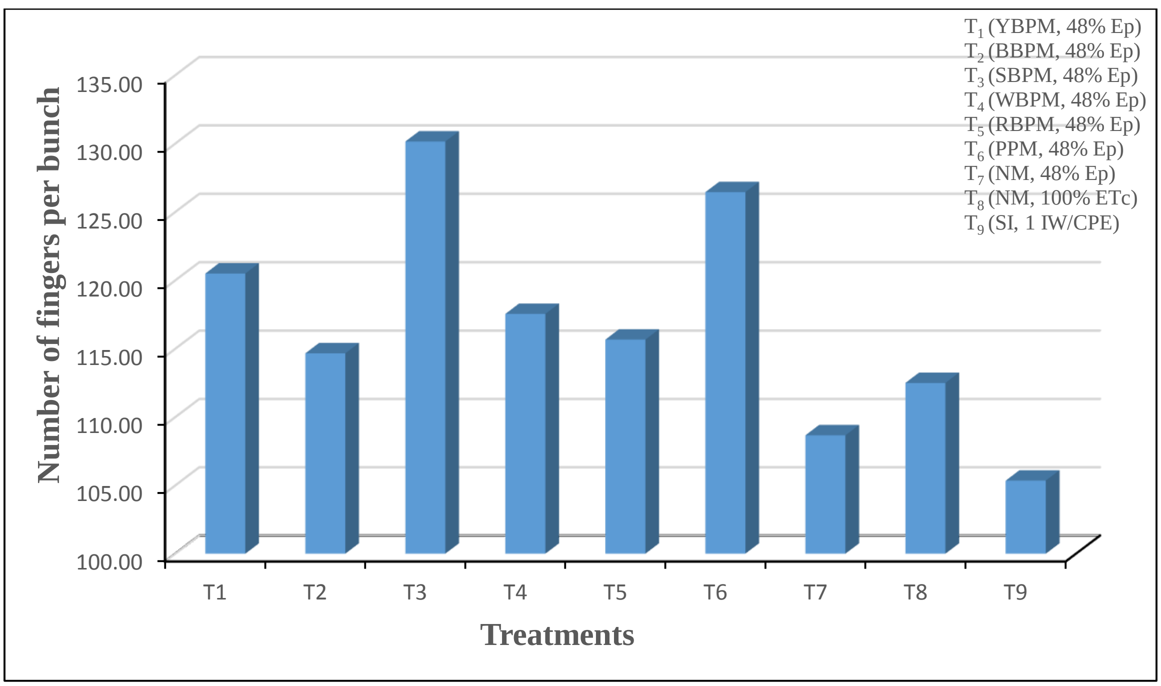

Fig. 4.9. Number of fingers per bunch of banana as influenced by different treatments

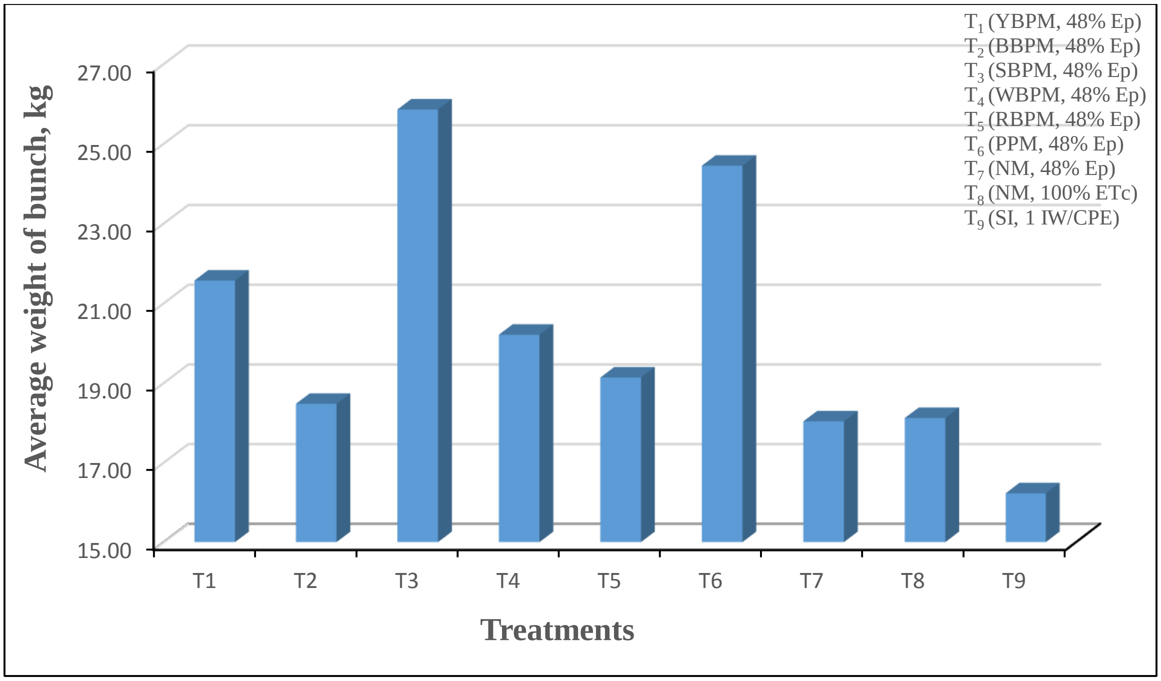

Fig. 4.10. Bunch weight of banana as influenced by different treatments

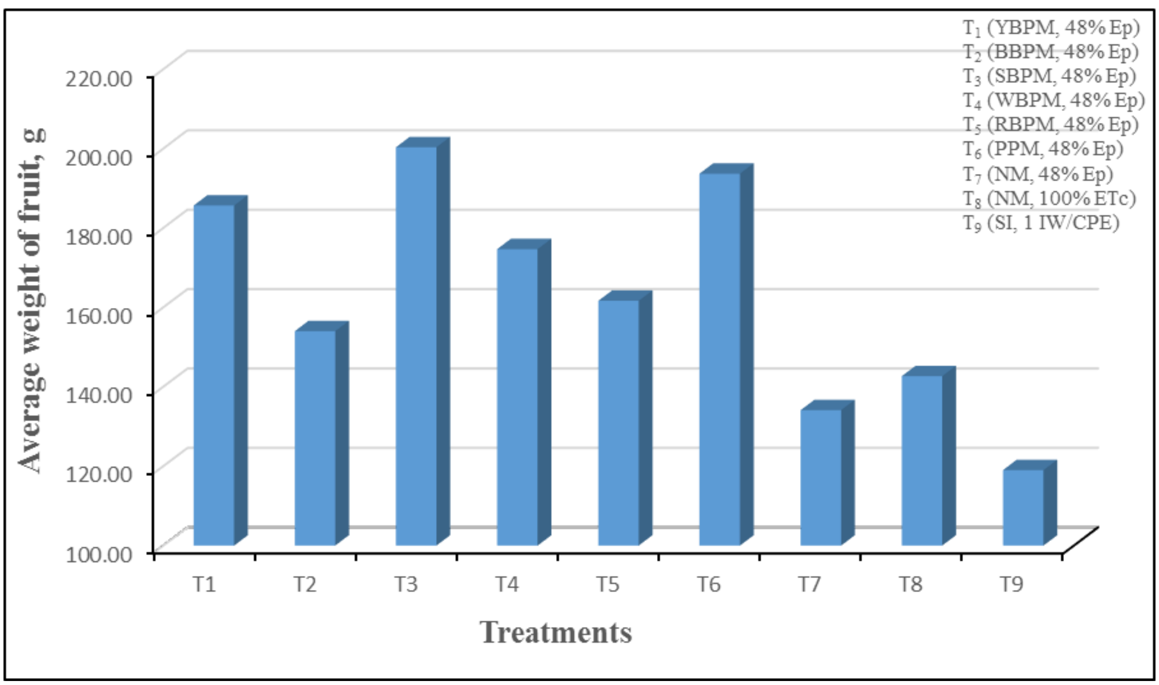

Fig. 4.11. Average fruit weight of banana as influenced by different treatments

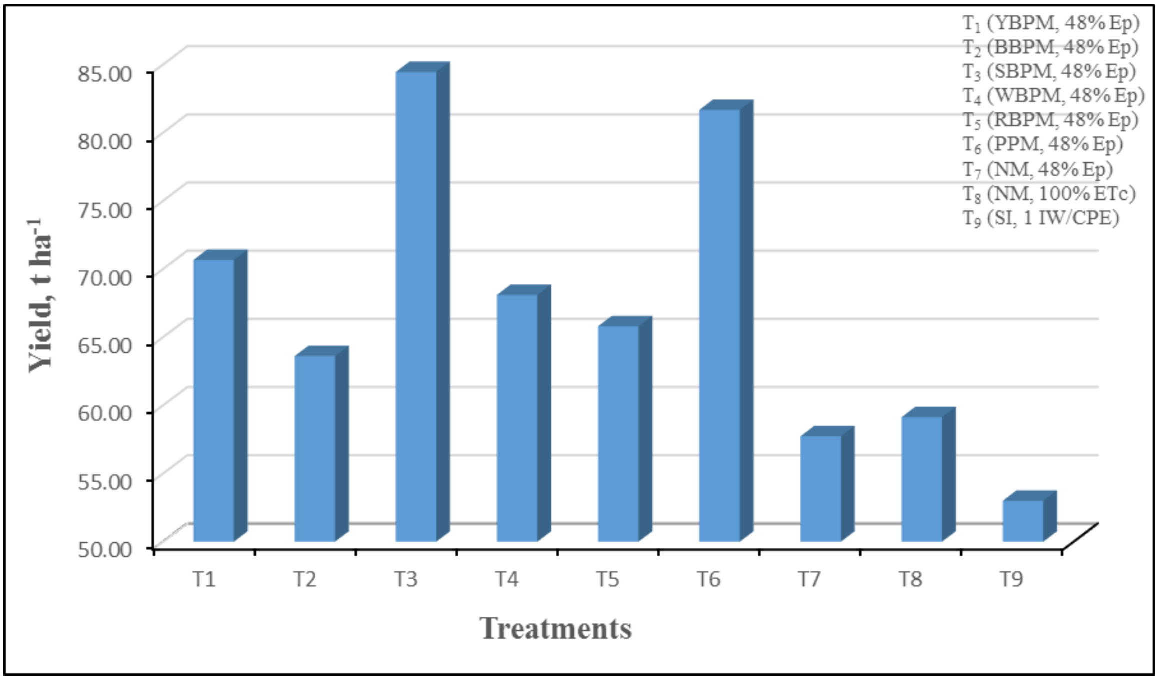

Fig. 4.12. Yield (t ha^{-1}) of banana as influenced by different treatments

Plate 4.1. Bunch of banana

Plate 4.2. Yield of banana

4.6.6 Length and girth of the banana fruit

4.6.6.1 Length of the fruit

The data regarding the length of the fruit of banana are presented in Table 4.10 and graphically depicted in Fig. 4.13. From the results, it was observed that, the highest and significantly superior fruit length (20.08 cm) recorded in treatment T_3, followed by T_6 (18.39 cm) and T_1 (18.08 cm), respectively. Treatment T_1 to T_6 (mulched plots) recorded greater fruit length as compared to treatment T_7 to T_9 (unmulched plots).

4.6.6.2 Girth of the fruit

The data pertaining the girth of fruit as influenced by different treatments are presented in Table 4.10 and graphically depicted in Fig. 4.13. The treatment T_3 recorded maximum fruit girth (14.03 cm), which was at par with treatment T_6 (13.28 cm). The treatment T_9 recorded minimum fruit girth of 10.50 cm. Treatment T_1 to T_6 (mulched plots) observed to be superior as compared to treatment T_7 to T_9 (unmulched plots) in this regard also.

Table 4.10. Length and girth of the fruit as affected by different treatments

Treatments	Length of fruit, cm	Girth of fruit, cm
T_1 (YBPM, 48% Ep)	18.08	12.67
T_2 (BBPM, 48% Ep)	17.08	12.17
T_3 (SBPM, 48% Ep)	20.08	14.03
T_4 (WBPM, 48% Ep)	17.50	12.53
T_5 (RBPM, 48% Ep)	17.36	12.37
T_6 (PPM, 48% Ep)	18.39	13.28
T_7 (NM, 48% Ep)	16.50	11.58
T_8 (NM, 100% ETc)	16.75	11.83
T_9 (SI, 1 IW/CPE ratio)	15.50	10.50
S.E.m±	0.50	0.38
C.D. at 5%	1.49	1.14

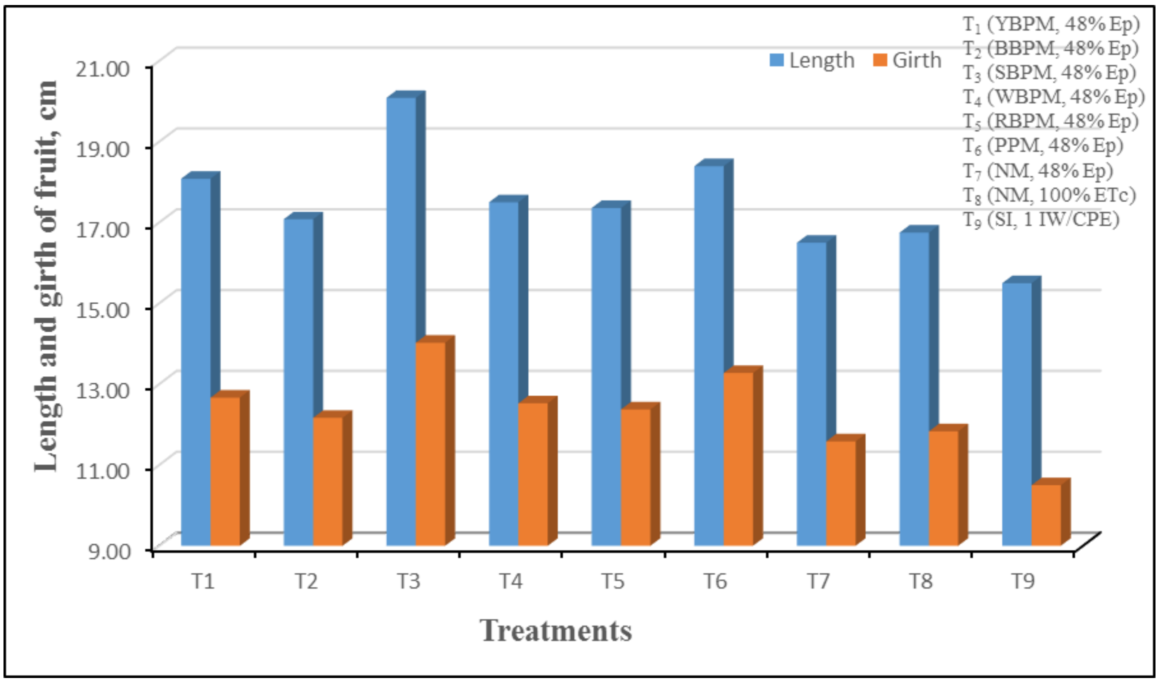

Fig 4.13. Length and girth of banana fruit as influenced by different treatments

4.7 Quality parameters

4.7.1 TSS of fruit

The data regarding Total Soluble Solids (TSS) of the fruit pulp are presented in Table 4.11 and graphically depicted in Fig. 4.14. From the data, it was clear that, there was no significant difference in TSS of fruit pulp of banana under different treatments.

4.7.2 Acidity

The data regarding acidity of banana fruit pulp are presented in Table 4.11 and graphically depicted in Fig. 4.15. From the data, it was clear that, the acidity of the fruit pulp of banana was not significantly influenced by different treatments.

Table 4.11. Quality parameters of banana as affected by different treatments

Treatments	TSS of fruit, ° Brix	Acidity of fruit, %
T_1 (YBPM, 48% Ep)	18.47	0.27
T_2 (BBPM, 48% Ep)	18.35	0.28
T_3 (SBPM, 48% Ep)	18.53	0.25
T_4 (WBPM, 48% Ep)	18.43	0.27
T_5 (RBPM, 48% Ep)	18.40	0.27
T_6 (PPM, 48% Ep)	18.50	0.25
T_7 (NM, 48% Ep)	18.27	0.27
T_8 (NM, 100% ETc)	18.30	0.27
T_9 (SI, 1 IW/CPE ratio)	18.00	0.28
S.E.m±	0.48	0.01
C.D. at 5%	N.S.	N.S.

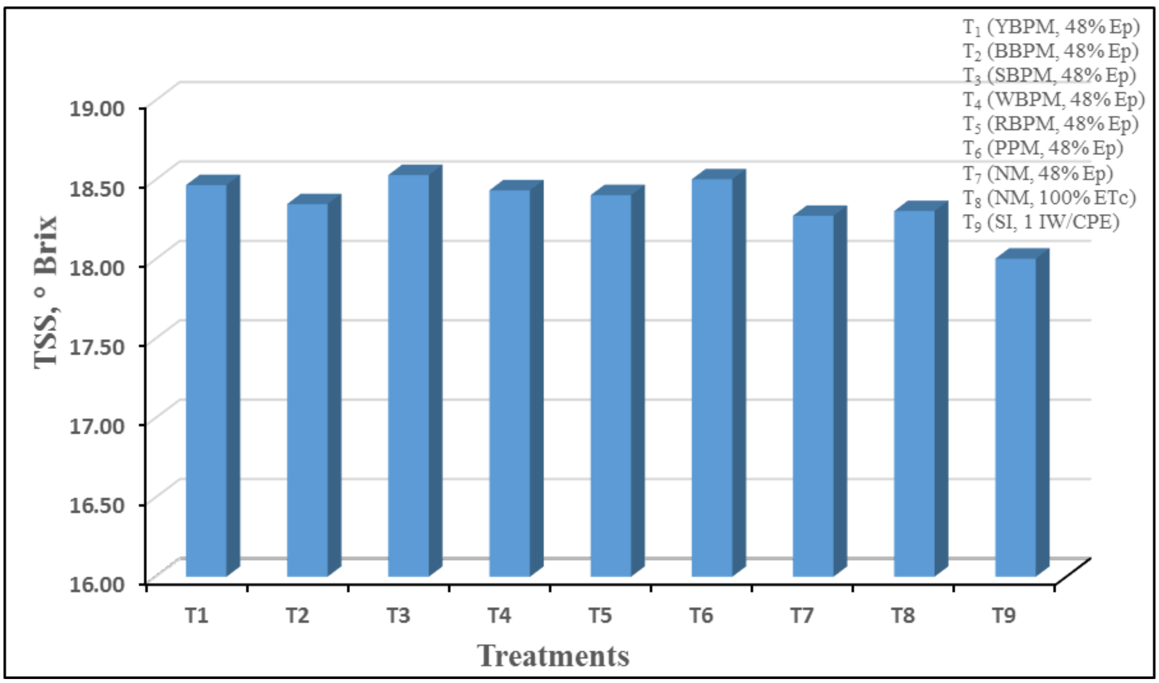

Fig. 4.14. TSS of banana fruit as influenced by different treatments

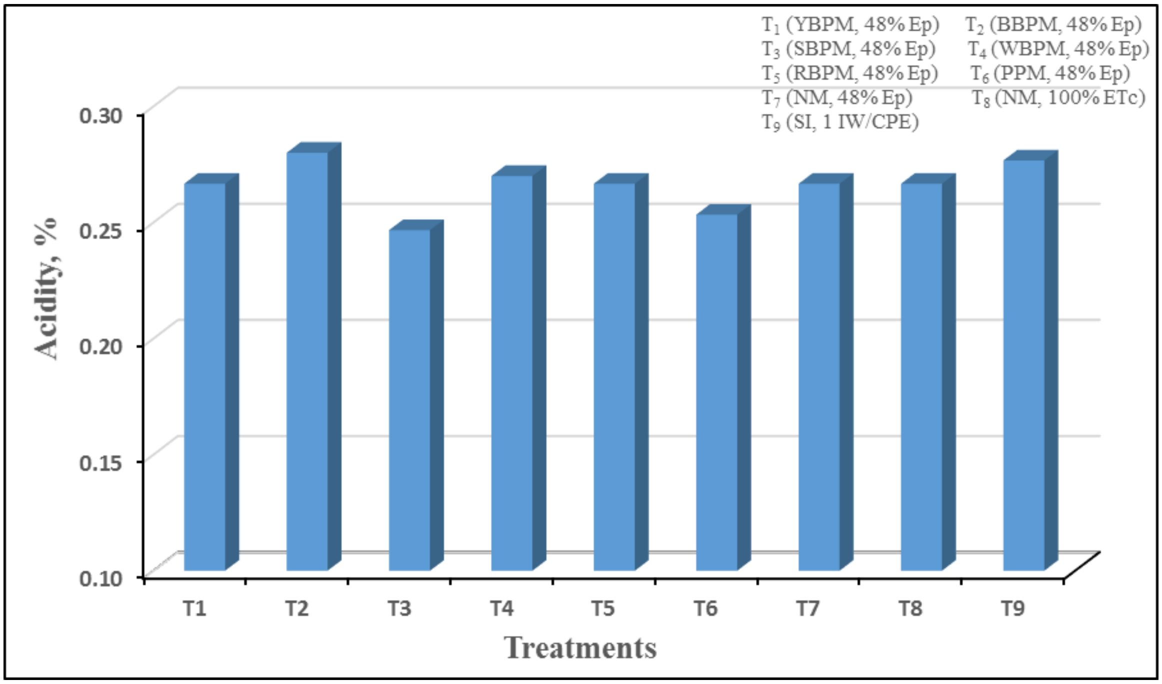

Fig. 4.15. Acidity of banana fruit as influenced by different treatments

4.8 PAR (Photosynthetically Active Radiation) (µmol m^{-2} s^{-1})

The data pertaining to mean photosynthetically active radiation (PAR) as influenced by the different treatments at 60, 120, 180, 240, 300 DAT and at first harvest stage (318 DAT) are presented in Table 4.12 and graphically depicted in Fig. 4.16. The periodical data on photosynthetically active radiation (PAR) in all replications are given in Appendix-L.

Table 4.12. Photosynthetically active radiation (µmol m^{-2} s^{-1}) of banana as influenced periodically by different treatments

Treatments	Photosynthetically active radiation (µmol m^{-2} s^{-1})					
	60 DAT	120 DAT	180 DAT	240 DAT	300 DAT	At harvest
T_1 (YBPM, 48% Ep)	295.09	483.43	827.60	1025.27	946.32	891.35
T_2 (BBPM, 48% Ep)	196.72	328.85	699.75	931.80	932.56	846.65
T_3 (SBPM, 48% Ep)	307.67	573.25	882.50	1060.78	975.55	900.27
T_4 (WBPM, 48% Ep)	295.62	511.71	866.00	1040.47	972.37	895.17
T_5 (RBPM, 48% Ep)	216.08	353.77	727.73	926.17	935.39	864.61
T_6 (PPM, 48% Ep)	192.25	314.35	655.35	876.00	897.19	842.37
T_7 (NM, 48% Ep)	177.67	290.65	614.50	855.51	864.15	800.53
T_8 (NM, 100% ETc)	187.37	294.50	624.80	860.17	866.17	816.18
T_9 (SI, 1 IW/CPE ratio)	168.17	251.17	569.53	826.00	838.67	785.83

S.E.m±	12.36	12.63	18.89	24.60	23.41	21.42
C.D. at 5%	37.07	37.88	56.63	73.76	70.17	64.20

The highest photosynthetically active radiation (µmol m^{-2} s^{-1}) was observed in the treatment T_3 at 60, 120, 180, 240, 300 DAT and at 1st harvest (318 DAT), that was 307.67, 573.25, 882.50, 1060.78, 975.55 and 900.27 µmol m^{-2} s^{-1}, respectively. The highest PAR (307.67 µmol m^{-2} s^{-1}) at 60 DAT was observed in treatment T_3 which was followed by treatment T_4 (295.62 µmol m^{-2} s^{-1}) and T_1 (295.09 µmol m^{-2} s^{-1}). Similar trend was observed at 120, 180, 240, 300 DAT and at harvesting stage also. It was observed that, the number of at par treatments to the treatment T_3 increased with increase in days after transplanting (DAT). This may be due to reason that, the weather affected the colour of the mulch with time, which reduced the difference in reflected radiations from various colour mulchs. It was also observed that, light colour mulches reflected more photosynthetically active radiation than dark colour mulches. These results were matching with results obtained by Decoteau *et al.* (1990).

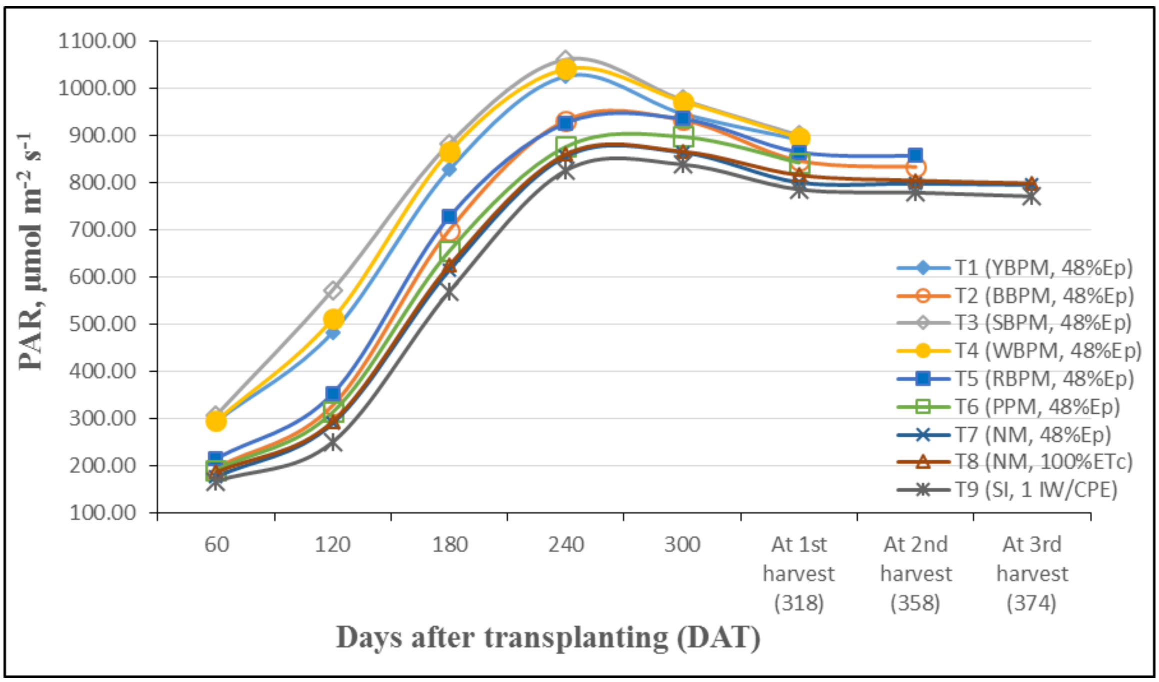

Fig. 4.16. Photosynthetically active radiation (µmol m^{-2} s^{-1}) of banana as influenced periodically by different treatments

4.9 Photosynthesis rate (µmol CO_2 m^{-2} s^{-1})

The data pertaining to mean photosynthesis rate as influenced by the different treatments at 60, 120, 180, 240, 300 days after transplanting and at first harvest are presented in Table

4.13 and graphically depicted in Fig. 4.17. The periodical data on photosynthesis rate in all replications are given in Appendix-M.

Table 4.13. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced periodically by different treatments

Treatments	Photosynthesis rate (µmol CO_2 m^{-2} s^{-1})					
	60 DAT	120 DAT	180 DAT	240 DAT	300 DAT	At harvest
T_1 (YBPM, 48% Ep)	3.22	6.77	14.26	18.96	28.55	27.33
T_2 (BBPM, 48% Ep)	2.95	6.26	13.70	17.25	27.89	26.23
T_3 (SBPM, 48% Ep)	3.63	7.95	15.05	19.72	29.33	28.38
T_4 (WBPM, 48% Ep)	3.47	7.56	14.58	19.16	29.02	28.16
T_5 (RBPM, 48% Ep)	3.00	7.27	14.30	18.79	28.38	26.44
T_6 (PPM, 48% Ep)	3.16	6.19	12.48	17.13	25.90	24.08
T_7 (NM, 48% Ep)	2.40	5.58	12.11	16.39	25.25	23.87
T_8 (NM, 100% ETc)	2.49	5.60	12.18	16.51	25.32	23.87
T_9 (SI, 1 IW/CPE ratio)	2.07	4.96	11.34	14.55	23.38	22.99
S.E.m±	0.10	0.17	0.36	0.48	0.72	0.67
C.D. at 5%	0.31	0.51	1.07	1.43	2.14	2.02

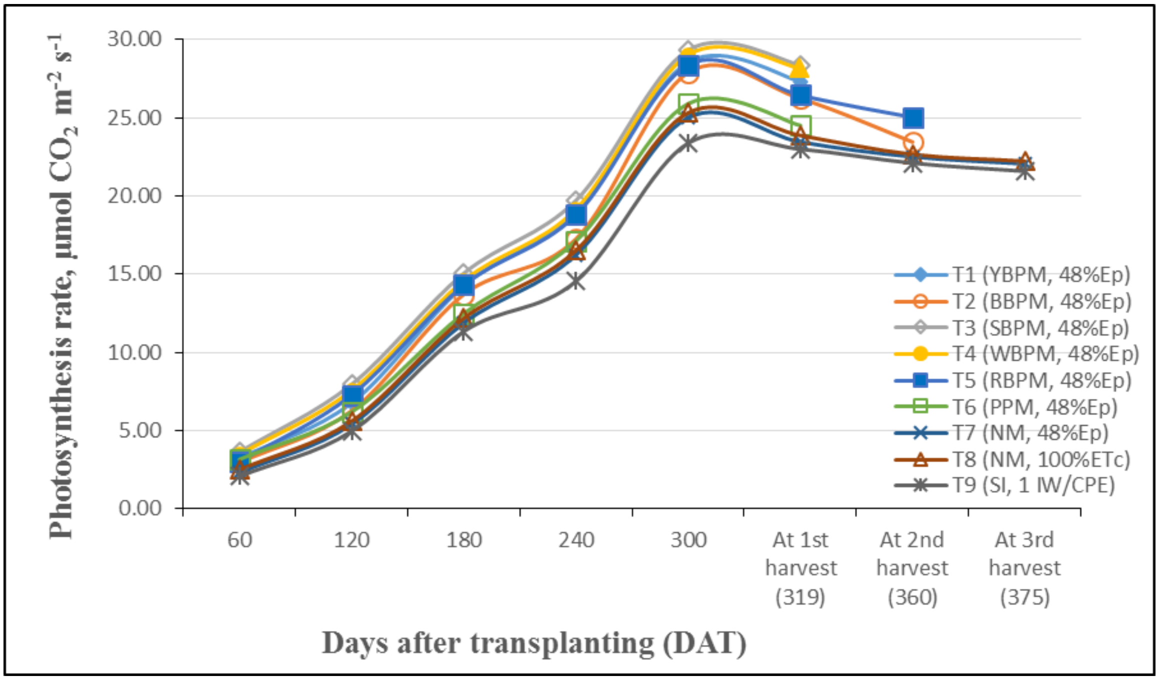

Fig. 4.17. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced periodically by different treatments

The highest rate of photosynthesis (µmol CO_2 m^{-2} s^{-1}) was observed in treatment T_3 at 60, 120, 180, 240, 300 days after transplanting and at 1st harvest that was 3.63, 7.95, 15.05, 19.72, 29.33 and 28.38 µmol CO_2 m^{-2} s^{-1}, respectively. The similar trend as PAR, observed in the case of photosynthesis rate. The highest rate of photosynthesis (3.63 µmol CO_2 m^{-2} s^{-1}) at 60 DAT was observed in treatment T_3, which was at par with treatment T_4 (3.47 µmol CO_2 m^{-2} s^{-1}). Similar trend was observed at 120, 180, 240, 300 DAT and at harvesting stage also. Similar to the PAR, in case of photosynthesis rate, it was observed that, the number of at par treatments to the treatment T_3 increased with increase in days after transplanting (DAT), because the weather affected the colour of the mulch with time, which reduced the difference in reflected radiations from different colour mulches, ultimately affecting the difference in the photosynthesis rate. In response to increased PAR and photosynthesis rate, more photosynthates produced and to store surplus photosynthates plant adapt itself by producing more yield.

4.10 Soil temperature

In the morning (8:30 am) and afternoon (2:30 pm) the data on soil temperature recorded under various treatments for banana crop. The monthly average daily soil temperature under different treatments are presented in Table 4.14 and graphically depicted in Fig. 4.18. The variation in seasonal average daily soil temperature as influenced by various treatments is also shown in Fig. 4.19.

Table 4.14. Monthly average daily soil temperature under different treatments

Month	Treatments								
	T_1 (YBPM, 48% Ep)	T_2 (BBPM, 48% Ep)	T_3 (SBPM, 48% Ep)	T_4 (WBPM, 48% Ep)	T_5 (RBPM, 48% Ep)	T_6 (PPM, 48% Ep)	T_7 (NM, 48% Ep)	T_8 (NM, 100% ETc)	T_9 (SI, 1.00 IW/CPE)
Jan,15	22.63	23.00	22.25	21.75	24.00	22.38	22.50	22.50	22.93
Feb,15	24.00	23.58	22.75	22.50	24.00	23.00	23.50	23.50	24.00
Mar,15	24.38	25.50	24.13	23.75	25.75	25.00	25.13	24.25	24.80
Apr,15	26.25	27.38	25.63	25.13	27.00	26.25	26.45	25.88	26.50
May,15	29.13	30.50	28.00	27.63	30.63	28.63	29.50	29.34	29.75
June,15	27.50	28.75	26.63	26.13	28.63	27.25	27.38	27.00	27.63
July,15	25.63	26.50	24.88	24.00	26.00	25.38	25.88	25.38	25.95
Aug,15	27.13	27.50	26.00	25.63	27.38	26.88	27.00	26.63	27.13
Sept,15	25.38	26.50	24.75	25.45	25.88	25.25	26.00	25.38	26.00

Oct,15	25.75	26.50	25.25	25.25	26.25	26.13	26.38	25.88	26.25
Nov,15	25.25	25.58	24.25	23.75	25.88	25.00	25.75	25.00	25.20
Dec,15	24.00	23.75	25.75	22.25	25.15	24.75	25.00	25.50	26.00
Seasonal average	**25.58**	**26.25**	**25.02**	**24.43**	**26.38**	**25.49**	**25.87**	**25.52**	**26.01**

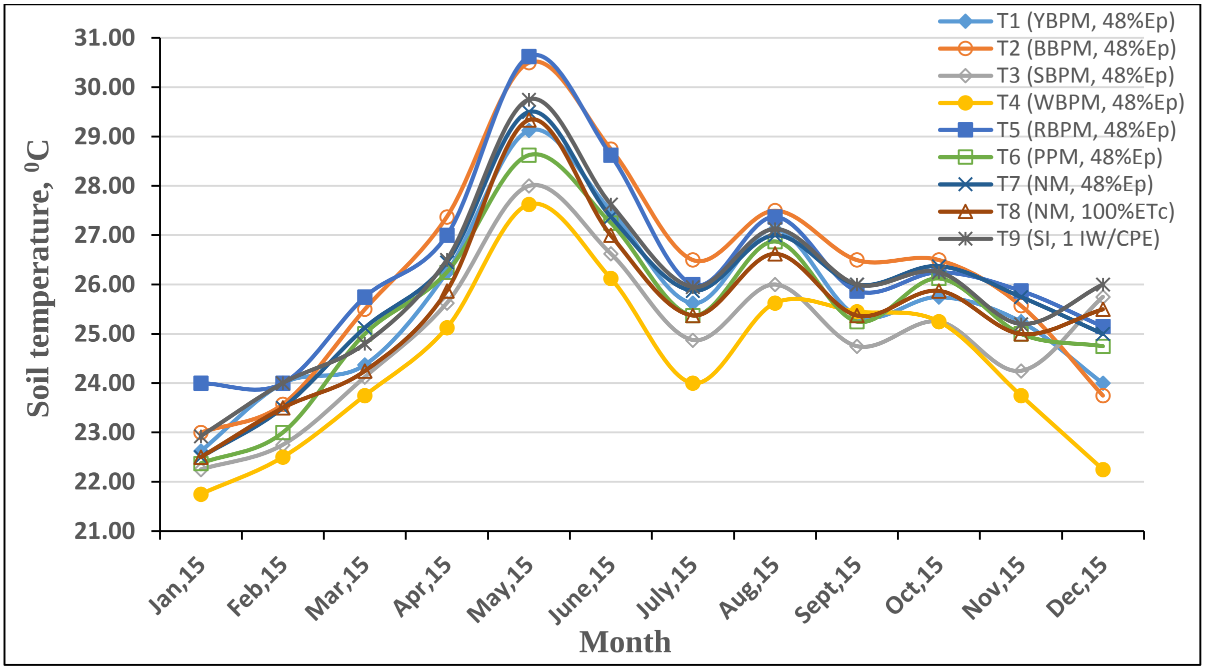

Fig. 4.18. Monthly average daily soil temperature under different treatments

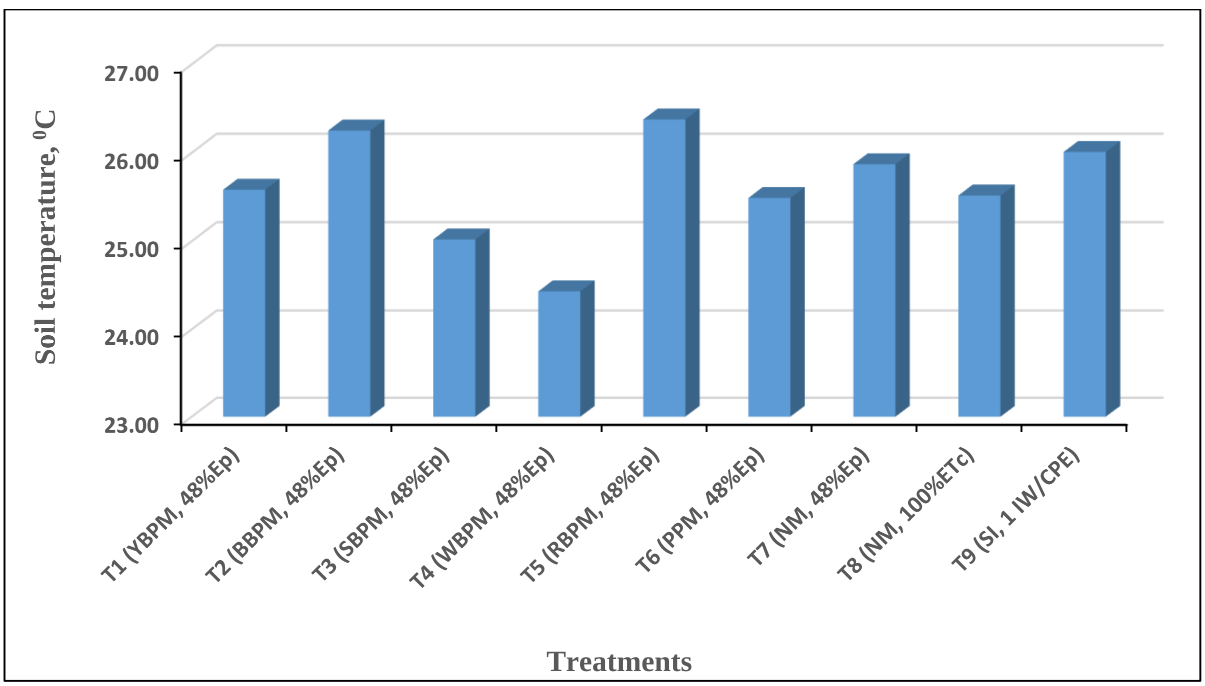

Fig. 4.19. Seasonal average daily soil temperature under various treatments

As shown in Table 4.14 and Fig. 4.18, the highest monthly average daily soil temperature (30.63 ^{0}C) was observed under treatment T_5 (RBPM, 48%Ep) in the month of May, followed by treatment T_2 (30.50 ^{0}C). This may be due to reason that, the dark colour mulches such as red, blue etc. absorb more of incoming solar radiations as compared to light colour mulches like white, silver etc. In contrast lighter colour mulches reflects more of incident solar radiation, hence temperature under light colour mulches observed to be less as compared to dark colour mulches. The treatment T_9 (SI, 1.00 IW/CPE ratio) recorded greater soil temperature as compared to treatment T_7 (NM, 48%Ep) and treatment T_8 (NM, 100%ETc), because of more evaporation losses of applied water. The minimum monthly average daily soil temperature (27.63 ^{0}C) in the month of May, was observed in treatment T_4 (WBPM, 48%Ep), which may be due to greater reflectivity of white colour mulch. Similar to monthly average daily soil temperature, the highest seasonal average daily soil temperature (26.38 ^{0}C) was observed in treatment T_5, which was followed by treatment T_2 (26.25 ^{0}C). The minimum seasonal average daily soil temperature (24.43 ^{0}C) was observed in treatment T_4 (WBPM, 48%Ep).

4.11 NDVI value over growth period of banana

4.11.1 Spectral library for banana crop

The spectral library for banana crop was prepared by using Spectroradiometer HR 1024. The detailed procedure for operation of spectroradiometer and data recording is given in the Appendix-N. The spectral signatures were recorded over the crop period of banana and presented in Appendix-O.

4.11.2 Variations in NDVI values for banana crop

The variations in NDVI values over growth period of banana as influenced by different treatments are presented in Table 4.15 and graphically depicted in Fig. 4.20.

Greater the amount of healthy green vegetation in the field of view of the sensor, the greater the NDVI value. This relationship is deduced from the physiological fact that chlorophyll a and b in the palisade layer of healthy green leaves absorbs most of the incident red radiant flux while the spongy mesophyll leaf layer reflects much of the near infrared radiant flux. This fact is also seen in the NDVI values recorded. In the vegetative and flowering stage, there is more amount of healthy vegetation present.

From Table 4.15 and Fig 4.20, it was seen that, the maximum NDVI value (0.8943) recorded in treatment T_6 at 300 DAT, followed by treatment T_3 (0.8918) and T_4 (0.8765), respectively. The photosynthetically active radiation for these treatments was maximum as compared to other treatments; thus due to denser green canopy, NDVI values recorded for these treatments were maximum. The minimum NDVI value (0.8104) at 300 DAT was recorded in treatment T_9.

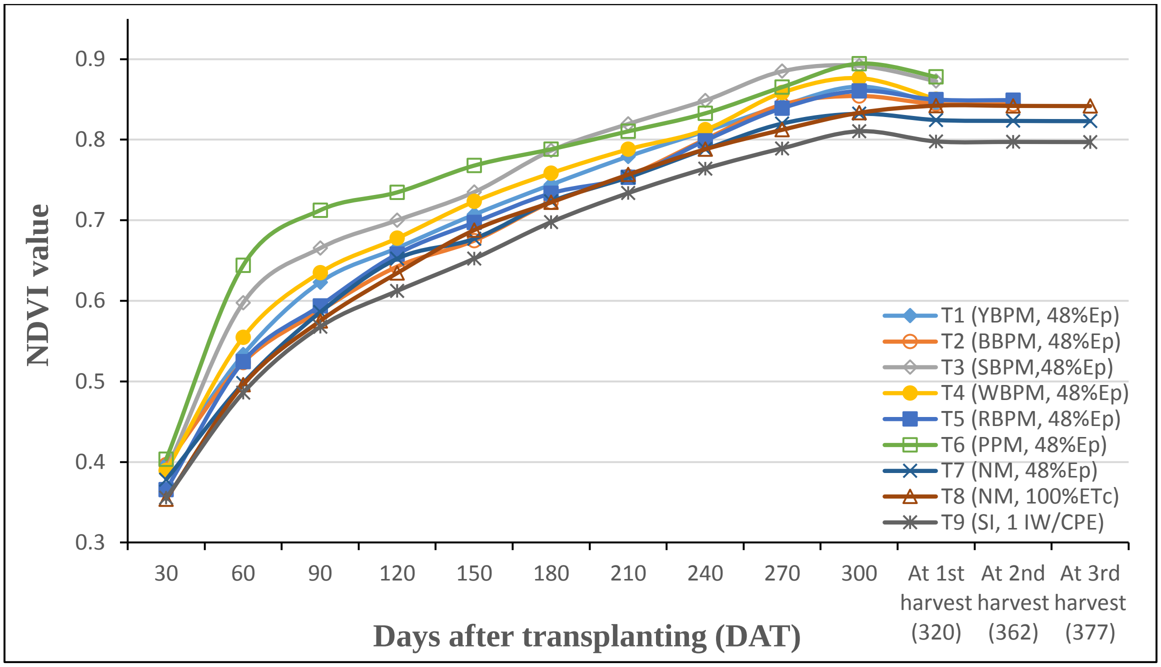

Fig. 4.20. NDVI values of banana crop as influenced by various treatments

From the Fig. 4.20, it was observed that, the NDVI values in all treatments increased continuously during peak growth period of banana crop and decreased slightly in the harvesting stage of the crop. This may be due to reason that, the banana crop remained green or healthy in the harvesting stage also.

4.12 Water use efficiency of banana

The data regarding the yield, total water applied and water use efficiency of banana crop in each treatment is presented in Table 4.16.

Table 4.16. Water use efficiency of banana under various treatments

Treatments	Yield, kg ha^{-1}	Seasonal water requirement, mm	Water use efficiency, kg ha^{-1} mm^{-1}
T_1 (YBPM with 48% Ep)	70667	1113.64	63.46
T_2 (BBPM with 48% Ep)	63613	1130.40	56.27
T_3 (SBPM with 48% Ep)	84450	1015.24	83.18
T_4 (WBPM with 48% Ep)	68100	1087.10	62.64
T_5 (RBPM with 48% Ep)	65800	1080.57	60.89
T_6 (PPM with 48% Ep)	81667	1059.50	77.08
T_7 (NM with 48% Ep)	57733	1141.94	50.56
T_8 (NM with 100% ETc)	59129	1323.31	44.68
T_9 (SI, 1.00 IW/CPE ratio)	53000	2204.40	24.04

From the data in Table 4.16, it was clear that, the highest water use efficiency (81.83 kg ha^{-1} mm^{-1}) obtained in treatment T_3, followed by treatment T_6 (75.90 kg ha^{-1} mm^{-1}) and minimum (26.03 kg ha^{-1} mm^{-1}) in T_9. The highest water use efficiency in treatment T_3 was due to maximum yield and comparatively lower seasonal water requirement. The water use efficiency was lower in surface irrigation amongst all other treatments because of lowest yield and highest seasonal water requirement.

4.13 Cost Economics

The data regarding the cost of cultivation, gross and net returns, benefit cost ratio of banana as influenced by different treatments are presented in Table 4.17.The cost of cultivation and calculations of benefit cost ratio are given in Appendix-P.

4.13.1 Cost of cultivation

The data in respect of cost of cultivation are given in Table 4.17. The cost of cultivation per hectare was maximum (₹ 3, 93,487/-) in treatment T_6. The lowest cost of cultivation (₹ 1, 36,799/-) was found in treatment T_9 due to surface irrigation (no drip irrigation components) and no plastic mulch used.

4.13.2 Gross monetary returns

The differences in respect of gross monetary returns were found due to the various treatments under the study. Amongst all treatments, the maximum of gross monetary returns per hectare (₹ 6, 75,463/-) were observed in treatment T_3 due to highest banana yield. It was followed by T_6 (₹ 6, 52,000 /-). The minimum gross monetary return per hectare (₹ 1, 85,524/-) was experienced with treatment T_9, as it produced lowest yield (53.00 t ha^{-1}).

4.13.3 Net income

The data regarding the net income from various treatments are reported in Table 4.17.The maximum net income per hectare (₹ 3, 86,286 /-) was observed in treatment T_3, followed by treatment T_6 (₹ 2, 58,513 /-), as there was highest yield. The lowest net income per hectare (₹ 48,725 /-) was observed in treatment T_9, which was due to lowest yield.

Table 4.17. Cost of cultivation, gross income, net income and benefit cost ratio influenced by treatments

Treatment	Total cost of cultivation (₹ ha^{-1})	Total income (₹ ha^{-1})	Net income (₹ ha^{-1})	Benefit cost ratio
T_1 (YBPM with 48% Ep)	289177	527706	238528	1.82
T_2 (BBPM with 48% Ep)	289177	475515	186338	1.64
T_3 (SBPM with 48% Ep)	289177	675463	386286	2.34
T_4 (WBPM with 48% Ep)	289177	510600	221423	1.77
T_5 (RBPM with 48% Ep)	289177	493418	204240	1.71
T_6 (PPM with 48% Ep)	393487	652000	258513	1.66
T_7 (NM with 48% Ep)	242801	375505	132704	1.55
T_8 (NM with 100% ETc)	242801	390780	147979	1.61
T_9 (SI, 1.00 IW/CPE ratio)	136799	185524	48725	1.36

4.13.4 Benefit cost ratio (B: C ratio)

The computed values of B: C ratios in various treatments are shown in Table 4.18., which are graphically presented in Fig. 4.21.

The maximum B: C ratio (2.34) was observed in treatment T_3, followed by treatment T_1 (1.82). The minimum B: C ratio (1.36) was recorded in treatment T_9.

Table 4.18. B: C ratio of banana as influenced by different treatments

Treatment	B: C ratio
T_1 (YBPM with 48% Ep)	1.82
T_2 (BBPM with 48% Ep)	1.64
T_3 (SBPM with 48% Ep)	2.34
T_4 (WBPM with 48% Ep)	1.77
T_5 (RBPM with 48% Ep)	1.71
T_6 (PPM with 48% Ep)	1.66
T_7 (NM with 48% Ep)	1.55
T_8 (NM with 100% ETc)	1.61
T_9 (SI, 1.00 IW/CPE ratio)	1.36

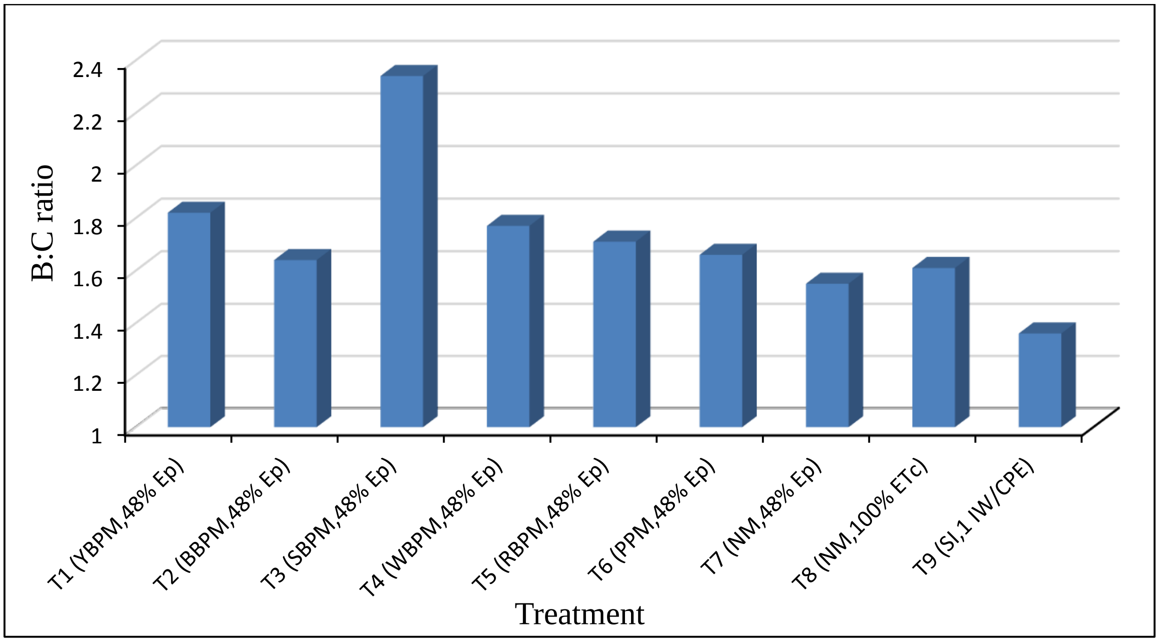

Fig. 4.21. Benefit cost ratio of banana production under various treatments

From Table 4.18 and Fig. 4.21, it was observed that, the highest B: C ratio (2.34) recorded in treatment T_3, followed by treatment T_1 (1.82). This was due to highest yield obtained in these treatments and comparatively low cost of cultivation. Although the yield in treatment T_6 was at par with that of treatment T_3, the B: C ratio in treatment T_6 was low as compared to that of treatment T_3. This was due to reason that, the cost of cultivation in treatment T_6 was higher due to higher cost of pervious plastic mulch as compared to other mulches. The lowest B: C ratio (1.36) was observed in treatment T_9. This was due to lowest yield obtained in treatment T_9.

Table 4.15. NDVI values of banana crop as influenced by different treatments

DAT	T_1 (YBPM, 48%Ep)	T_2 (BBPM, 48%Ep)	T_3 (SBPM, 48%Ep)	T_4 (WBPM, 48%Ep)	T_5 (RBPM, 48%Ep)	T_6 (PPM, 48%Ep)	T_7 (NM, 48%Ep)	T_8 (NM, 100%ETc)	T_9 (SI, 1 IW/CPE)
30	0.3978	0.3967	0.3895	0.3895	0.3657	0.4036	0.3781	0.3539	0.3557
60	0.5334	0.5234	0.5978	0.5549	0.5246	0.644	0.4978	0.4958	0.4861
90	0.6232	0.5874	0.6655	0.6351	0.5938	0.7124	0.5859	0.5751	0.5678
120	0.6656	0.6424	0.7002	0.6778	0.6580	0.7346	0.6523	0.6345	0.6123
150	0.7071	0.6745	0.7351	0.7234	0.6971	0.7678	0.6771	0.6878	0.6524
180	0.7443	0.7223	0.7867	0.7586	0.7334	0.7881	0.7234	0.7223	0.6978
210	0.7792	0.7546	0.8197	0.7881	0.7534	0.8103	0.7533	0.7567	0.7337
240	0.8103	0.8001	0.8488	0.8123	0.7987	0.8326	0.7882	0.7881	0.7641
270	0.8423	0.8434	0.8850	0.8585	0.839	0.8652	0.8201	0.8123	0.7892
300	0.8659	0.8541	0.8918	0.8765	0.8605	0.8943	0.8323	0.8334	0.8104
At 1st harvest (320)	0.8445	0.8443	0.8727	0.8502	0.8497	0.8778	0.8245	0.8423	0.7978
At 2nd harvest (362)	-	0.8440	-	-	0.8491	-	0.8234	0.8420	0.7972
At 3rd harvest (377)	-	-	-	-	-	-	0.8231	0.8418	0.7970

5. Summary and Conclusions

5.1 Summary

An experiment entitled “Effect of different colour plastic mulches on growth and yield of banana crop” was conducted during year 2014-15, at Research cum Demonstration Farm of Precision Farming Development Centre (PFDC), Department of Irrigation and Drainage Engineering, Dr. Annasaheb Shinde College of Agriculture Engineering, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (M.S). In order to fulfil the objectives of the experiment, nine treatments were adopted with three replications. The experiment was laid with randomised block design. The plants were transplanted on raised beds on 9^{th} December, 2014. The harvesting of banana crop was done upto 15^{th} December, 2015.

5.1.1 Importance of study with objectives

Now-a-days, a lot of emphasis has been given on adoption of micro-irrigation systems and mulching technique to horticultural crops, vegetables, oil seeds and other crops. Banana as horticultural crop having great market potential as well as export potential. In order to increase the productivity and production of banana with efficient water use, there is a need to have information about irrigation scheduling, irrigation levels, water requirement, and water saving due to plastic mulches as well as use of specific colour mulch in respect of banana. The present study entitled “Effect of different colour plastic mulches on growth and yield of banana crop” was undertaken with the following specific objectives.

1. To study the effect of different colour plastic mulches on growth, yield and quality of banana.
2. To compare the yield of banana under drip irrigation and surface irrigation.
3. To determine the water requirement and water use efficiency of banana.
4. To find out NDVI values of banana over its growth period.
5. To study the economic viability of banana production under different colour plastic mulches.

5.1.2 Treatment details

To obtain the maximum yield under drip irrigation and various mulches, it is necessary to know the appropriate irrigation criteria and suitable colour mulches. Treatments were therefore based on different colour plastic mulches along with daily drip irrigation and surface irrigation treatment for comparison of yield of banana under drip and surface irrigation. The treatment details are given as below:

T_1 = Yellow-black plastic mulch with drip irrigation at the rate of 48% pan evaporation

T_2 = Blue-black plastic mulch with drip irrigation at the rate of 48% pan evaporation

T_3 = Silver-black plastic mulch with drip irrigation at the rate of 48% pan evaporation

T_4 = White-black plastic mulch with drip irrigation at the rate of 48% pan evaporation

T_5 = Red-black plastic mulch with drip irrigation at the rate of 48% pan evaporation

T_6 = Pervious black plastic mulch with drip irrigation at the rate of 48% pan evaporation

T_7 = No mulch with drip irrigation at the rate of 48% pan evaporation

T_8 = No mulch with drip irrigation at the rate of 100% ET_c based on K_c values

T_9 = No mulch with surface irrigation @ 1.00 IW/CPE ratio

5.1.3. Experimental details

The experiment was carried out on open field with various colour mulches and irrigation treatments. The size of the open field was 43.5 x 27.0 m. The experiment was laid out in randomised block design with nine treatments and three replications. The size of each plot was 7.0 × 3.5 m. A 1.5 m buffer strip was provided between two beds to do the intercultural operations.

5.1.4 Agronomical Details of the Crop

The agronomical details of the crop are given below:

Local name	:	*Keli*, Banana
Common name	:	*Kela*
Botanical name	:	*Musa paradisica* L.
Variety	:	Grandnaine
Crop duration	:	360-390 days
Crop Spacing	:	1.75 m X 1.75 m

5.1.5 Physical and chemical properties of soil and irrigation water

The texture of experimental field soil was clay texture, having sand, silt and clay percentage as 18.76, 23.16 and 57.09, respectively. The available N, P and K were (81.53, 7.40 and 302.40 kg ha^{-1}, respectively). The moisture content at field capacity and permanent wilting point on wet basis were 40.09 and 17.37 %, respectively. The soil was slightly alkaline (pH 8.72 and EC 0.99 dS m^{-1}). The bulk density was 1.24 g cm^{-3}. The pH and EC of irrigation water was 7.95 and 0.62, respectively.

5.1.6 Emission uniformity (EU)

The field EU was calculated by collecting the discharges from the dripper from different treatments and replications. The values of emission uniformity (EU) of drip irrigation system were found in the range of 94.81 to 96.34 % for all treatments and replications, with an average value of 95.57 % for the entire system.

5.2 Biometric observations

5.2.1 Growth studies

The plant heights, number of functional leaves, stem girth, days to flowering, days to maturity, total duration, weight of bunch, number of hands per bunch, number of fruits per bunch, length and girth of fruit, TSS and acidity of fruit were influenced by different treatments.

5.2.1.1 Plant height

The plant height of banana was increased with advanced age up to the harvest stage. The maximum plant height (266.74 cm) was recorded at harvesting stage (320 DAT) in treatment T_3 which was at par with treatment T_6 (252.59 cm). The minimum plant height (194.72 cm) was observed in treatment T_9.

5.2.1.2 Stem girth

The maximum stem girth (63.99 cm) was recorded at harvesting stage (320 DAT) in treatment T_3, followed by treatment T_6 (63.50 cm) and minimum (51.34 cm) in the treatment T_9.

5.2.1.3 Number of functional leaves

The number of functional leaves were highest (14.08) in treatment T_3, followed by treatment T_6 (13.42) and treatment T_1 (13.33), respectively. The minimum number of leaves (10.83) were observed under treatment T_9.

5.2.2 Duration

5.2.2.1 Days required to flower

The minimum number of days required for flowering (220 days) was observed in treatment T_3, followed by treatment T_6 (226 days) and treatment T_1 (230 days), respectively. The maximum number of days for flowering (287 days) was observed in treatment T_9.

5.2.2.2 Total duration of crop

The treatment T_3 took minimum number of days to complete its life cycle (323 days), which was at par with treatment T_6 (339 days) and treatment T_1 (347 days), respectively. The maximum total duration (378 days) was observed in treatment T_9.

5.3 Yield parameters of banana

5.3.1 Bunch weight

The bunch weight of banana was taken at harvest. The maximum bunch weight (25.86 kg) was recorded in treatment T_3, which was at par with treatment T_6 (24.75 kg). The minimum weight of bunch (16.23 kg) was recorded in treatment T_9.

5.3.2 Number of hands per bunch

The treatment T_3 recorded significantly maximum number of hands per bunch (9.25), followed by treatment T_6 (8.42) and treatment T_1 (8.00), respectively. The minimum number of hands per bunch (5.67) was observed with treatment T_9.

5.3.3 Number of fingers per bunch

The treatment T_3 recorded maximum number of fingers per bunch (130.15), followed by treatment T_6 (126.50). The minimum number of fingers per bunch (105.33) was observed with treatment T_9.

5.3.4 Average weight of fruit

The treatment T_3 registered maximum fruit weight (200.33 g), which was at par with treatment T_6 (193.67 g) and treatment T_1 (185.67 g), respectively. The treatment T_9 recorded lowest fruit weight of 145.50 g.

5.3.5 Yield per hectare

The treatment T_3 registered maximum yield (84.45 t ha^{-1}), which was at par with treatment T_6 (81.67 t ha^{-1}). The treatment T_9 recorded lowest yield of 53.00 t ha^{-1}.

5.4 Length and girth of the fruit

5.4.1 Length of fruit

The highest and significantly superior fruit length (20.08 cm) recorded in treatment T_3, followed by treatment T_6 (18.39 cm) and treatment T_1 (18.08 cm), respectively. The lowest fruit length (15.5 cm) was observed with treatment T_9.

5.4.2 Girth of fruit

The treatment T_3 recorded maximum fruit girth (14.03 cm), which was at par with treatment T_6 (13.28 cm). The treatment T_9 recorded minimum fruit girth of 10.50 cm.

5.5 Quality parameters of banana

5.5.1 TSS of fruit

There was no significant difference in TSS of fruit pulp of banana under different treatments.

5.5.2 Acidity of fruit

The acidity of the fruit pulp of banana was not significantly influenced by different treatments.

5.6 Irrigation Studies

5.6.1 Water applied

The total water applied to banana was varied as per the treatments. The maximum depth of irrigation (2204 mm) was applied for treatment T_9, followed by treatment T_8 (1323 mm) and minimum (1015 mm) in treatment T_3.

5.6.2 Water use efficiency

The highest water use efficiency (83.18 kg ha^{-1} mm^{-1}) was obtained in treatment T_3, followed by treatment T_6 (77.08 kg ha^{-1} mm^{-1}) and minimum (24.04 kg ha^{-1} mm^{-1}) in treatment T_9.

5.7 Micrometeorological studies

5.7.1 Absorbed photosynthetically active radiation (µmol m^{-2} s^{-1})

The highest photosynthetically active radiation was observed in treatment T_3 at 60, 120, 180, 240, 300 days after transplanting and at 1^{st} harvest, that was 307.67, 573.25, 882.50, 1060.78, 975.55 and 900.27 µmol m^{-2} s^{-1}, respectively. The lowest photosynthetically active radiation (μmol m^{-2} s^{-1}) was observed in treatment T_9 as 168.17, 251.17, 569.53, 826.00, 838.67 and 785.83 μmol m^{-2} s^{-1}, respectively.

5.7.2 Photosynthesis rate (μmol CO_2 m^{-2} s^{-1})

The highest rate of photosynthesis was observed in treatment T_3 at 60, 120, 180, 240, 300 days after transplanting and at 1st harvest, that was 3.63, 7.95, 15.05, 19.72, 29.33 and 28.38 μmol CO_2 m^{-2} s^{-1}, respectively. The lowest rate of photosynthesis was observed in treatment T_9 as 2.07, 4.96, 11.34, 14.55, 23.38 and 22.99 μmol CO_2 m^{-2} s^{-1}, respectively.

5.7.3 Soil temperature

The highest monthly average daily soil temperature (30.63 ^{0}C) was observed under treatment T_5 in the month of May, followed by treatment T_2 (30.50 ^{0}C). The minimum soil temperature was observed under treatment T_4 which may be due to greater reflectivity of white colour mulch.

5.7.4 NDVI value over growth period of banana

The maximum NDVI value (0.8943) recorded in treatment T_6, followed by treatment T_3 (0.8918) at 300 DAT. The minimum NDVI value (0.8104) at 300 DAT was recorded in treatment T_9. The NDVI values in all treatments increased continuously in peak growth period and slightly decreased in the harvesting stage.

5.8 Economics

The economic study showed that the benefit: cost ratio was maximum (2.34) in treatment T_3, followed by T_1 (1.82) and minimum (1.36) in treatment T_9. The maximum net income per hectare (₹ 3, 86,286 /-) was observed in treatment T_3, followed by the treatment T_6 (₹ 2, 58,513 /-), as there was higher yield. The lowest net income (₹ 48,725 /-) was observed in treatment T_9, which was due to lowest yield. The cost of cultivation per hectare was maximum (₹ 3, 93,487/-) in treatment T_6. The lowest cost of cultivation (₹ 1, 36,799/-) was found in treatment T_9.

5.9 Conclusions

Based on the results obtained from the present investigation, the following conclusions were drawn:

1. The maximum yield of banana (84.45 t ha^{-1}) was due to silver-black plastic mulch with daily drip irrigation at 48% Ep (treatment T_3), which was at par with that of pervious plastic mulch with irrigation at 48% Ep (treatment T_6).
2. The adoption of silver- black plastic mulch with daily drip irrigation at 48% Ep (treatment T_3) has resulted in 37.24% increase in yield of banana over surface irrigation with 1.00 IW/CPE ratio (treatment T_9).
3. The seasonal water requirement of banana crop cultivated with silver- black plastic mulch at daily drip irrigation with 48% Ep (treatment T_3) was 1015 mm with water use efficiency of 83.18 kg ha^{-1} mm^{-1}.
4. The NDVI values of banana crop in treatment T_3 were in the range of 0.3895 to 0.8918 during the growth period of 323 days. The NDVI value of 0.3895 in initial stage of banana increased to 0.8918 in peak growth stage and again it slightly decreased to 0.8727 in harvesting stage of banana.
5. From the economic point of view, the adoption of silver-black plastic mulch was found to be the best amongst all other treatments, having maximum B: C ratio of 2.34 and maximum net income of ₹ 3, 86,286 /- per hectare.

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7. Appendices

Appendix – A

Climatological data

Table A.1. Climatological data recorded during the growth period of banana crop

Date	Wind Speed, km hr^{-1}	Temperature, ^{0}C		Relative Humidity, %		Actual sunshine hours, hrs	Rainfall, mm
		Max.	Min.	Max.	Min.		
09-12-2014	0.2	30.8	12.4	56	32	9.6	-
10-12-2014	0.1	31.6	13.9	59	40	9.1	-
11-12-2014	0.2	30.6	15.4	75	39	7.3	-
12-12-2014	0.6	31.0	17.4	65	58	7.5	-
13-12-2014	3.8	30.0	20.4	94	64	6.5	-
14-12-2014	2.5	28.0	17.9	84	52	1.4	-
15-12-2014	1.0	27.6	8.9	37	34	9.1	-
16-12-2014	1.3	26.6	8.2	56	41	8.5	-
17-12-2014	1.9	24.4	8.9	58	44	9.0	-
18-12-2014	1.1	23.0	5.9	55	31	6.8	-
19-12-2014	2.2	24.8	6.4	43	31	9.6	-
20-12-2014	0.9	26.8	6.4	44	37	8.7	-
21-12-2014	0.2	26.4	7.9	62	35	7.4	-
22-12-2014	0.3	26.6	5.5	46	24	9.4	-
23-12-2014	0.3	28.0	7.5	56	32	9.7	-
24-12-2014	0.2	30.0	9.9	52	36	9.0	-
25-12-2014	0.8	28.2	9.4	62	43	8.7	-
26-12-2014	0.1	28.8	9.9	56	40	8.8	-
27-12-2014	1.1	25.8	7.9	51	37	9.1	-
28-12-2014	1.5	25.8	6.4	58	36	9.0	-
29-12-2014	1.2	24.4	5.9	58	30	8.4	-
30-12-2014	0.1	27.4	8.4	59	41	9.0	-
31-12-2014	0.9	29.2	15.9	69	39	6.0	-
01-01-2015	0.3	26.8	14.9	70	60	1.7	-
02-01-2015	0.2	22.4	14.4	72	65	0.9	-
03-01-2015	0.9	23.2	13.2	85	77	1.9	-
04-01-2015	0.2	22.0	13.3	93	59	2.0	-
05-01-2015	0.7	25.0	11.9	77	45	6.3	-
06-01-2015	0.5	27.0	9.4	71	40	8.7	-
07-01-2015	0.4	27.8	10.9	72	41	9.0	-
08-01-2015	0.7	27.6	8.4	51	28	9.4	-

09-01-2015	0.8	27.2	6.4	39	27	9.5	-
10-01-2015	1.6	26.0	5.9	38	26	9.8	-
11-01-2015	0.8	26.8	5.8	29	29	9.9	-
12-01-2015	0.9	26.4	6.3	57	29	9.4	-
13-01-2015	0.8	26.8	7.5	60	24	10.0	-
14-01-2015	0.3	29.4	7.4	65	20	10.1	-
15-01-2015	0.2	30.0	8.4	53	34	10.8	-
16-01-2015	0.5	27.8	9.4	57	28	9.2	-
17-01-2015	0.2	29.9	9.3	47	30	9.5	-
18-01-2015	0.3	27.8	9.4	53	36	9.4	-
19-01-2015	0.6	27.2	9.9	66	35	9.1	-
20-01-2015	0.5	29.4	13.4	52	32	8.0	-
21-01-2015	1.2	29.0	13.5	54	36	8.5	-
22-01-2015	0.4	29.4	15.4	55	37	6.9	-
23-01-2015	1.2	29.2	13.4	54	46	6.7	-
24-01-2015	0.7	27.6	14.9	59	37	7.0	-
25-01-2015	1.0	30.0	12.9	57	34	7.8	-
26-01-2015	1.6	30.2	13.4	70	38	5.2	-
27-01-2015	0.4	29.4	14.9	67	34	7.1	-
28-01-2015	0.8	30.0	13.5	66	37	8.0	-
29-01-2015	0.5	31.0	13.9	72	43	8.8	-
30-01-2015	0.6	27.8	12.4	66	49	8.9	-
31-01-2015	1.1	26.6	10.7	43	30	9.4	-
01-02-2015	0.3	29.2	11.9	50	35	9.0	-
02-02-2015	0.6	32.0	11.5	44	26	9.7	-
03-02-2015	3.1	32.6	15.9	43	33	9.3	-
04-02-2015	2.0	31.5	13.9	44	32	9.5	-
05-02-2015	1.5	31.2	12.9	57	25	9.0	-
06-02-2015	0.8	31.4	11.9	44	16	8.7	-
07-02-2015	2.4	31.8	10.9	46	20	8.4	-
08-02-2015	3.4	31.8	12.9	53	27	8.3	-
09-02-2015	1.0	31.6	10.9	39	36	10.2	-
10-02-2015	1.3	29.6	13.9	58	36	9.6	-
11-02-2015	2.4	32.0	12.9	59	25	9.2	-
12-02-2015	0.9	32.4	14.9	53	37	9.8	-
13-02-2015	0.5	30.0	13.4	47	25	9.9	-
14-02-2015	0.4	32.0	12.9	53	14	10.3	-
15-02-2015	0.5	33.6	13.9	54	24	10.4	-
16-02-2015	0.9	34.0	11.9	46	18	10.5	-
17-02-2015	0.5	34.2	13.2	58	18	10.4	-
18-02-2015	1.4	35.0	10.4	60	23	10.8	-
19-02-2015	1.7	33.0	12.9	57	25	10.6	-

20-02-2015	0.8	30.2	13.4	56	20	10.4	-
21-02-2015	0.9	34.0	13.6	52	23	10.3	-
22-02-2015	1.7	31.8	13.7	48	19	10.4	-
23-02-2015	1.9	32.8	13.9	52	23	10.2	-
24-02-2015	0.8	33.6	13.9	60	28	10.0	-
25-02-2015	0.9	34.0	13.9	55	27	9.0	-
26-02-2015	1.0	35.0	14.5	54	25	9.5	-
27-02-2015	1.6	33.0	12.4	41	25	10.0	-
28-02-2015	1.1	33.0	13.9	52	24	10.4	-
01-03-2015	5.5	31.0	14.9	98	86	3.4	-
02-03-2015	0.3	29.0	13.4	79	75	1.0	-
03-03-2015	3.4	27.6	11.4	67	35.0	9.7	-
04-03-2015	4.3	25.6	10.9	72	28.0	9.8	-
05-03-2015	1.2	27.2	11.4	53	28.0	9.4	-
06-03-2015	0.9	32.0	13.9	49	19.0	9.8	-
07-03-2015	1.4	32.0	13.7	45	25.0	9.6	-
08-03-2015	0.3	32.0	14.4	69	27	9.3	-
09-03-2015	1.0	34.0	14.9	48	22	9.3	-
10-03-2015	1.0	33.4	15.9	96	37	8.9	-
11-03-2015	2.8	32.8	19.3	66	46	6.1	-
12-03-2015	1.7	30.0	18.9	70	33	8.9	-
13-03-2015	1.6	32.0	16.4	68	43	9.2	-
14-03-2015	3.4	31.0	17.3	68	53	9.0	-
15-03-2015	1.8	31.4	17.9	83	35	7.7	-
16-03-2015	0.2	31.4	15.9	77	43	9.1	-
17-03-2015	0.7	30.8	15.4	57	36	10.0	-
18-03-2015	1.2	31.5	15.9	47	31	9.6	-
19-03-2015	1.2	32.6	16.4	44	31	9.8	-
20-03-2015	2.2	34.0	17.9	45	27	9.1	-
21-03-2015	0.9	35.0	19.4	48	23	8.5	-
22-03-2015	0.5	35.5	19.9	47	22	8.8	-
23-03-2015	0.7	36.5	20.4	48	21	8.7	-
24-03-2015	0.7	36.6	18.9	42	22	9.3	-
25-03-2015	1.0	37.0	20.3	43	17	9.1	-
26-03-2015	0.8	37.6	19.9	42	20	9.2	-
27-03-2015	1.3	37.0	19.5	56	15	7.0	-
28-03-2015	1.8	38.0	20.9	59	19	8.6	-
29-03-2015	0.8	37.0	23.9	55	30	7.3	-
30-03-2015	1.6	34.4	20.4	60	28	2.7	-
31-03-2015	1.1	34.0	16.9	50	18	9.0	-
01-04-2015	1.4	35.8	15.4	54	18	9.5	-
02-04-2015	1.9	36.0	16.4	51	19	9.9	-

03-04-2015	1.9	37.0	16.3	44	17	9.6	-
04-04-2015	2.9	35.0	15.4	47	17	9.0	-
05-04-2015	3.2	34.6	14.9	50	20	9.6	-
06-04-2015	1.6	35.8	15.9	47	19	9.0	-
07-04-2015	1.2	35.8	14.9	54	23	9.3	-
08-04-2015	0.6	36.8	18.9	66	25	8.9	-
09-04-2015	1.2	36.6	21.9	56	28	8.3	-
10-04-2015	1.4	37.0	25.4	60	38	8.1	-
11-04-2015	0.7	35.8	19.9	58	35	5.4	-
12-04-2015	1.8	34.4	18.4	87	42	5.2	5.0
13-04-2015	1.9	32.0	16.9	65	47	8.0	-
14-04-2015	1.5	31.6	16.4	70	42	6.4	2.2
15-04-2015	0.9	30.0	17.4	65	28	6.0	-
16-04-2015	1.0	33.4	15.4	61	30	8.7	-
17-04-2015	1.2	33.8	19.2	51	26	10.7	-
18-04-2015	1.6	36.0	20.9	48	19	10.6	-
19-04-2015	1.1	38.2	21.9	47	19	10.0	-
20-04-2015	0.6	39.0	23.9	43	20	10.3	-
21-04-2015	0.8	39.8	24.5	42	20	10.3	-
22-04-2015	0.8	40.5	25.4	43	20	7.2	-
23-04-2015	1.6	39.4	22.9	43	14	8.0	-
24-04-2015	1.6	39.0	21.9	46	11	10.4	-
25-04-2015	5.8	38.0	16.9	36	16	10.9	-
26-04-2015	1.5	37.6	19.4	32	15	10.5	-
27-04-2015	1.6	39.0	20.9	39	17	10.6	-
28-04-2015	1.1	39.4	21.9	41	14	10.6	-
29-04-2015	4.1	41.6	19.9	43	8.0	10.2	-
30-04-2015	4.5	41.2	19.3	51	16	10.5	-
01-05-2015	3.8	40.8	19.9	32	14	10.5	-
02-05-2015	4.5	41.4	19.4	22	17	10.9	-
03-05-2015	4.6	41.0	20.9	32	16	10.8	-
04-05-2015	2.2	40.0	21.4	36	11	10.1	-
05-05-2015	1.5	40.6	24.4	36	22	10.0	-
06-05-2015	2.6	38.0	22.2	43	18	10.6	-
07-05-2015	1.7	39.0	23.1	38	18	10.3	-
08-05-2015	0.9	40.2	25.4	50	16	10.0	-
09-05-2015	1.8	40.0	25.2	37	17	10.0	-
10-05-2015	3.8	40.0	23.5	41	20	10.1	-
11-05-2015	1.1	39.0	25.4	38	17	9.9	-
12-05-2015	2.4	40.2	26.4	35	17	10.2	-
13-05-2015	0.5	39.2	25.9	48	27	9.8	8.0
14-05-2015	2.8	37.4	22.4	69	36	2.8	-

15-05-2015	0.3	35.0	23.9	57	53	6.5	-
16-05-2015	1.6	37.2	22.9	53	26	7.5	-
17-05-2015	1.4	37.6	24.5	49	18	10.9	-
18-05-2015	2.5	40.6	24.4	32	15	10.7	-
19-05-2015	4.8	41.5	22.9	33	21	10.8	-
20-05-2015	6.2	41.2	23.5	50	21	10.5	-
21-05-2015	7.5	41.5	24.9	46	23	10.7	-
22-05-2015	6.4	41.2	22.5	50	19	11.0	-
23-05-2015	6.4	41.2	24.4	43	18	10.9	-
24-05-2015	9.5	40.0	25.4	45	27	11.3	-
25-05-2015	6.7	39.2	22.5	59	28	12.0	-
26-05-2015	7.1	38.6	22.9	48	25	11.0	-
27-05-2015	6.6	39.0	22.4	55	18	10.7	-
28-05-2015	7.2	41.0	22.9	53	21	11.8	-
29-05-2015	6.2	40.0	22.7	81	25	9.8	-
30-05-2015	5.7	40.2	26.4	54	45	3.0	3.0
31-05-2015	0.5	34.2	24.9	33	24	1.0	-
01-06-2015	4.2	41.2	22.5	54	19	9.1	-
02-06-2015	4.7	39.8	22.4	61	23	9.2	-
03-06-2015	4.3	39.0	21.4	55	22	9.9	-
04-06-2015	3.6	38.2	22.9	55	25	10.8	-
05-06-2015	3.2	39.2	23.4	84	48	10.0	6.2
06-06-2015	0.7	33.0	21.9	70	41	1.8	1.0
07-06-2015	2.2	36.2	22.9	83	68	9.1	-
08-06-2015	2.1	35.8	23.4	62	54	6.0	6.4
09-06-2015	4.5	35.0	21.9	71	67	8.9	3.6
10-06-2015	2.3	34.6	22.9	68	42	8.9	19.2
11-06-2015	2.7	35.0	22.4	73	43	8.1	-
12-06-2015	2.9	35.6	24.8	89	63	8.5	-
13-06-2015	2.4	33.4	24.4	75	67	8.3	4.0
14-06-2015	2.3	30.0	23.9	80	75	2.4	-
15-06-2015	1.7	30.0	22.4	82	64	0.0	21.8
16-06-2015	4.1	29.0	22.9	79	63	0.0	-
17-06-2015	4.6	33.0	21.9	71	46	5.8	-
18-06-2015	7.3	33.8	23.9	70	51	7.5	-
19-06-2015	4.7	34.4	23.7	70	63	4.5	5.4
20-06-2015	9.1	30.0	23.4	68	54	0.6	-
21-06-2015	17.1	30.8	24.3	66	57	4.0	-
22-06-2015	8.4	31.8	23.9	81	77	1.8	2.2
23-06-2015	7.5	30.0	22.4	71	63	1.1	3.0
24-06-2015	7.4	29.8	23.9	72	54	0.0	1.0
25-06-2015	20.8	31.8	24.9	56	51	5.3	-

26-06-2015	13.2	32.0	24.4	61	52	7.4	-
27-06-2015	11.0	33.8	22.4	68	47	9.1	-
28-06-2015	9.6	34.2	22.3	72	45	9.9	-
29-06-2015	4.1	34.4	23.4	71	41	4.7	-
30-06-2015	4.8	34.6	22.9	67	35	8.1	-
01-07-2015	5.1	36.2	22.7	68	46	10.4	-
02-07-2015	6.0	35.0	22.4	69	37	9.4	-
03-07-2015	6.8	35.6	21.9	65	36	9.5	-
04-07-2015	7.9	35.0	22.4	61	39	9.8	-
05-07-2015	9.5	34.5	23.5	65	45	10.1	-
06-07-2015	12.0	34.4	25.4	67	46	9.9	-
07-07-2015	14.8	34.8	24.9	71	44	8.2	-
08-07-2015	11.2	33.6	24.5	63	53	7.0	-
09-07-2015	9.6	33.4	27.9	70	48	4.1	-
10-07-2015	9.6	33.8	24.4	70	43	8.3	-
11-07-2015	9.4	34.2	24.5	71	40	6.5	-
12-07-2015	10.7	37.8	23.9	67	43	7.5	-
13-07-2015	7.3	32.0	22.4	62	36	9.8	-
14-07-2015	2.1	35.4	22.7	65	37	8.2	-
15-07-2015	3.8	36.2	22.4	70	42	9.5	-
16-07-2015	8.5	35.0	23.9	74	50	7.9	-
17-07-2015	8.5	33.0	24.5	69	51	7.9	-
18-07-2015	7.6	32.4	24.4	62	46	7.5	-
19-07-2015	10.2	33.4	22.9	70	63	3.0	-
20-07-2015	9.6	33.4	24.5	64	61	4.7	-
21-07-2015	6.9	31.6	21.9	97	69	0.0	16.4
22-07-2015	4.8	29.0	23.9	80	57	0.0	1.0
23-07-2015	8.0	31.6	24.4	72	71	3.1	-
24-07-2015	7.8	29.6	23.9	76	50	0.8	-
25-07-2015	9.1	33.2	23.5	77	63	4.7	8.4
26-07-2015	11.4	30.4	22.9	68	57	0.4	-
27-07-2015	14.4	31.2	23.9	67	55	0.5	-
28-07-2015	14.1	29.4	23.4	71	54	0.8	-
29-07-2015	15.1	30.0	22.7	67	70	4.7	-
30-07-2015	9.0	29.0	22.4	76	59	0.4	-
31-07-2015	6.9	29.4	22.7	74	55	0.9	-
01-08-2015	5.7	32.4	22.4	74	45	6.4	-
02-08-2015	5.4	33.0	22.9	78	54	6.3	-
03-08-2015	6.2	31.8	21.9	78	44	5.1	-
04-08-2015	8.0	32.0	22.9	70	68	4.3	-
05-08-2015	5.5	28.2	21.9	91	88	0.0	7.4
06-08-2015	4.8	25.4	22.4	82	64	0.0	2.6

07-08-2015	2.4	29.4	20.9	80	71	1.4	-
08-08-2015	2.5	29.0	22.9	78	63	0.7	-
09-08-2015	2.9	30.8	20.9	75	51	3.1	-
10-08-2015	1.6	33.2	21.4	73	46	4.6	-
11-08-2015	3.2	34.2	23.4	66	52	6.0	-
12-08-2015	1.0	31.0	23.5	76	72	0.4	1.4
13-08-2015	0.6	27.4	22.4	75	55	0.0	-
14-08-2015	4.7	30.6	23.4	79	63	0.0	-
15-08-2015	4.5	29.6	22.4	64	52	0.9	-
16-08-2015	7.0	32.8	23.5	64	42	8.1	-
17-08-2015	6.1	34.0	22.9	70	46	7.4	-
18-08-2015	3.6	34.0	23.5	69	41	4.5	-
19-08-2015	2.2	34.6	23.4	77	44	6.1	-
20-08-2015	1.7	34.6	22.9	71	38	5.1	-
21-08-2015	5.3	35.0	21.9	59	57	8.9	-
22-08-2015	5.6	33.0	21.8	80	49	5.2	1.0
23-08-2015	3.8	31.6	19.9	73	52	3.9	-
24-08-2015	5.8	34.0	23.4	75	39	8.2	-
25-08-2015	6.6	35.0	21.9	65	65	9.0	-
26-08-2015	1.9	28.2	21.4	63	60	1.0	-
27-08-2015	4.7	34.4	21.9	69	45	8.8	-
28-08-2015	2.4	33.0	22.4	84	57	4.8	2.0
29-08-2015	2.2	31.4	21.7	74	50	1.9	1.0
30-08-2015	2.5	32.6	21.9	71	52	6.1	-
31-08-2015	5.0	32.8	21.5	64	47	6.7	-
01-09-2015	5.9	33.4	20.9	67	35	8.3	-
02-09-2015	5.5	34.0	19.9	67	43	9.6	-
03-09-2015	1.1	32.6	22.9	78	40	6.6	-
04-09-2015	1.2	36.0	24.9	77	37	7.8	-
05-09-2015	1.3	36.0	22.4	86	53	8.6	3.4
06-09-2015	1.0	34.0	24.4	97	77	8.1	-
07-09-2015	0.9	32.6	21.4	79	51	3.7	17.2
08-09-2015	0.4	32.2	24.5	84	56	6.2	-
09-09-2015	0.4	31.0	22.9	87	52	1.1	-
10-09-2015	0.7	32.2	23.5	85	55	4.3	4.4
11-09-2015	1.8	32.0	20.9	84	46	7.9	30.4
12-09-2015	0.8	33.0	21.9	71	46	9.1	-
13-09-2015	0.7	34.0	21.4	75	74	8.4	11.4
14-09-2015	2.0	29.4	22.4	78	75	0.5	-
15-09-2015	1.9	28.8	21.9	84	57	0.4	2.2
16-09-2015	1.2	30.0	22.5	75	54	1.8	-
17-09-2015	2.3	31.8	22.9	79	50	2.4	11.0

18-09-2015	5.7	31.4	22.5	97	93	2.2	28.4
19-09-2015	11.1	24.0	22.4	88	53	0.0	15.2
20-09-2015	8.8	30.0	22.9	77	61	5.7	-
21-09-2015	12.4	29.0	22.4	74	56	4.5	-
22-09-2015	4.2	32.0	23.4	73	51	7.1	-
23-09-2015	3.2	33.0	21.9	68	46	8.0	-
24-09-2015	0.9	33.6	21.4	74	47	7.0	-
25-09-2015	0.3	33.6	20.9	74	44	8.6	-
26-09-2015	0.9	33.6	17.9	61	35	9.0	-
27-09-2015	0.2	32.6	18.3	58	46	9.4	-
28-09-2015	0.1	33.6	17.5	71	41	9.5	-
29-09-2015	0.3	33.8	21.4	70	35	8.2	-
30-09-2015	1.9	34.0	20.9	66	36	8.7	-
01-10-2015	3.1	34.2	20.4	68	42	8.8	-
02-10-2015	1.4	34.0	22.9	78	62	8.2	4.0
03-10-2015	1.5	31.0	20.4	79	64	2.8	9.4
04-10-2015	1.2	32.0	21.9	90	60	5.4	7.3
05-10-2015	0.1	31.8	23.4	73	44	7.4	-
06-10-2015	0.8	33.0	19.9	76	39	7.6	-
07-10-2015	0.7	33.4	11.4	71	41	9.4	-
08-10-2015	0.4	34.5	11.9	71	32	9.0	-
09-10-2015	0.2	34.8	19.4	70	36	8.8	-
10-10-2015	0.1	35.0	21.4	74	46	8.0	-
11-10-2015	0.2	34.0	22.9	71	62	6.8	-
12-10-2015	0.6	33.8	23.9	73	51	3.8	-
13-10-2015	0.4	32.5	20.9	76	29	2.4	-
14-10-2015	0.6	34.8	18.9	65	20	8.8	-
15-10-2015	0.3	35.4	17.9	51	24	9.1	-
16-10-2015	0.5	35.8	18.4	46	31	9.3	-
17-10-2015	0.8	34.2	20.9	58	39	9.1	-
18-10-2015	1.7	34.0	20.4	66	42	9.9	-
19-10-2015	1.2	35.0	17.4	66	20	10.0	-
20-10-2015	0.8	35.6	18.9	52	28	9.9	-
21-10-2015	0.2	34.8	19.9	52	29	9.5	-
22-10-2015	0.3	34.8	20.3	66	39	7.6	-
23-10-2015	0.3	35.0	20.9	51	29	8.7	-
24-10-2015	0.5	35.5	20.9	57	35	8.9	-
25-10-2015	0.3	35.0	20.4	50	40	7.3	-
26-10-2015	1.0	35.0	21.5	64	43	4.3	-
27-10-2015	0.2	33.8	20.4	55	36	5.2	-
28-10-2015	0.5	33.8	18.1	56	33	6.4	-
29-10-2015	0.1	33.2	20.5	57	37	5.9	-

30-10-2015	1.3	32.0	16.1	61	41	6.1	-
31-10-2015	0.3	32.2	17.4	54	43	6.8	-
01-11-2015	0.1	31.4	16.9	62	39	7.8	-
02-11-2015	1.0	31.4	15.4	57	32	9.6	-
03-11-2015	0.9	31.4	16.9	55	35	9.7	-
04-11-2015	0.8	31.6	17.9	56	33	9.6	-
05-11-2015	0.6	33.6	17.9	59	31	9.7	-
06-11-2015	0.3	33.0	18.9	48	43	8.8	-
07-11-2015	0.3	33.6	18.4	57	33	9.4	-
08-11-2015	0.3	34.0	17.9	44	36	7.1	-
09-11-2015	0.7	33.4	15.4	59	45	6.9	-
10-11-2015	0.6	31.6	16.4	66	45	8.9	-
11-11-2015	1.5	31.4	15.4	75	30	6.6	-
12-11-2015	2.8	32.4	14.9	53	33	9.2	-
13-11-2015	2.6	32.6	14.4	53	30	9.4	-
14-11-2015	0.6	32.0	15.9	48	36	9.6	-
15-11-2015	1.5	32.2	14.5	44	36	9.0	-
16-11-2015	1.6	32.8	13.9	51	25	10.0	-
17-11-2015	2.2	32.6	14.9	56	29	9.8	-
18-11-2015	1.1	32.0	13.4	47	24	9.6	-
19-11-2015	2.9	31.0	11.9	44	23	9.0	-
20-11-2015	2.7	30.0	12.4	55	35	10.3	-
21-11-2015	2.6	31.6	19.4	55	77	7.5	-
22-11-2015	1.2	29.4	20.9	81	66	1.8	-
23-11-2015	0.7	31.4	20.9	98	82	2.9	9.8
24-11-2015	0.2	26.8	20.4	79	71	1.3	2.2
25-11-2015	0.2	30.2	19.4	83	64	2.7	14.0
26-11-2015	0.1	29.0	18.9	84	48	1.7	-
27-11-2015	0.3	31.2	18.4	79	41	7.6	-
28-11-2015	0.2	31.6	18.9	69	51	7.9	-
29-11-2015	0.1	32.8	17.9	61	51	9.1	-
30-11-2015	0.1	32.6	15.9	55	35	9.2	-
01-12-2015	0.3	32.0	16.9	71	38	9.0	-
02-12-2015	0.3	32.4	17.9	72	46	8.0	-
03-12-2015	0.3	32.0	16.9	62	34	8.9	-
04-12-2015	0.1	31.8	15.9	76	31	8.9	-
05-12-2015	0.9	31.4	16.9	55	35	9.7	-
06-12-2015	0.8	31.6	17.9	56	33	9.6	-
07-12-2015	0.6	33.6	17.9	59	31	9.7	-
08-12-2015	0.3	33.0	18.9	48	43	8.8	-
09-12-2015	0.3	33.6	18.4	57	33	9.4	-
10-12-2015	2.7	30.0	12.4	55	35	10.3	-

11-12-2015	2.6	31.6	19.4	55	77	7.5	-
12-12-2015	1.2	29.4	20.9	81	66	1.8	-
13-12-2015	0.7	31.4	20.9	98	82	2.9	-
14-12-2015	0.2	26.8	20.4	79	71	1.3	-
15-12-2015	0.2	30.2	19.4	83	64	2.7	-

Appendix – B

Daily values of various parameters for calculation of water requirement

Table B.1. Daily values of crop coefficient, reference evapotranspiration crop evapotranspiration and pan evaporation.

Date	Kc values	ETr, mm day^{-1}	ETc, mm day^{-1}	Ep, mm day^{-1}
09-12-2014	0.3877	2.31	0.90	5.8
10-12-2014	0.3902	2.39	0.93	5.6
11-12-2014	0.3927	2.26	0.89	4.7
12-12-2014	0.3950	2.56	1.01	4.5
13-12-2014	0.3972	2.89	1.15	4.5
14-12-2014	0.3993	2.01	0.80	4.3
15-12-2014	0.4013	2.33	0.93	4.6
16-12-2014	0.4032	2.37	0.96	4.3
17-12-2014	0.4050	2.49	1.01	4.5
18-12-2014	0.4068	1.98	0.81	4.3
19-12-2014	0.4084	2.60	1.06	4.6
20-12-2014	0.4100	2.21	0.91	4.0
21-12-2014	0.4116	1.91	0.79	4.4
22-12-2014	0.4130	1.93	0.80	4.9
23-12-2014	0.4144	2.14	0.89	4.0
24-12-2014	0.4158	2.18	0.91	4.6
25-12-2014	0.4170	2.36	0.98	4.5
26-12-2014	0.4183	2.15	0.90	4.2
27-12-2014	0.4194	2.32	0.97	4.8
28-12-2014	0.4206	2.41	1.01	4.5
29-12-2014	0.4216	2.20	0.93	5.2
30-12-2014	0.4227	2.13	0.90	4.7
31-12-2014	0.4237	2.28	0.97	5.6
01-01-2015	0.4246	1.57	0.67	3.8
02-01-2015	0.4256	1.38	0.59	3.6
03-01-2015	0.4265	1.58	0.67	3.4
04-01-2015	0.4274	1.50	0.64	3.0
05-01-2015	0.4282	2.10	0.90	3.6
06-01-2015	0.4291	2.29	0.98	4.4
07-01-2015	0.4299	2.37	1.02	4.6
08-01-2015	0.4307	2.30	0.99	5.0
09-01-2015	0.4315	2.28	0.98	5.8
10-01-2015	0.4322	2.55	1.10	5.6
11-01-2015	0.4330	2.30	1.00	4.7
12-01-2015	0.4338	2.35	1.02	4.5
13-01-2015	0.4345	2.38	1.03	4.8
14-01-2015	0.4353	2.25	0.98	5.2

15-01-2015	0.4360	2.48	1.08	4.7
16-01-2015	0.4368	2.33	1.02	4.9
17-01-2015	0.4376	2.31	1.01	4.5
18-01-2015	0.4383	2.37	1.04	4.9
19-01-2015	0.4391	2.46	1.08	4.6
20-01-2015	0.4399	2.41	1.06	4.2
21-01-2015	0.4407	2.74	1.21	4.4
22-01-2015	0.4415	2.37	1.05	4.9
23-01-2015	0.4424	2.59	1.15	4.0
24-01-2015	0.4432	2.44	1.08	4.6
25-01-2015	0.4441	2.67	1.19	4.5
26-01-2015	0.4450	2.59	1.15	4.2
27-01-2015	0.4459	2.46	1.10	4.8
28-01-2015	0.4469	2.72	1.22	4.5
29-01-2015	0.4479	2.87	1.29	5.2
30-01-2015	0.4489	2.77	1.24	4.7
31-01-2015	0.4499	2.74	1.23	5.6
01-02-2015	0.4510	2.62	1.18	4.9
02-02-2015	0.4521	2.80	1.27	5.8
03-02-2015	0.4532	3.89	1.76	5.6
04-02-2015	0.4543	3.44	1.56	5.2
05-02-2015	0.4555	3.16	1.44	5.8
06-02-2015	0.4568	2.72	1.24	6.0
07-02-2015	0.4581	3.46	1.58	5.6
08-02-2015	0.4594	3.86	1.77	5.7
09-02-2015	0.4607	3.22	1.48	6.2
10-02-2015	0.4621	3.27	1.51	5.9
11-02-2015	0.4636	3.68	1.71	5.6
12-02-2015	0.4651	3.36	1.56	5.2
13-02-2015	0.4666	2.96	1.38	5.9
14-02-2015	0.4682	2.91	1.36	6.3
15-02-2015	0.4698	3.23	1.52	6.5
16-02-2015	0.4715	3.29	1.55	6.6
17-02-2015	0.4732	3.19	1.51	6.8
18-02-2015	0.4750	3.73	1.77	7.1
19-02-2015	0.4768	3.80	1.81	6.5
20-02-2015	0.4786	3.27	1.57	7.4
21-02-2015	0.4805	3.50	1.68	6.8
22-02-2015	0.4825	3.72	1.79	7.0
23-02-2015	0.4845	3.89	1.88	6.9
24-02-2015	0.4866	3.56	1.73	7.2
25-02-2015	0.4887	3.45	1.69	6.8
26-02-2015	0.4909	3.63	1.78	7.6
27-02-2015	0.4931	3.79	1.87	7.0
28-02-2015	0.4954	3.72	1.84	6.6

01-03-2015	0.4978	2.61	1.30	5.8
02-03-2015	0.5001	1.57	0.79	1.9
03-03-2015	0.5026	4.04	2.03	5.2
04-03-2015	0.5051	4.15	2.10	5.6
05-03-2015	0.5077	3.41	1.73	5.4
06-03-2015	0.5103	3.55	1.81	5.9
07-03-2015	0.5129	3.79	1.94	6.4
08-03-2015	0.5157	3.46	1.78	6.0
09-03-2015	0.5184	3.71	1.92	5.8
10-03-2015	0.5213	3.92	2.04	6.2
11-03-2015	0.5241	3.89	2.04	4.8
12-03-2015	0.5271	4.00	2.11	5.6
13-03-2015	0.5301	4.10	2.17	6.4
14-03-2015	0.5331	4.41	2.35	5.4
15-03-2015	0.5362	3.90	2.09	5.9
16-03-2015	0.5394	3.76	2.03	6.5
17-03-2015	0.5426	3.90	2.12	5.6
18-03-2015	0.5459	3.98	2.17	6.0
19-03-2015	0.5492	4.09	2.25	6.4
20-03-2015	0.5526	4.46	2.46	6.2
21-03-2015	0.5560	3.90	2.17	6.8
22-03-2015	0.5595	3.80	2.13	6.5
23-03-2015	0.5631	3.93	2.21	6.6
24-03-2015	0.5667	4.00	2.27	7.0
25-03-2015	0.5703	4.11	2.34	7.4
26-03-2015	0.5740	4.09	2.35	7.8
27-03-2015	0.5777	3.92	2.26	7.5
28-03-2015	0.5815	4.59	2.67	7.9
29-03-2015	0.5854	4.04	2.36	8.4
30-03-2015	0.5893	3.21	1.89	7.2
31-03-2015	0.5932	4.05	2.44	6.8
01-04-2015	0.5972	4.35	2.60	7.6
02-04-2015	0.6013	4.69	2.82	8.0
03-04-2015	0.6054	4.67	2.83	8.4
04-04-2015	0.6095	4.90	2.99	7.8
05-04-2015	0.6137	5.10	3.13	7.5
06-04-2015	0.6179	4.41	2.73	8.2
07-04-2015	0.6222	4.33	2.69	7.4
08-04-2015	0.6265	4.23	2.65	7.2
09-04-2015	0.6309	4.43	2.79	7.0
10-04-2015	0.6353	4.69	2.98	7.6
11-04-2015	0.6397	3.59	2.30	6.4
12-04-2015	0.6442	3.82	2.46	6.0
13-04-2015	0.6488	4.30	2.79	6.8
14-04-2015	0.6533	3.83	2.50	5.9

15-04-2015	0.6579	3.51	2.31	6.5
16-04-2015	0.6626	4.18	2.77	6.8
17-04-2015	0.6673	4.73	3.16	5.8
18-04-2015	0.6720	4.95	3.33	6.6
19-04-2015	0.6767	4.75	3.21	7.4
20-04-2015	0.6815	4.66	3.18	7.8
21-04-2015	0.6863	4.81	3.30	8.0
22-04-2015	0.6912	4.22	2.92	7.6
23-04-2015	0.6961	4.62	3.22	7.6
24-04-2015	0.7010	5.00	3.50	8.0
25-04-2015	0.7059	6.97	4.92	8.4
26-04-2015	0.7109	4.83	3.43	8.5
27-04-2015	0.7159	5.09	3.64	8.8
28-04-2015	0.7209	4.83	3.48	8.0
29-04-2015	0.7260	6.44	4.68	8.6
30-04-2015	0.7311	6.68	4.88	8.2
01-05-2015	0.7362	6.28	4.62	8.6
02-05-2015	0.7413	6.77	5.02	9.5
03-05-2015	0.7464	6.79	5.07	9.8
04-05-2015	0.7516	5.30	3.98	9.6
05-05-2015	0.7568	5.18	3.92	9.2
06-05-2015	0.7620	5.61	4.27	8.8
07-05-2015	0.7672	5.18	3.97	9.4
08-05-2015	0.7724	4.90	3.78	9.0
09-05-2015	0.7777	5.26	4.09	9.6
10-05-2015	0.7829	6.26	4.90	9.2
11-05-2015	0.7882	4.85	3.82	8.6
12-05-2015	0.7935	5.65	4.48	10.4
13-05-2015	0.7988	4.83	3.86	9.0
14-05-2015	0.8041	3.94	3.17	8.2
15-05-2015	0.8094	4.05	3.28	7.5
16-05-2015	0.8147	4.61	3.76	8.2
17-05-2015	0.8200	5.22	4.28	9.6
18-05-2015	0.8253	5.73	4.73	9.0
19-05-2015	0.8306	6.99	5.81	9.6
20-05-2015	0.8360	7.49	6.26	10.4
21-05-2015	0.8413	8.11	6.82	11.2
22-05-2015	0.8466	7.68	6.50	11.8
23-05-2015	0.8519	7.73	6.59	12.4
24-05-2015	0.8573	8.69	7.45	11.6
25-05-2015	0.8626	7.58	6.54	12.0
26-05-2015	0.8679	7.56	6.56	11.0
27-05-2015	0.8732	7.42	6.48	11.4
28-05-2015	0.8785	8.10	7.12	11.8
29-05-2015	0.8837	6.97	6.16	8.8

30-05-2015	0.8890	5.11	4.54	8.8
31-05-2015	0.8943	2.65	2.37	8.4
01-06-2015	0.8995	6.33	5.69	7.6
02-06-2015	0.9047	6.39	5.78	8.0
03-06-2015	0.9100	6.29	5.72	8.5
04-06-2015	0.9151	6.17	5.65	8.8
05-06-2015	0.9203	5.91	5.44	8.6
06-06-2015	0.9255	2.86	2.65	7.8
07-06-2015	0.9306	5.21	4.85	8.2
08-06-2015	0.9357	4.39	4.11	6.8
09-06-2015	0.9408	5.32	5.01	7.4
10-06-2015	0.9459	5.07	4.80	6.2
11-06-2015	0.9509	4.98	4.74	6.6
12-06-2015	0.9559	5.16	4.93	7.4
13-06-2015	0.9609	4.90	4.71	6.0
14-06-2015	0.9659	3.11	3.00	4.8
15-06-2015	0.9708	2.46	2.39	2.6
16-06-2015	0.9757	2.80	2.73	2.4
17-06-2015	0.9806	4.70	4.61	4.5
18-06-2015	0.9854	5.64	5.56	5.6
19-06-2015	0.9902	4.32	4.28	4.8
20-06-2015	0.9949	4.09	4.07	4.2
21-06-2015	0.9997	5.86	5.86	4.6
22-06-2015	1.0043	3.46	3.48	4.0
23-06-2015	1.0090	3.63	3.66	3.4
24-06-2015	1.0136	3.62	3.67	3.8
25-06-2015	1.0181	7.38	7.51	6.2
26-06-2015	1.0227	6.51	6.66	6.8
27-06-2015	1.0271	6.68	6.86	6.6
28-06-2015	1.0316	6.66	6.87	7.2
29-06-2015	1.0359	4.53	4.69	5.4
30-06-2015	1.0403	5.56	5.78	7.6
01-07-2015	1.0445	6.16	6.43	8.0
02-07-2015	1.0488	6.13	6.43	7.8
03-07-2015	1.0530	6.44	6.78	7.4
04-07-2015	1.0571	6.69	7.07	6.8
05-07-2015	1.0612	6.87	7.29	7.2
06-07-2015	1.0652	7.26	7.73	7.6
07-07-2015	1.0692	7.38	7.89	8.7
08-07-2015	1.0731	6.23	6.69	8.0
09-07-2015	1.0769	5.45	5.87	6.4
10-07-2015	1.0807	6.43	6.95	7.0
11-07-2015	1.0845	6.14	6.66	6.6
12-07-2015	1.0882	7.01	7.63	7.4
13-07-2015	1.0918	6.28	6.86	6.8

14-07-2015	1.0954	4.87	5.33	8.0
15-07-2015	1.0989	5.66	6.22	8.5
16-07-2015	1.1023	6.01	6.62	8.8
17-07-2015	1.1057	5.88	6.50	7.0
18-07-2015	1.1090	5.79	6.42	6.4
19-07-2015	1.1122	4.64	5.16	5.8
20-07-2015	1.1154	5.18	5.78	4.4
21-07-2015	1.1185	2.82	3.15	4.0
22-07-2015	1.1216	2.98	3.34	4.4
23-07-2015	1.1245	4.05	4.55	5.2
24-07-2015	1.1275	3.85	4.34	4.8
25-07-2015	1.1303	4.76	5.38	5.0
26-07-2015	1.1331	4.29	4.86	4.0
27-07-2015	1.1358	4.93	5.60	4.6
28-07-2015	1.1384	4.70	5.35	5.5
29-07-2015	1.1410	4.98	5.68	6.0
30-07-2015	1.1434	3.62	4.14	6.2
31-07-2015	1.1459	3.60	4.13	5.8
01-08-2015	1.1482	4.99	5.73	6.6
02-08-2015	1.1505	4.79	5.51	5.6
03-08-2015	1.1527	4.71	5.43	5.4
04-08-2015	1.1548	4.39	5.07	5.8
05-08-2015	1.1568	2.27	2.63	4.2
06-08-2015	1.1588	2.66	3.08	3.8
07-08-2015	1.1607	2.77	3.22	3.2
08-08-2015	1.1625	2.71	3.15	4.0
09-08-2015	1.1642	3.48	4.05	4.4
10-08-2015	1.1659	3.69	4.30	4.8
11-08-2015	1.1675	4.49	5.24	6.0
12-08-2015	1.1690	2.44	2.85	4.2
13-08-2015	1.1704	2.21	2.59	4.0
14-08-2015	1.1718	2.89	3.39	4.0
15-08-2015	1.1730	3.33	3.91	4.8
16-08-2015	1.1742	5.80	6.81	5.6
17-08-2015	1.1754	5.41	6.36	6.2
18-08-2015	1.1764	4.27	5.02	5.6
19-08-2015	1.1774	4.29	5.05	5.8
20-08-2015	1.1782	3.91	4.61	6.2
21-08-2015	1.1791	5.54	6.53	6.8
22-08-2015	1.1798	4.55	5.37	5.4
23-08-2015	1.1804	3.80	4.49	6.0
24-08-2015	1.1810	5.58	6.59	6.4
25-08-2015	1.1815	5.56	6.57	6.8
26-08-2015	1.1819	2.66	3.14	4.6
27-08-2015	1.1823	5.40	6.38	5.2

28-08-2015	1.1825	3.79	4.48	4.4
29-08-2015	1.1827	3.04	3.60	4.5
30-08-2015	1.1828	4.12	4.87	6.4
31-08-2015	1.1829	4.85	5.74	6.0
01-09-2015	1.1828	5.56	6.58	6.6
02-09-2015	1.1827	5.63	6.66	6.8
03-09-2015	1.1825	3.93	4.65	7.4
04-09-2015	1.1823	4.45	5.26	7.0
05-09-2015	1.1819	4.68	5.53	6.6
06-09-2015	1.1815	4.60	5.44	6.0
07-09-2015	1.1811	3.15	3.72	4.5
08-09-2015	1.1805	3.78	4.46	4.2
09-09-2015	1.1799	2.40	2.83	3.8
10-09-2015	1.1792	3.29	3.88	4.0
11-09-2015	1.1784	4.23	4.98	4.6
12-09-2015	1.1776	4.34	5.11	5.4
13-09-2015	1.1767	4.39	5.17	5.8
14-09-2015	1.1757	2.36	2.77	4.6
15-09-2015	1.1747	2.38	2.80	4.4
16-09-2015	1.1736	2.65	3.11	4.0
17-09-2015	1.1725	3.07	3.60	4.2
18-09-2015	1.1712	2.57	3.01	3.8
19-09-2015	1.1699	3.17	3.71	4.0
20-09-2015	1.1686	4.46	5.21	4.4
21-09-2015	1.1672	4.73	5.52	3.6
22-09-2015	1.1657	4.47	5.21	4.8
23-09-2015	1.1642	4.51	5.25	5.6
24-09-2015	1.1626	3.76	4.37	5.8
25-09-2015	1.1610	3.92	4.55	5.5
26-09-2015	1.1593	3.92	4.54	6.2
27-09-2015	1.1576	3.83	4.43	5.0
28-09-2015	1.1558	3.83	4.43	6.0
29-09-2015	1.1540	3.68	4.25	5.8
30-09-2015	1.1521	4.24	4.88	6.4
`01-10-2015	1.1502	4.58	5.27	6.8
02-10-2015	1.1482	4.17	4.79	6.0
03-10-2015	1.1462	2.72	3.12	4.8
04-10-2015	1.1441	3.33	3.81	4.5
05-10-2015	1.1420	3.47	3.96	5.4
06-10-2015	1.1399	3.57	4.07	6.0
07-10-2015	1.1378	3.62	4.12	6.6
08-10-2015	1.1356	3.41	3.87	6.2
09-10-2015	1.1333	3.58	4.06	6.5
10-10-2015	1.1311	3.59	4.06	6.0
11-10-2015	1.1288	3.47	3.92	6.8

12-10-2015	1.1265	2.84	3.20	5.4
13-10-2015	1.1242	2.33	2.62	5.8
14-10-2015	1.1218	3.39	3.80	7.2
15-10-2015	1.1195	3.26	3.65	7.5
16-10-2015	1.1171	3.46	3.87	6.8
17-10-2015	1.1147	3.68	4.10	7.8
18-10-2015	1.1123	4.10	4.56	5.8
19-10-2015	1.1099	3.70	4.11	6.4
20-10-2015	1.1074	3.60	3.99	7.0
21-10-2015	1.1050	3.28	3.62	6.6
22-10-2015	1.1026	3.19	3.52	5.8
23-10-2015	1.1002	3.18	3.50	6.5
24-10-2015	1.0978	3.41	3.74	6.8
25-10-2015	1.0954	3.04	3.33	6.2
26-10-2015	1.0930	2.81	3.07	5.4
27-10-2015	1.0906	2.56	2.79	5.8
28-10-2015	1.0882	2.78	3.03	5.0
29-10-2015	1.0859	2.61	2.83	4.6
30-10-2015	1.0836	2.92	3.16	4.5
31-10-2015	1.0813	2.73	2.95	4.8
01-11-2015	1.0790	2.76	2.98	5.4
02-11-2015	1.0768	3.17	3.41	6.0
03-11-2015	1.0746	3.19	3.43	5.8
04-11-2015	1.0724	3.14	3.37	5.2
05-11-2015	1.0703	3.14	3.36	5.6
06-11-2015	1.0683	2.98	3.18	5.0
07-11-2015	1.0663	2.98	3.18	5.8
08-11-2015	1.0643	2.62	2.79	5.5
09-11-2015	1.0624	2.77	2.94	5.4
10-11-2015	1.0606	2.99	3.17	5.6
11-11-2015	1.0588	2.83	3.00	6.0
12-11-2015	1.0571	3.61	3.82	6.4
13-11-2015	1.0554	3.55	3.75	6.6
14-11-2015	1.0539	2.86	3.01	6.8
15-11-2015	1.0524	3.07	3.23	6.4
16-11-2015	1.0510	3.16	3.32	6.2
17-11-2015	1.0497	3.40	3.57	5.8
18-11-2015	1.0485	2.82	2.96	6.4
19-11-2015	1.0474	3.41	3.57	5.4
20-11-2015	1.0464	3.39	3.55	5.0
21-11-2015	1.0455	3.16	3.30	4.4
22-11-2015	1.0447	1.96	2.05	5.6
23-11-2015	1.0440	2.13	2.22	4.0
24-11-2015	1.0435	1.66	1.73	3.0
25-11-2015	1.0431	1.93	2.01	3.8

26-11-2015	1.0428	1.67	1.74	3.6
27-11-2015	1.0426	2.55	2.66	5.6
28-11-2015	1.0426	2.64	2.75	6.4
29-11-2015	1.0427	2.76	2.88	6.8
30-11-2015	1.0430	2.47	2.58	5.8
01-12-2015	1.0434	2.62	2.73	5.5
02-12-2015	1.0440	2.61	2.72	4.8
03-12-2015	1.0447	2.51	2.62	5.8
04-12-2015	1.0457	2.43	2.54	6.2
05-12-2015	1.0468	2.98	3.12	6.0
06-12-2015	1.0481	2.98	3.12	5.6
07-12-2015	1.0495	2.62	2.75	5.8
08-12-2015	1.0512	2.77	2.91	5.4
09-12-2015	1.0531	2.99	3.15	5.0
10-12-2015	1.0551	2.83	2.99	5.6
11-12-2015	1.0574	2.98	3.15	6.0
12-12-2015	1.0599	2.98	3.16	5.4
13-12-2015	1.0626	2.62	2.78	5.2
14-12-2015	1.0656	2.77	2.95	6.4
15-12-2015	1.0688	2.99	3.20	6.0

Appendix – C

Water requirement of banana crop for drip irrigation with 48%Ep

Table C.1. Gross depth of water applied, volume of water applied and operating time of drip system for drip irrigation with 48% of pan evaporation

Date	Effective Rainfall, mm	Net depth, mm	Gross depth, mm	Volume of water applied, lit	Time of operation, min
09-12-2014	-	2.78	2.91	58.46	58.77
10-12-2014	-	2.69	2.81	56.45	56.74
11-12-2014	-	2.26	2.36	47.38	47.62
12-12-2014	-	2.16	2.26	45.36	45.59
13-12-2014	-	2.16	2.26	45.36	45.59
14-12-2014	-	2.06	2.16	43.34	43.57
15-12-2014	-	2.21	2.31	46.37	46.61
16-12-2014	-	2.06	2.16	43.34	43.57
17-12-2014	-	2.16	2.26	45.36	45.59
18-12-2014	-	2.06	2.16	43.34	43.57
19-12-2014	-	2.21	2.31	46.37	46.61
20-12-2014	-	1.92	2.01	40.32	40.53
21-12-2014	-	2.11	2.21	44.35	44.58
22-12-2014	-	2.35	2.46	49.39	49.65
23-12-2014	-	1.92	2.01	40.32	40.53
24-12-2014	-	2.21	2.31	46.37	46.61
25-12-2014	-	2.16	2.26	45.36	45.59
26-12-2014	-	2.02	2.11	42.34	42.55
27-12-2014	-	2.30	2.41	48.38	48.63
28-12-2014	-	2.16	2.26	45.36	45.59
29-12-2014	-	2.50	2.61	52.42	52.69
30-12-2014	-	2.26	2.36	47.38	47.62
31-12-2014	-	2.69	2.81	56.45	56.74
01-01-2015	-	1.82	1.91	38.30	38.50
02-01-2015	-	1.73	1.81	36.29	36.48
03-01-2015	-	1.63	1.71	34.27	34.45
04-01-2015	-	1.44	1.51	30.24	30.40
05-01-2015	-	1.73	1.81	36.29	36.48
06-01-2015	-	2.11	2.21	44.35	44.58
07-01-2015	-	2.21	2.31	46.37	46.61
08-01-2015	-	2.40	2.51	50.40	50.66
09-01-2015	-	2.78	2.91	58.46	58.77
10-01-2015	-	2.69	2.81	56.45	56.74
11-01-2015	-	2.26	2.36	47.38	47.62
12-01-2015	-	2.16	2.26	45.36	45.59
13-01-2015	-	2.30	2.41	48.38	48.63
14-01-2015	-	2.50	2.61	52.42	52.69
15-01-2015	-	2.26	2.36	47.38	47.62
16-01-2015	-	2.35	2.46	49.39	49.65

17-01-2015	-	2.16	2.26	45.36	45.59
18-01-2015	-	2.35	2.46	49.39	49.65
19-01-2015	-	2.21	2.31	46.37	46.61
20-01-2015	-	2.02	2.11	42.34	42.55
21-01-2015	-	2.11	2.21	44.35	44.58
22-01-2015	-	2.35	2.46	49.39	49.65
23-01-2015	-	1.92	2.01	40.32	40.53
24-01-2015	-	2.21	2.31	46.37	46.61
25-01-2015	-	2.16	2.26	45.36	45.59
26-01-2015	-	2.02	2.11	42.34	42.55
27-01-2015	-	2.30	2.41	48.38	48.63
28-01-2015	-	2.16	2.26	45.36	45.59
29-01-2015	-	2.50	2.61	52.42	52.69
30-01-2015	-	2.26	2.36	47.38	47.62
31-01-2015	-	2.69	2.81	56.45	56.74
01-02-2015	-	2.35	2.46	49.39	49.65
02-02-2015	-	2.78	2.91	58.46	58.77
03-02-2015	-	2.69	2.81	56.45	56.74
04-02-2015	-	2.50	2.61	52.42	52.69
05-02-2015	-	2.78	2.91	58.46	58.77
06-02-2015	-	2.88	3.01	60.48	60.79
07-02-2015	-	2.69	2.81	56.45	56.74
08-02-2015	-	2.74	2.86	57.46	57.75
09-02-2015	-	2.98	3.11	62.50	62.82
10-02-2015	-	2.83	2.96	59.47	59.78
11-02-2015	-	2.69	2.81	56.45	56.74
12-02-2015	-	2.50	2.61	52.42	52.69
13-02-2015	-	2.83	2.96	59.47	59.78
14-02-2015	-	3.02	3.16	63.50	63.83
15-02-2015	-	3.12	3.26	65.52	65.86
16-02-2015	-	3.17	3.31	66.53	66.87
17-02-2015	-	3.26	3.41	68.54	68.90
18-02-2015	-	3.41	3.56	71.57	71.94
19-02-2015	-	3.12	3.26	65.52	65.86
20-02-2015	-	3.55	3.71	74.59	74.98
21-02-2015	-	3.26	3.41	68.54	68.90
22-02-2015	-	3.36	3.51	70.56	70.92
23-02-2015	-	3.31	3.46	69.55	69.91
24-02-2015	-	3.46	3.61	72.58	72.95
25-02-2015	-	3.26	3.41	68.54	68.90
26-02-2015	-	3.65	3.81	76.61	77.00
27-02-2015	-	3.36	3.51	70.56	70.92
28-02-2015	-	3.17	3.31	66.53	66.87
01-03-2015	-	2.78	2.91	58.46	58.77
02-03-2015	-	0.91	0.95	19.15	19.25
03-03-2015	-	2.50	2.61	52.42	52.69
04-03-2015	-	2.69	2.81	56.45	56.74
05-03-2015	-	2.59	2.71	54.43	54.71

06-03-2015	-	2.83	2.96	59.47	59.78
07-03-2015	-	3.07	3.21	64.51	64.85
08-03-2015	-	2.88	3.01	60.48	60.79
09-03-2015	-	2.78	2.91	58.46	58.77
10-03-2015	-	2.98	3.11	62.50	62.82
11-03-2015	-	2.30	2.41	48.38	48.63
12-03-2015	-	2.69	2.81	56.45	56.74
13-03-2015	-	3.07	3.21	64.51	64.85
14-03-2015	-	2.59	2.71	54.43	54.71
15-03-2015	-	2.83	2.96	59.47	59.78
16-03-2015	-	3.12	3.26	65.52	65.86
17-03-2015	-	2.69	2.81	56.45	56.74
18-03-2015	-	2.88	3.01	60.48	60.79
19-03-2015	-	3.07	3.21	64.51	64.85
20-03-2015	-	2.98	3.11	62.50	62.82
21-03-2015	-	3.26	3.41	68.54	68.90
22-03-2015	-	3.12	3.26	65.52	65.86
23-03-2015	-	3.17	3.31	66.53	66.87
24-03-2015	-	3.36	3.51	70.56	70.92
25-03-2015	-	3.55	3.71	74.59	74.98
26-03-2015	-	3.74	3.91	78.62	79.03
27-03-2015	-	3.60	3.76	75.60	75.99
28-03-2015	-	3.79	3.96	79.63	80.04
29-03-2015	-	4.03	4.21	84.67	85.11
30-03-2015	-	3.46	3.61	72.58	72.95
31-03-2015	-	3.26	3.41	68.54	68.90
01-04-2015	-	3.65	3.81	76.61	77.00
02-04-2015	-	3.84	4.01	80.64	81.06
03-04-2015	-	4.03	4.21	84.67	85.11
04-04-2015	-	3.74	3.91	78.62	79.03
05-04-2015	-	3.60	3.76	75.60	75.99
06-04-2015	-	3.94	4.11	82.66	83.08
07-04-2015	-	3.55	3.71	74.59	74.98
08-04-2015	-	3.46	3.61	72.58	72.95
09-04-2015	-	3.36	3.51	70.56	70.92
10-04-2015	-	3.65	3.81	76.61	77.00
11-04-2015	-	3.07	3.21	64.51	64.85
12-04-2015	2.88	0.48	0.50	0.00	0.00
13-04-2015	-	3.26	3.41	68.54	68.90
14-04-2015	-	1.78	1.86	59.47	59.78
15-04-2015	-	3.12	3.26	65.52	65.86
16-04-2015	-	3.26	3.41	68.54	68.90
17-04-2015	-	2.78	2.91	58.46	58.77
18-04-2015	-	3.17	3.31	66.53	66.87
19-04-2015	-	3.55	3.71	74.59	74.98
20-04-2015	-	3.74	3.91	78.62	79.03
21-04-2015	-	3.84	4.01	80.64	81.06
22-04-2015	-	3.65	3.81	76.61	77.00

23-04-2015	-	3.65	3.81	76.61	77.00
24-04-2015	-	3.84	4.01	80.64	81.06
25-04-2015	-	4.03	4.21	84.67	85.11
26-04-2015	-	4.08	4.27	85.68	86.12
27-04-2015	-	4.22	4.42	88.70	89.16
28-04-2015	-	3.84	4.01	80.64	81.06
29-04-2015	-	4.13	4.32	86.69	87.14
30-04-2015	-	3.94	4.11	82.66	83.08
01-05-2015	-	4.13	4.32	86.69	87.14
02-05-2015	-	4.56	4.77	95.76	96.25
03-05-2015	-	4.70	4.92	98.78	99.29
04-05-2015	-	4.61	4.82	96.77	97.27
05-05-2015	-	4.42	4.62	92.74	93.21
06-05-2015	-	4.22	4.42	88.70	89.16
07-05-2015	-	4.51	4.72	94.75	95.24
08-05-2015	-	4.32	4.52	90.72	91.19
09-05-2015	-	4.61	4.82	96.77	97.27
10-05-2015	-	4.42	4.62	92.74	93.21
11-05-2015	-	4.13	4.32	86.69	87.14
12-05-2015	-	4.99	5.22	104.83	105.37
13-05-2015	4.32	0.48	0.50	0.00	0.00
14-05-2015	-	3.94	4.11	82.66	83.08
15-05-2015	-	3.60	3.76	75.60	75.99
16-05-2015	-	3.94	4.11	82.66	83.08
17-05-2015	-	4.61	4.82	96.77	97.27
18-05-2015	-	4.32	4.52	90.72	91.19
19-05-2015	-	4.61	4.82	96.77	97.27
20-05-2015	-	4.99	5.22	104.83	105.37
21-05-2015	-	5.38	5.62	112.90	113.48
22-05-2015	-	5.66	5.92	118.94	119.56
23-05-2015	-	5.95	6.22	124.99	125.64
24-05-2015	-	5.57	5.82	116.93	117.53
25-05-2015	-	5.76	6.02	120.96	121.58
26-05-2015	-	5.28	5.52	110.88	111.45
27-05-2015	-	5.47	5.72	114.91	115.51
28-05-2015	-	5.66	5.92	118.94	119.56
29-05-2015	-	4.22	4.42	88.70	89.16
30-05-2015	3.00	2.78	2.91	25.70	25.84
31-05-2015	-	4.03	4.21	84.67	85.11
01-06-2015	-	3.65	3.81	76.61	77.00
02-06-2015	-	3.84	4.01	80.64	81.06
03-06-2015	-	4.08	4.27	85.68	86.12
04-06-2015	-	4.22	4.42	88.70	89.16
05-06-2015	4.13	1.15	1.20	0.00	0.00
06-06-2015	-	3.26	3.41	78.62	79.03
07-06-2015	-	3.94	4.11	82.66	83.08
08-06-2015	3.26	0.19	0.20	0.00	0.00
09-06-2015	3.55	1.82	1.91	0.00	0.00

10-06-2015	2.98	0.00	0.00	0.00	0.00
11-06-2015	3.17	3.17	3.31	0.00	0.00
12-06-2015	-	3.55	3.71	74.59	74.98
13-06-2015	2.88	0.96	1.00	0.00	0.00
14-06-2015	-	2.30	2.41	48.38	48.63
15-06-2015	1.25	0.00	0.00	0.00	0.00
16-06-2015	1.15	1.15	1.20	0.00	0.00
17-06-2015	2.16	2.16	2.26	0.00	0.00
18-06-2015	-	2.69	2.81	56.45	56.74
19-06-2015	2.30	0.00	0.00	0.00	0.00
20-06-2015	-	2.02	2.11	42.34	42.55
21-06-2015	-	2.21	2.31	46.37	46.61
22-06-2015	-	0.86	0.90	40.32	40.53
23-06-2015	1.63	0.19	0.20	0.00	0.00
24-06-2015	-	1.34	1.40	38.30	38.50
25-06-2015	-	2.98	3.11	62.50	62.82
26-06-2015	-	3.26	3.41	68.54	68.90
27-06-2015	-	3.17	3.31	66.53	66.87
28-06-2015	-	3.46	3.61	72.58	72.95
29-06-2015	-	2.59	2.71	54.43	54.71
30-06-2015	-	3.65	3.81	76.61	77.00
01-07-2015	-	3.84	4.01	80.64	81.06
02-07-2015	-	3.74	3.91	78.62	79.03
03-07-2015	-	3.55	3.71	74.59	74.98
04-07-2015	-	3.26	3.41	68.54	68.90
05-07-2015	-	3.46	3.61	72.58	72.95
06-07-2015	-	3.65	3.81	76.61	77.00
07-07-2015	-	4.18	4.37	87.70	88.15
08-07-2015	-	3.84	4.01	80.64	81.06
09-07-2015	-	3.07	3.21	64.51	64.85
10-07-2015	-	3.36	3.51	70.56	70.92
11-07-2015	-	3.17	3.31	66.53	66.87
12-07-2015	-	3.55	3.71	74.59	74.98
13-07-2015	-	3.26	3.41	68.54	68.90
14-07-2015	-	3.84	4.01	80.64	81.06
15-07-2015	-	4.08	4.27	85.68	86.12
16-07-2015	-	4.22	4.42	88.70	89.16
17-07-2015	-	3.36	3.51	70.56	70.92
18-07-2015	-	3.07	3.21	64.51	64.85
19-07-2015	-	2.78	2.91	58.46	58.77
20-07-2015	-	2.11	2.21	44.35	44.58
21-07-2015	1.92	0.00	0.00	0.00	0.00
22-07-2015	2.11	1.63	1.71	0.00	0.00
23-07-2015	-	2.50	2.61	52.42	52.69
24-07-2015	-	2.30	2.41	48.38	48.63
25-07-2015	2.40	0.00	0.00	0.00	0.00
26-07-2015	-	1.92	2.01	40.32	40.53
27-07-2015	-	2.21	2.31	46.37	46.61

28-07-2015	-	2.64	2.76	55.44	55.73
29-07-2015	-	2.88	3.01	60.48	60.79
30-07-2015	-	2.98	3.11	62.50	62.82
31-07-2015	-	2.78	2.91	58.46	58.77
01-08-2015	-	3.17	3.31	66.53	66.87
02-08-2015	-	2.69	2.81	56.45	56.74
03-08-2015	-	2.59	2.71	54.43	54.71
04-08-2015	-	2.78	2.91	58.46	58.77
05-08-2015	2.02	0.00	0.00	0.00	0.00
06-08-2015	-	0.58	0.60	38.30	38.50
07-08-2015	-	1.54	1.61	32.26	32.42
08-08-2015	-	1.92	2.01	40.32	40.53
09-08-2015	-	2.11	2.21	44.35	44.58
10-08-2015	-	2.30	2.41	48.38	48.63
11-08-2015	-	2.88	3.01	60.48	60.79
12-08-2015	-	1.34	1.40	42.34	42.55
13-08-2015	-	1.92	2.01	40.32	40.53
14-08-2015	-	1.92	2.01	40.32	40.53
15-08-2015	-	2.30	2.41	48.38	48.63
16-08-2015	-	2.69	2.81	56.45	56.74
17-08-2015	-	2.98	3.11	62.50	62.82
18-08-2015	-	2.69	2.81	56.45	56.74
19-08-2015	-	2.78	2.91	58.46	58.77
20-08-2015	-	2.98	3.11	62.50	62.82
21-08-2015	-	3.26	3.41	68.54	68.90
22-08-2015	-	2.11	2.21	54.43	54.71
23-08-2015	-	2.88	3.01	60.48	60.79
24-08-2015	-	3.07	3.21	64.51	64.85
25-08-2015	-	3.26	3.41	68.54	68.90
26-08-2015	-	2.21	2.31	46.37	46.61
27-08-2015	-	2.50	2.61	52.42	52.69
28-08-2015	-	1.15	1.20	44.35	44.58
29-08-2015	-	1.68	1.76	45.36	45.59
30-08-2015	-	3.07	3.21	64.51	64.85
31-08-2015	-	2.88	3.01	60.48	60.79
01-09-2015	-	3.17	3.31	66.53	66.87
02-09-2015	-	3.26	3.41	68.54	68.90
03-09-2015	-	3.55	3.71	74.59	74.98
04-09-2015	-	3.36	3.51	70.56	70.92
05-09-2015	3.17	1.54	1.61	0.00	0.00
06-09-2015	-	2.88	3.01	60.48	60.79
07-09-2015	2.16	0.00	0.00	0.00	0.00
08-09-2015	2.02	2.02	2.11	0.00	0.00
09-09-2015	-	1.82	1.91	38.30	38.50
10-09-2015	1.92	0.00	0.00	0.00	0.00
11-09-2015	2.21	0.00	0.00	0.00	0.00
12-09-2015	2.59	2.59	2.71	0.00	0.00
13-09-2015	2.78	0.00	0.00	0.00	0.00

14-09-2015	2.21	2.21	2.31	0.00	0.00
15-09-2015	-	1.06	1.10	44.35	44.58
16-09-2015	-	1.92	2.01	40.32	40.53
17-09-2015	2.02	0.00	0.00	0.00	0.00
18-09-2015	1.82	0.00	0.00	0.00	0.00
19-09-2015	1.92	0.00	0.00	0.00	0.00
20-09-2015	2.11	2.11	2.21	0.00	0.00
21-09-2015	1.73	1.73	1.81	0.00	0.00
22-09-2015	-	2.30	2.41	48.38	48.63
23-09-2015	-	2.69	2.81	56.45	56.74
24-09-2015	-	2.78	2.91	58.46	58.77
25-09-2015	-	2.64	2.76	55.44	55.73
26-09-2015	-	2.98	3.11	62.50	62.82
27-09-2015	-	2.40	2.51	50.40	50.66
28-09-2015	-	2.88	3.01	60.48	60.79
29-09-2015	-	2.78	2.91	58.46	58.77
30-09-2015	-	3.07	3.21	64.51	64.85
01-10-2015	-	3.26	3.41	68.54	68.90
02-10-2015	2.88	0.96	1.00	0.00	0.00
03-10-2015	2.30	0.00	0.00	0.00	0.00
04-10-2015	2.16	0.00	0.00	0.00	0.00
05-10-2015	-	2.59	2.71	54.43	54.71
06-10-2015	-	2.88	3.01	60.48	60.79
07-10-2015	-	3.17	3.31	66.53	66.87
08-10-2015	-	2.98	3.11	62.50	62.82
09-10-2015	-	3.12	3.26	65.52	65.86
10-10-2015	-	2.88	3.01	60.48	60.79
11-10-2015	-	3.26	3.41	68.54	68.90
12-10-2015	-	2.59	2.71	54.43	54.71
13-10-2015	-	2.78	2.91	58.46	58.77
14-10-2015	-	3.46	3.61	72.58	72.95
15-10-2015	-	3.60	3.76	75.60	75.99
16-10-2015	-	3.26	3.41	68.54	68.90
17-10-2015	-	3.74	3.91	78.62	79.03
18-10-2015	-	2.78	2.91	58.46	58.77
19-10-2015	-	3.07	3.21	64.51	64.85
20-10-2015	-	3.36	3.51	70.56	70.92
21-10-2015	-	3.17	3.31	66.53	66.87
22-10-2015	-	2.78	2.91	58.46	58.77
23-10-2015	-	3.12	3.26	65.52	65.86
24-10-2015	-	3.26	3.41	68.54	68.90
25-10-2015	-	2.98	3.11	62.50	62.82
26-10-2015	-	2.59	2.71	54.43	54.71
27-10-2015	-	2.78	2.91	58.46	58.77
28-10-2015	-	2.40	2.51	50.40	50.66
29-10-2015	-	2.21	2.31	46.37	46.61
30-10-2015		2.16	2.26	45.36	45.59
31-10-2015	-	2.30	2.41	48.38	48.63

01-11-2015	-	2.59	2.71	54.43	54.71
02-11-2015	-	2.88	3.01	60.48	60.79
03-11-2015	-	2.78	2.91	58.46	58.77
04-11-2015	-	2.50	2.61	52.42	52.69
05-11-2015	-	2.69	2.81	56.45	56.74
06-11-2015	-	2.40	2.51	50.40	50.66
07-11-2015	-	2.78	2.91	58.46	58.77
08-11-2015	-	2.64	2.76	55.44	55.73
09-11-2015	-	2.59	2.71	54.43	54.71
10-11-2015	-	2.69	2.81	56.45	56.74
11-11-2015	-	2.88	3.01	60.48	60.79
12-11-2015	-	3.07	3.21	64.51	64.85
13-11-2015	-	3.17	3.31	66.53	66.87
14-11-2015	-	3.26	3.41	68.54	68.90
15-11-2015	-	3.07	3.21	64.51	64.85
16-11-2015	-	2.98	3.11	62.50	62.82
17-11-2015	-	2.78	2.91	58.46	58.77
18-11-2015	-	3.07	3.21	64.51	64.85
19-11-2015	-	2.59	2.71	54.43	54.71
20-11-2015	-	2.40	2.51	50.40	50.66
21-11-2015	-	2.11	2.21	44.35	44.58
22-11-2015	-	2.69	2.81	56.45	56.74
23-11-2015	1.92	0.00	0.00	0.00	0.00
24-11-2015	-	0.38	0.40	30.24	30.40
25-11-2015	1.82	0.00	0.00	0.00	0.00
26-11-2015	1.73	1.73	1.81	0.00	0.00
27-11-2015	-	2.69	2.81	56.45	56.74
28-11-2015	-	3.07	3.21	64.51	64.85
29-11-2015	-	3.26	3.41	68.54	68.90
30-11-2015	-	2.78	2.91	58.46	58.77
01-12-2015	-	2.64	2.76	55.44	55.73
02-12-2015	-	2.30	2.41	48.38	48.63
03-12-2015	-	2.78	2.91	58.46	58.77
04-12-2015	-	2.98	3.11	62.50	62.82
05-12-2015	-	2.88	3.01	60.48	60.79
06-12-2015	-	2.69	2.81	56.45	56.74
07-12-2015	-	2.78	2.91	58.46	58.77
08-12-2015	-	2.59	2.71	54.43	54.71
09-12-2015	-	2.40	2.51	50.40	50.66
10-12-2015	-	2.69	2.81	56.45	56.74
11-12-2015	-	2.88	3.01	60.48	60.79
12-12-2015	-	2.59	2.71	54.43	54.71
13-12-2015	-	2.50	2.61	52.42	52.69
14-12-2015	-	3.07	3.21	64.51	64.85
15-12-2015	-	2.88	3.01	60.48	60.79
Total	**88.58**		**1053.36**		

Water requirement of banana crop for drip irrigation with 100%ETc

Table C.2. Gross depth of water applied, volume of water applied and operating time of drip system for drip irrigation with 100% ETc

Date	Effective Rainfall, mm	Net depth, mm	Gross depth, mm	Volume of water applied, lit	Time of operation, min
09-12-2014	-	0.90	0.94	18.81	18.97
10-12-2014	-	0.93	0.98	19.59	19.76
11-12-2014	-	0.89	0.93	18.64	18.80
12-12-2014	-	1.01	1.06	21.23	21.42
13-12-2014	-	1.15	1.20	24.10	24.31
14-12-2014	-	0.80	0.84	16.85	17.00
15-12-2014	-	0.93	0.98	19.63	19.80
16-12-2014	-	0.96	1.00	20.07	20.24
17-12-2014	-	1.01	1.06	21.18	21.36
18-12-2014	-	0.81	0.84	16.91	17.06
19-12-2014	-	1.06	1.11	22.30	22.49
20-12-2014	-	0.91	0.95	19.03	19.19
21-12-2014	-	0.79	0.82	16.51	16.65
22-12-2014	-	0.80	0.84	16.74	16.88
23-12-2014	-	0.89	0.93	18.62	18.78
24-12-2014	-	0.91	0.95	19.03	19.20
25-12-2014	-	0.98	1.03	20.67	20.85
26-12-2014	-	0.90	0.94	18.88	19.05
27-12-2014	-	0.97	1.02	20.43	20.61
28-12-2014	-	1.01	1.06	21.28	21.47
29-12-2014	-	0.93	0.97	19.48	19.65
30-12-2014	-	0.90	0.94	18.91	19.07
31-12-2014	-	0.97	1.01	20.29	20.46
01-01-2015	-	0.67	0.70	14.00	14.12
02-01-2015	-	0.59	0.62	12.33	12.44
03-01-2015	-	0.67	0.71	14.15	14.27
04-01-2015	-	0.64	0.67	13.46	13.58
05-01-2015	-	0.90	0.94	18.88	19.05
06-01-2015	-	0.98	1.03	20.63	20.81
07-01-2015	-	1.02	1.07	21.40	21.58
08-01-2015	-	0.99	1.04	20.80	20.98
09-01-2015	-	0.98	1.03	20.66	20.84
10-01-2015	-	1.10	1.16	23.15	23.35
11-01-2015	-	1.00	1.04	20.91	21.10
12-01-2015	-	1.02	1.07	21.41	21.59
13-01-2015	-	1.03	1.08	21.72	21.91
14-01-2015	-	0.98	1.03	20.57	20.75
15-01-2015	-	1.08	1.13	22.71	22.91
16-01-2015	-	1.02	1.07	21.37	21.56
17-01-2015	-	1.01	1.06	21.23	21.41
18-01-2015	-	1.04	1.09	21.82	22.00

19-01-2015	-	1.08	1.13	22.69	22.88
20-01-2015	-	1.06	1.11	22.26	22.46
21-01-2015	-	1.21	1.27	25.36	25.58
22-01-2015	-	1.05	1.10	21.98	22.17
23-01-2015	-	1.15	1.20	24.06	24.27
24-01-2015	-	1.08	1.13	22.71	22.91
25-01-2015	-	1.19	1.24	24.90	25.12
26-01-2015	-	1.15	1.21	24.20	24.41
27-01-2015	-	1.10	1.15	23.04	23.24
28-01-2015	-	1.22	1.28	25.53	25.75
29-01-2015	-	1.29	1.35	26.99	27.23
30-01-2015	-	1.24	1.30	26.11	26.34
31-01-2015	-	1.23	1.29	25.89	26.11
01-02-2015	-	1.18	1.24	24.81	25.03
02-02-2015	-	1.27	1.33	26.58	26.81
03-02-2015	-	1.76	1.85	37.02	37.34
04-02-2015	-	1.56	1.64	32.82	33.11
05-02-2015	-	1.44	1.51	30.23	30.49
06-02-2015	-	1.24	1.30	26.09	26.32
07-02-2015	-	1.58	1.66	33.28	33.57
08-02-2015	-	1.77	1.86	37.24	37.56
09-02-2015	-	1.48	1.56	31.16	31.42
10-02-2015	-	1.51	1.59	31.73	32.01
11-02-2015	-	1.71	1.79	35.83	36.14
12-02-2015	-	1.56	1.64	32.82	33.10
13-02-2015	-	1.38	1.45	29.00	29.25
14-02-2015	-	1.36	1.43	28.61	28.86
15-02-2015	-	1.52	1.59	31.87	32.14
16-02-2015	-	1.55	1.63	32.57	32.86
17-02-2015	-	1.51	1.58	31.70	31.97
18-02-2015	-	1.77	1.86	37.20	37.52
19-02-2015	-	1.81	1.90	38.05	38.37
20-02-2015	-	1.57	1.64	32.87	33.15
21-02-2015	-	1.68	1.76	35.32	35.63
22-02-2015	-	1.79	1.88	37.69	38.02
23-02-2015	-	1.88	1.98	39.58	39.92
24-02-2015	-	1.73	1.82	36.38	36.69
25-02-2015	-	1.69	1.77	35.41	35.71
26-02-2015	-	1.78	1.87	37.42	37.75
27-02-2015	-	1.87	1.96	39.25	39.59
28-02-2015	-	1.84	1.93	38.70	39.04
01-03-2015	-	1.30	1.36	27.28	27.52
02-03-2015	-	0.79	0.82	16.49	16.63
03-03-2015	-	2.03	2.13	42.64	43.01
04-03-2015	-	2.10	2.20	44.02	44.40
05-03-2015	-	1.73	1.82	36.35	36.67
06-03-2015	-	1.81	1.90	38.04	38.37
07-03-2015	-	1.94	2.04	40.82	41.18

08-03-2015	-	1.78	1.87	37.47	37.79
09-03-2015	-	1.92	2.02	40.39	40.74
10-03-2015	-	2.04	2.14	42.91	43.28
11-03-2015	-	2.04	2.14	42.82	43.19
12-03-2015	-	2.11	2.21	44.28	44.66
13-03-2015	-	2.17	2.28	45.64	46.03
14-03-2015	-	2.35	2.47	49.37	49.80
15-03-2015	-	2.09	2.19	43.92	44.30
16-03-2015	-	2.03	2.13	42.59	42.96
17-03-2015	-	2.12	2.22	44.44	44.83
18-03-2015	-	2.17	2.28	45.63	46.02
19-03-2015	-	2.25	2.36	47.17	47.58
20-03-2015	-	2.46	2.59	51.76	52.20
21-03-2015	-	2.17	2.27	45.54	45.93
22-03-2015	-	2.13	2.23	44.65	45.04
23-03-2015	-	2.21	2.32	46.47	46.87
24-03-2015	-	2.27	2.38	47.60	48.01
25-03-2015	-	2.34	2.46	49.22	49.65
26-03-2015	-	2.35	2.46	49.30	49.73
27-03-2015	-	2.26	2.38	47.56	47.97
28-03-2015	-	2.67	2.80	56.06	56.54
29-03-2015	-	2.36	2.48	49.66	50.09
30-03-2015	-	1.89	1.98	39.72	40.07
31-03-2015	-	2.44	2.56	51.33	51.77
01-04-2015	-	2.60	2.73	54.56	55.03
02-04-2015	-	2.82	2.96	59.22	59.73
03-04-2015	-	2.83	2.97	59.37	59.88
04-04-2015	-	2.99	3.13	62.72	63.26
05-04-2015	-	3.13	3.28	65.73	66.30
06-04-2015	-	2.73	2.86	57.23	57.72
07-04-2015	-	2.69	2.83	56.58	57.07
08-04-2015	-	2.65	2.78	55.65	56.14
09-04-2015	-	2.79	2.93	58.69	59.20
10-04-2015	-	2.98	3.13	62.57	63.11
11-04-2015	-	2.30	2.41	48.23	48.65
12-04-2015	2.46	0.00	0.00	0.00	0.00
13-04-2015	-	2.79	2.93	58.59	59.10
14-04-2015	-	0.30	0.32	52.55	53.00
15-04-2015	-	2.31	2.42	48.50	48.92
16-04-2015	-	2.77	2.91	58.16	58.66
17-04-2015	-	3.16	3.31	66.28	66.85
18-04-2015	-	3.33	3.49	69.85	70.46
19-04-2015	-	3.21	3.37	67.50	68.09
20-04-2015	-	3.18	3.33	66.69	67.27
21-04-2015	-	3.30	3.46	69.33	69.93
22-04-2015	-	2.92	3.06	61.25	61.78
23-04-2015	-	3.22	3.37	67.53	68.12
24-04-2015	-	3.50	3.68	73.60	74.24

25-04-2015	-	4.92	5.16	103.33	104.22
26-04-2015	-	3.43	3.60	72.11	72.73
27-04-2015	-	3.64	3.82	76.52	77.19
28-04-2015	-	3.48	3.65	73.13	73.76
29-04-2015	-	4.68	4.90	98.18	99.03
30-04-2015	-	4.88	5.12	102.55	103.44
01-05-2015	-	4.62	4.85	97.09	97.92
02-05-2015	-	5.02	5.26	105.39	106.30
03-05-2015	-	5.07	5.32	106.43	107.35
04-05-2015	-	3.98	4.18	83.65	84.38
05-05-2015	-	3.92	4.11	82.32	83.03
06-05-2015	-	4.27	4.48	89.77	90.54
07-05-2015	-	3.97	4.17	83.45	84.18
08-05-2015	-	3.78	3.97	79.48	80.17
09-05-2015	-	4.09	4.29	85.90	86.64
10-05-2015	-	4.90	5.14	102.92	103.81
11-05-2015	-	3.82	4.01	80.28	80.97
12-05-2015	-	4.48	4.70	94.15	94.96
13-05-2015	3.86	0.00	0.00	0.00	0.00
14-05-2015	-	3.17	3.32	66.57	67.15
15-05-2015	-	3.28	3.44	48.51	48.93
16-05-2015	-	3.76	3.94	78.87	79.55
17-05-2015	-	4.28	4.49	89.89	90.66
18-05-2015	-	4.73	4.96	99.31	100.17
19-05-2015	-	5.81	6.09	121.93	122.98
20-05-2015	-	6.26	6.57	131.49	132.63
21-05-2015	-	6.82	7.16	143.28	144.52
22-05-2015	-	6.50	6.82	136.54	137.72
23-05-2015	-	6.59	6.91	138.29	139.49
24-05-2015	-	7.45	7.81	156.44	157.79
25-05-2015	-	6.54	6.86	137.30	138.49
26-05-2015	-	6.56	6.88	137.78	138.97
27-05-2015	-	6.48	6.80	136.06	137.23
28-05-2015	-	7.12	7.46	149.43	150.72
29-05-2015	-	6.16	6.46	129.35	130.47
30-05-2015	3.00	1.54	1.62	32.34	32.62
31-05-2015	-	2.37	2.49	49.77	50.20
01-06-2015	-	5.69	5.97	119.57	120.60
02-06-2015	-	5.78	6.06	121.41	122.46
03-06-2015	-	5.72	6.00	120.20	121.23
04-06-2015	-	5.65	5.92	118.58	119.60
05-06-2015	5.44	0.00	0.00	0.00	0.00
06-06-2015	-	1.65	1.73	55.65	56.13
07-06-2015	-	4.85	5.09	101.82	102.70
08-06-2015	4.11	0.00	0.00	0.00	0.00
09-06-2015	3.60	1.41	1.47	29.61	29.87
10-06-2015	4.80	0.00	0.00	0.00	0.00
11-06-2015	4.74	4.74	4.97	0.00	0.00

12-06-2015	-	4.93	5.17	103.53	104.42
13-06-2015	4.00	0.71	0.74	14.91	15.04
14-06-2015	-	3.00	3.15	63.08	63.63
15-06-2015	2.39	0.00	0.00	0.00	0.00
16-06-2015	2.73	2.73	2.87	0.00	0.00
17-06-2015	4.61	4.61	4.83	0.00	0.00
18-06-2015	-	5.56	5.83	116.71	117.72
19-06-2015	4.28	0.00	0.00	0.00	0.00
20-06-2015	-	4.07	4.27	85.47	86.21
21-06-2015	-	5.86	6.15	123.02	124.08
22-06-2015	-	1.28	1.34	72.98	73.61
23-06-2015	3.00	0.66	0.70	13.86	13.98
24-06-2015	-	2.67	2.80	77.05	77.72
25-06-2015	-	7.51	7.88	157.79	159.16
26-06-2015	-	6.66	6.98	139.81	141.02
27-06-2015	-	6.86	7.20	144.09	145.33
28-06-2015	-	6.87	7.21	144.27	145.52
29-06-2015	-	4.69	4.92	98.55	99.40
30-06-2015	-	5.78	6.07	121.46	122.51
01-07-2015	-	6.43	6.75	135.12	136.29
02-07-2015	-	6.43	6.74	135.01	136.18
03-07-2015	-	6.78	7.11	142.40	143.63
04-07-2015	-	7.07	7.42	148.51	149.79
05-07-2015	-	7.29	7.65	153.10	154.42
06-07-2015	-	7.73	8.11	162.40	163.80
07-07-2015	-	7.89	8.28	165.70	167.13
08-07-2015	-	6.69	7.01	140.39	141.60
09-07-2015	-	5.87	6.16	123.26	124.32
10-07-2015	-	6.95	7.29	145.93	147.19
11-07-2015	-	6.66	6.98	139.83	141.04
12-07-2015	-	7.63	8.00	160.19	161.57
13-07-2015	-	6.86	7.19	143.99	145.23
14-07-2015	-	5.33	5.60	112.02	112.99
15-07-2015	-	6.22	6.52	130.61	131.74
16-07-2015	-	6.62	6.95	139.12	140.32
17-07-2015	-	6.50	6.82	136.53	137.71
18-07-2015	-	6.42	6.74	134.84	136.01
19-07-2015	-	5.16	5.41	108.38	109.31
20-07-2015	-	5.78	6.06	121.33	122.38
21-07-2015	3.15	0.00	0.00	0.00	0.00
22-07-2015	3.34	2.34	2.46	0.00	0.00
23-07-2015	-	4.55	4.78	95.55	96.38
24-07-2015	-	4.34	4.55	91.15	91.94
25-07-2015	5.38	0.00	0.00	0.00	0.00
26-07-2015	-	4.86	5.10	102.06	102.94
27-07-2015	-	5.60	5.87	117.59	118.60
28-07-2015	-	5.35	5.61	112.36	113.33
29-07-2015	-	5.68	5.96	119.32	120.35

30-07-2015	-	4.14	4.34	86.92	87.68
31-07-2015	-	4.13	4.33	86.63	87.38
01-08-2015	-	5.73	6.01	120.32	121.36
02-08-2015	-	5.51	5.78	115.72	116.73
03-08-2015	-	5.43	5.69	114.01	114.99
04-08-2015	-	5.07	5.32	106.46	107.38
05-08-2015	2.63	0.00	0.00	0.00	0.00
06-08-2015	-	0.48	0.51	64.68	65.24
07-08-2015	-	3.22	3.37	67.52	68.10
08-08-2015	-	3.15	3.30	66.16	66.73
09-08-2015	-	4.05	4.25	85.08	85.82
10-08-2015	-	4.30	4.51	90.34	91.13
11-08-2015	-	5.24	5.50	110.08	111.03
12-08-2015	-	1.45	1.52	59.90	60.42
13-08-2015	-	2.59	2.71	54.32	54.79
14-08-2015	-	3.39	3.55	71.11	71.73
15-08-2015	-	3.91	4.10	82.03	82.74
16-08-2015	-	6.81	7.14	143.02	144.26
17-08-2015	-	6.36	6.67	133.53	134.69
18-08-2015	-	5.02	5.27	105.49	106.40
19-08-2015	-	5.05	5.30	106.07	106.99
20-08-2015	-	4.61	4.83	96.75	97.58
21-08-2015	-	6.53	6.85	137.17	138.36
22-08-2015	-	4.37	4.58	112.73	113.70
23-08-2015	-	4.49	4.71	94.20	95.01
24-08-2015	-	6.59	6.91	138.39	139.59
25-08-2015	-	6.57	6.89	137.95	139.15
26-08-2015	-	3.26	3.42	68.50	69.10
27-08-2015	-	6.38	6.70	134.07	135.23
28-08-2015	-	0.00	0.00	94.12	94.93
29-08-2015	-	0.00	0.00	75.51	76.16
30-08-2015	-	4.87	5.11	102.34	103.22
31-08-2015	-	5.74	6.02	120.48	121.52
01-09-2015	-	6.58	6.90	138.11	139.30
02-09-2015	-	6.66	6.98	139.83	141.04
03-09-2015	-	4.65	4.88	97.60	98.44
04-09-2015	-	5.26	5.52	110.48	111.44
05-09-2015	3.40	0.00	0.00	44.73	45.12
06-09-2015	-	5.44	5.70	114.14	115.12
07-09-2015	3.72	0.00	0.00	0.00	0.00
08-09-2015	4.46	4.46	4.68	0.00	0.00
09-09-2015	-	2.83	2.97	59.43	59.94
10-09-2015	3.88	0.00	0.00	0.00	0.00
11-09-2015	4.98	0.00	0.00	0.00	0.00
12-09-2015	5.11	5.11	5.36	0.00	0.00
13-09-2015	5.17	0.00	0.00	0.00	0.00
14-09-2015	2.77	2.77	2.91	0.00	0.00
15-09-2015	-	0.00	0.00	58.71	59.22

16-09-2015	-	3.11	3.26	65.31	65.88
17-09-2015	3.60	0.00	0.00	0.00	0.00
18-09-2015	3.01	0.00	0.00	0.00	0.00
19-09-2015	3.71	0.00	0.00	0.00	0.00
20-09-2015	5.21	5.21	5.47	0.00	0.00
21-09-2015	5.52	5.52	5.79	0.00	0.00
22-09-2015	-	5.21	5.47	109.43	110.37
23-09-2015	-	5.25	5.51	110.26	111.22
24-09-2015	-	4.37	4.59	91.80	92.60
25-09-2015	-	4.55	4.77	95.57	96.40
26-09-2015	-	4.54	4.77	95.44	96.26
27-09-2015	-	4.43	4.65	93.10	93.91
28-09-2015	-	4.43	4.64	92.96	93.76
29-09-2015	-	4.25	4.45	89.18	89.95
30-09-2015	-	4.88	5.12	102.58	103.47
01-10-2015	-	5.27	5.53	110.62	111.58
02-10-2015	4.00	0.00	0.00	16.59	16.73
03-10-2015	3.12	0.00	0.00	0.00	0.00
04-10-2015	3.81	0.00	0.00	0.00	0.00
05-10-2015	-	3.96	4.16	83.22	83.94
06-10-2015	-	4.07	4.27	85.46	86.20
07-10-2015	-	4.12	4.32	86.49	87.24
08-10-2015	-	3.87	4.06	81.32	82.02
09-10-2015	-	4.06	4.26	85.20	85.94
10-10-2015	-	4.06	4.26	85.27	86.01
11-10-2015	-	3.92	4.11	82.26	82.97
12-10-2015	-	3.20	3.36	67.18	67.76
13-10-2015	-	2.62	2.75	55.01	55.48
14-10-2015	-	3.80	3.99	79.86	80.55
15-10-2015	-	3.65	3.83	76.64	77.30
16-10-2015	-	3.87	4.05	81.17	81.87
17-10-2015	-	4.10	4.30	86.14	86.89
18-10-2015	-	4.56	4.78	95.77	96.59
19-10-2015	-	4.11	4.31	86.24	86.98
20-10-2015	-	3.99	4.18	83.72	84.45
21-10-2015	-	3.62	3.80	76.11	76.77
22-10-2015	-	3.52	3.69	73.86	74.50
23-10-2015	-	3.50	3.67	73.47	74.11
24-10-2015	-	3.74	3.93	78.61	79.29
25-10-2015	-	3.33	3.49	69.93	70.53
26-10-2015	-	3.07	3.22	64.50	65.05
27-10-2015	-	2.79	2.93	58.63	59.14
28-10-2015	-	3.03	3.17	63.53	64.08
29-10-2015	-	2.83	2.97	59.52	60.03
30-10-2015	-	3.16	3.32	66.45	67.02
31-10-2015	-	2.95	3.10	61.99	62.53
01-11-2015	-	2.98	3.12	62.54	63.08
02-11-2015	-	3.41	3.58	71.68	72.30

03-11-2015	-	3.43	3.60	71.99	72.61
04-11-2015	-	3.37	3.53	70.72	71.33
05-11-2015	-	3.36	3.53	70.58	71.19
06-11-2015	-	3.18	3.34	66.85	67.43
07-11-2015	-	3.18	3.33	66.73	67.30
08-11-2015	-	2.79	2.93	58.56	59.06
09-11-2015	-	2.94	3.09	61.80	62.33
10-11-2015	-	3.17	3.33	66.59	67.17
11-11-2015	-	3.00	3.14	62.92	63.47
12-11-2015	-	3.82	4.00	80.14	80.83
13-11-2015	-	3.75	3.93	78.68	79.36
14-11-2015	-	3.01	3.16	63.30	63.84
15-11-2015	-	3.23	3.39	67.85	68.44
16-11-2015	-	3.32	3.48	69.75	70.35
17-11-2015	-	3.57	3.74	74.95	75.60
18-11-2015	-	2.96	3.10	62.09	62.63
19-11-2015	-	3.57	3.75	75.00	75.65
20-11-2015	-	3.55	3.72	74.49	75.14
21-11-2015	-	3.30	3.47	69.38	69.98
22-11-2015	-	2.05	2.15	43.00	43.37
23-11-2015	2.22	0.00	0.00	0.00	0.00
24-11-2015	-	0.00	0.00	36.33	36.64
25-11-2015	2.01	0.00	0.00	0.00	0.00
26-11-2015	1.74	1.74	1.83	0.00	0.00
27-11-2015	-	2.66	2.79	55.83	56.31
28-11-2015	-	2.75	2.89	57.80	58.30
29-11-2015	-	2.88	3.02	60.43	60.96
30-11-2015	-	2.58	2.70	54.10	54.57
01-12-2015	-	2.73	2.87	57.41	57.90
02-12-2015	-	2.72	2.86	57.22	57.72
03-12-2015	-	2.62	2.75	55.07	55.54
04-12-2015	-	2.54	2.67	53.36	53.82
05-12-2015	-	3.12	3.27	65.51	66.07
06-12-2015	-	3.12	3.28	65.59	66.15
07-12-2015	-	2.75	2.88	57.75	58.24
08-12-2015	-	2.91	3.05	61.15	61.68
09-12-2015	-	3.15	3.30	66.12	66.69
10-12-2015	-	2.99	3.13	62.71	63.25
11-12-2015	-	3.15	3.31	66.17	66.74
12-12-2015	-	3.16	3.31	66.33	66.90
13-12-2015	-	2.78	2.92	58.47	58.97
14-12-2015	-	2.95	3.10	61.98	62.52
15-12-2015	-	3.20	3.35	67.11	67.69
Total	**138.96**		**1184.35**		

Water requirement of banana crop for surface irrigation with 1.00 IW/CPE ratio

Table C.3. Gross depth of water applied, volume of water applied and operating time for surface irrigation

Date	Pan evaporation, mm	Cumulative pan evaporation, mm	Effective rainfall, mm	Time of operation, min
09-12-2014	5.8	5.8	-	-
10-12-2014	5.6	11.4	-	-
11-12-2014	4.7	16.1	-	-
12-12-2014	4.5	20.6	-	-
13-12-2014	4.5	25.1	-	-
14-12-2014	4.3	29.4	-	-
15-12-2014	4.6	34.0	-	-
16-12-2014	4.3	38.3	-	-
17-12-2014	4.5	**42.8**	-	52.50
18-12-2014	4.3	7.1	-	-
19-12-2014	4.6	11.7	-	-
20-12-2014	4.0	15.7	-	-
21-12-2014	4.4	20.1	-	-
22-12-2014	4.9	25.0	-	-
23-12-2014	4.0	29.0	-	-
24-12-2014	4.6	33.6	-	-
25-12-2014	4.5	38.1	-	-
26-12-2014	4.2	**42.9**	-	52.50
27-12-2014	4.8	7.7	-	-
28-12-2014	4.5	12.2	-	-
29-12-2014	5.2	17.4	-	-
30-12-2014	4.7	22.1	-	-
31-12-2014	5.6	27.7	-	-
01-01-2015	3.8	31.5	-	-
02-01-2015	3.6	35.1	-	-
03-01-2015	3.4	38.5	-	-
04-01-2015	3.0	**41.5**	-	52.50
05-01-2015	3.6	5.1	-	-
06-01-2015	4.4	9.5	-	-
07-01-2015	4.6	14.3	-	-
08-01-2015	5.0	19.4	-	-
09-01-2015	5.8	25.2	-	-
10-01-2015	5.6	30.8	-	-
11-01-2015	4.7	35.6	-	-
12-01-2015	4.5	**40.3**	-	52.50
13-01-2015	4.8	5.1	-	-
14-01-2015	5.2	10.3	-	-
15-01-2015	4.7	15.0	-	-
16-01-2015	4.9	19.9	-	-

17-01-2015	4.5	24.4	-	-
18-01-2015	4.9	29.3	-	-
19-01-2015	4.6	33.9	-	-
20-01-2015	4.2	38.1	-	-
21-01-2015	4.4	**42.5**	-	52.50
22-01-2015	4.9	7.4	-	-
23-01-2015	4.0	11.4	-	-
24-01-2015	4.6	16.0	-	-
25-01-2015	4.5	20.5	-	-
26-01-2015	4.2	24.7	-	-
27-01-2015	4.8	29.5	-	-
28-01-2015	4.5	34.0	-	-
29-01-2015	5.2	39.2	-	-
30-01-2015	4.7	**43.9**	-	52.50
31-01-2015	5.6	9.5	-	-
01-02-2015	4.9	14.4	-	-
02-02-2015	5.8	20.2	-	-
03-02-2015	5.6	25.8	-	-
04-02-2015	5.2	31.0	-	-
05-02-2015	5.8	36.8	-	-
06-02-2015	6.0	**42.8**	-	52.50
07-02-2015	5.6	8.4	-	-
08-02-2015	5.7	14.1	-	-
09-02-2015	6.2	20.3	-	-
10-02-2015	5.9	26.2	-	-
11-02-2015	5.6	31.8	-	-
12-02-2015	5.2	37.0	-	-
13-02-2015	5.9	**42.9**	-	52.50
14-02-2015	6.3	9.2	-	-
15-02-2015	6.5	15.7	-	-
16-02-2015	6.6	22.3	-	-
17-02-2015	6.8	29.1	-	-
18-02-2015	7.1	36.2	-	-
19-02-2015	6.5	**42.7**	-	52.50
20-02-2015	7.4	10.1	-	-
21-02-2015	6.8	16.9	-	-
22-02-2015	7.0	23.9	-	-
23-02-2015	6.9	30.8	-	-
24-02-2015	7.2	38.0	-	-
25-02-2015	6.8	**44.8**	-	52.50
26-02-2015	7.6	12.4	-	-
27-02-2015	7.0	19.4	-	-
28-02-2015	6.6	26.0	-	-
01-03-2015	5.8	31.8	-	-
02-03-2015	1.9	33.7	-	-
03-03-2015	5.2	38.9	-	-
04-03-2015	5.6	**44.5**	-	52.50
05-03-2015	5.4	9.9	-	-

06-03-2015	5.9	15.8	-	-
07-03-2015	6.4	22.2	-	-
08-03-2015	6.0	28.2	-	-
09-03-2015	5.8	34.0	-	-
10-03-2015	6.2	**40.2**	-	52.50
11-03-2015	4.8	5.0	-	-
12-03-2015	5.6	10.6	-	-
13-03-2015	6.4	17.0	-	-
14-03-2015	5.4	22.4	-	-
15-03-2015	5.9	28.3	-	-
16-03-2015	6.5	34.8	-	-
17-03-2015	5.6	40.4	-	-
18-03-2015	6.0	46.4	-	-
19-03-2015	6.4	**52.8**	-	65.63
20-03-2015	6.2	9.0	-	-
21-03-2015	6.8	15.8	-	-
22-03-2015	6.5	22.3	-	-
23-03-2015	6.6	28.9	-	-
24-03-2015	7.0	35.9	-	-
25-03-2015	7.4	43.3	-	-
26-03-2015	7.8	**51.1**	-	65.63
27-03-2015	7.5	8.6	-	-
28-03-2015	7.9	16.5	-	-
29-03-2015	8.4	24.9	-	-
30-03-2015	7.2	32.1	-	-
31-03-2015	6.8	38.9	-	-
01-04-2015	7.6	46.5	-	-
02-04-2015	8.0	**54.5**	-	65.63
03-04-2015	8.4	12.9	-	-
04-04-2015	7.8	20.7	-	-
05-04-2015	7.5	28.2	-	-
06-04-2015	8.2	36.4	-	-
07-04-2015	7.4	43.8	-	-
08-04-2015	7.2	**51.0**	-	65.63
09-04-2015	7.0	8.0	-	-
10-04-2015	7.6	15.6	-	-
11-04-2015	6.4	22.0	-	-
12-04-2015	6.0	23.0	5.0	-
13-04-2015	6.8	29.8	-	-
14-04-2015	5.9	35.7	-	-
15-04-2015	6.5	42.2	-	-
16-04-2015	6.8	49.0	-	-
17-04-2015	5.8	**54.8**	-	65.63
18-04-2015	6.6	11.4	-	-
19-04-2015	7.4	18.8	-	-
20-04-2015	7.8	26.6	-	-
21-04-2015	8.0	34.6	-	-
22-04-2015	7.6	42.2	-	-

23-04-2015	7.6	**49.8**	-	65.63
24-04-2015	8.0	8.0	-	-
25-04-2015	8.4	16.4	-	-
26-04-2015	8.5	24.9	-	-
27-04-2015	8.8	33.7	-	-
28-04-2015	8.0	41.7	-	-
29-04-2015	8.6	**50.3**	-	65.63
30-04-2015	8.2	8.5	-	-
01-05-2015	8.6	17.1	-	-
02-05-2015	9.5	26.6	-	-
03-05-2015	9.8	36.4	-	-
04-05-2015	9.6	46.0	-	-
05-05-2015	9.2	**55.2**	-	65.63
06-05-2015	8.8	14.0	-	-
07-05-2015	9.4	23.4	-	-
08-05-2015	9.0	32.4	-	-
09-05-2015	9.6	42.0	-	-
10-05-2015	9.2	**51.2**	-	65.63
11-05-2015	8.6	9.8	-	-
12-05-2015	10.0	20.2	-	-
13-05-2015	9.0	21.2	8.0	-
14-05-2015	8.2	29.4	-	-
15-05-2015	7.5	36.9	-	-
16-05-2015	8.2	45.1	-	-
17-05-2015	9.6	**54.7**	-	65.63
18-05-2015	9.0	13.7	-	-
19-05-2015	9.6	23.3	-	-
20-05-2015	10.0	33.7	-	-
21-05-2015	11.0	44.9	-	-
22-05-2015	12.0	**56.7**	-	65.63
23-05-2015	12.0	19.1	-	-
24-05-2015	12.0	30.7	-	-
25-05-2015	12.0	42.7	-	-
26-05-2015	11.0	**53.7**	-	65.63
27-05-2015	11.0	15.1	-	-
28-05-2015	12.0	26.9	-	-
29-05-2015	8.8	35.7	-	-
30-05-2015	8.8	41.5	8.0	-
31-05-2015	8.4	**49.9**	-	65.63
01-06-2015	7.6	10.5	-	-
02-06-2015	8.0	18.5	-	-
03-06-2015	8.5	27.0	-	-
04-06-2015	8.8	35.8	-	-
05-06-2015	8.6	38.2	6.2	-
06-06-2015	7.8	46.0	-	-
07-06-2015	8.2	**54.2**	-	65.63
08-06-2015	6.8	4.6	6.4	-
09-06-2015	7.4	8.4	3.6	-

10-06-2015	6.2	8.4	6.2	-
11-06-2015	6.6	8.4	6.6	-
12-06-2015	7.4	15.8	6.4	-
13-06-2015	6.0	17.8	4.0	-
14-06-2015	4.8	22.6	-	-
15-06-2015	2.6	22.6	2.6	-
16-06-2015	2.4	22.6	2.5	-
17-06-2015	4.5	22.6	4.5	-
18-06-2015	5.6	28.2	-	-
19-06-2015	4.8	28.2	5.4	-
20-06-2015	4.2	32.4	-	-
21-06-2015	4.6	37.0	-	-
22-06-2015	4.0	41.0	-	-
23-06-2015	3.4	41.4	3.0	-
24-06-2015	3.8	45.2	-	-
25-06-2015	6.2	**51.4**	-	65.63
26-06-2015	6.8	8.2	-	-
27-06-2015	6.6	14.8	-	-
28-06-2015	7.2	22.0	-	-
29-06-2015	5.4	27.4	-	-
30-06-2015	7.6	35.0	-	-
01-07-2015	8.0	43.0	-	-
02-07-2015	7.8	**50.8**	-	65.63
03-07-2015	7.4	8.2	-	-
04-07-2015	6.8	15.0	-	-
05-07-2015	7.2	22.2	-	-
06-07-2015	7.6	29.8	-	-
07-07-2015	8.7	38.5	-	-
08-07-2015	8.0	46.5	-	-
09-07-2015	6.4	**52.9**	-	65.63
10-07-2015	7.0	9.9	-	-
11-07-2015	6.6	16.5	-	-
12-07-2015	7.4	23.9	-	-
13-07-2015	6.8	30.7	-	-
14-07-2015	8.0	38.7	-	-
15-07-2015	8.5	47.2	-	-
16-07-2015	8.8	**56.0**	-	65.63
17-07-2015	7.0	13.0	-	-
18-07-2015	6.4	19.4	-	-
19-07-2015	5.8	25.2	-	-
20-07-2015	4.4	29.6	-	-
21-07-2015	4.0	29.6	4.0	-
22-07-2015	4.4	29.6	4.4	-
23-07-2015	5.2	34.8	5.2	-
24-07-2015	4.8	39.6	-	-
25-07-2015	5.0	39.6	5.0	-
26-07-2015	4.0	43.6	3.4	-
27-07-2015	4.6	48.2	-	-

28-07-2015	5.5	**53.7**	-	65.63
29-07-2015	6.0	9.7	-	-
30-07-2015	6.2	15.9	-	-
31-07-2015	5.8	21.7	-	-
01-08-2015	6.6	28.3	-	-
02-08-2015	5.6	33.9	-	-
03-08-2015	5.4	39.3	-	-
04-08-2015	5.8	45.1	-	-
05-08-2015	4.2	45.1	4.2	-
06-08-2015	3.8	46.3	3.8	-
07-08-2015	3.2	49.5	3.2	-
08-08-2015	4.0	**53.5**	-	65.63
09-08-2015	4.4	7.9	-	-
10-08-2015	4.8	12.7	-	-
11-08-2015	6.0	18.7	-	-
12-08-2015	4.2	22.9	-	-
13-08-2015	4.0	26.9	-	-
14-08-2015	4.0	30.9	-	-
15-08-2015	4.8	35.7	-	-
16-08-2015	5.6	41.3	-	-
17-08-2015	6.2	47.5	-	-
18-08-2015	5.6	**53.1**	-	65.63
19-08-2015	5.8	8.9	-	-
20-08-2015	6.2	15.1	-	-
21-08-2015	6.8	21.9	-	-
22-08-2015	5.4	27.3	-	-
23-08-2015	6.0	33.3	-	-
24-08-2015	6.4	39.7	-	-
25-08-2015	6.8	46.5	-	-
26-08-2015	4.6	**51.1**	-	65.63
27-08-2015	5.2	6.3	-	-
28-08-2015	4.4	10.7	-	-
29-08-2015	4.5	15.2	-	-
30-08-2015	6.4	21.6	-	-
31-08-2015	6.0	27.6	-	-
01-09-2015	6.6	34.2	-	-
02-09-2015	6.8	41.0	-	-
03-09-2015	7.4	48.4	-	-
04-09-2015	7.0	**55.4**	-	65.63
05-09-2015	6.6	8.6	3.4	-
06-09-2015	6.0	14.6	-	-
07-09-2015	4.5	14.6	4.5	-
08-09-2015	4.2	14.6	4.2	-
09-09-2015	3.8	18.4	3.8	-
10-09-2015	4.0	18.0	4.0	-
11-09-2015	4.6	18.0	4.6	-
12-09-2015	5.4	18.0	5.4	-
13-09-2015	5.8	18.0	5.8	-

14-09-2015	4.6	18.0	4.6	-
15-09-2015	4.4	22.4	-	-
16-09-2015	4.0	26.4	-	-
17-09-2015	4.2	26.4	4.2	-
18-09-2015	3.8	26.4	3.8	-
19-09-2015	4.0	26.4	4.0	-
20-09-2015	4.4	26.4	4.4	-
21-09-2015	3.6	26.4	3.6	-
22-09-2015	4.8	31.2	-	-
23-09-2015	5.6	36.8	-	-
24-09-2015	5.8	42.6	-	-
25-09-2015	5.5	48.1	-	-
26-09-2015	6.2	**54.3**	-	65.63
27-09-2015	5.0	9.3	-	-
28-09-2015	6.0	15.3	-	-
29-09-2015	5.8	21.1	-	-
30-09-2015	6.4	27.5	-	-
01-10-2015	6.8	34.3	-	-
02-10-2015	6.0	36.3	4.0	-
03-10-2015	4.8	36.3	4.8	-
04-10-2015	4.5	36.3	4.5	-
05-10-2015	5.4	41.7	2.8	-
06-10-2015	6.0	47.7	-	-
07-10-2015	6.6	**54.3**	-	65.63
08-10-2015	6.2	10.5	-	-
09-10-2015	6.5	17.0	-	-
10-10-2015	6.0	23.0	-	-
11-10-2015	6.8	29.8	-	-
12-10-2015	5.4	35.2	-	-
13-10-2015	5.8	41.0	-	-
14-10-2015	7.2	48.2	-	-
15-10-2015	7.5	**55.7**	-	65.63
16-10-2015	6.8	12.5	-	-
17-10-2015	7.8	20.3	-	-
18-10-2015	5.8	26.1	-	-
19-10-2015	6.4	32.5	-	-
20-10-2015	7.0	39.5	-	-
21-10-2015	6.6	46.1	-	-
22-10-2015	5.8	**51.9**	-	65.63
23-10-2015	6.5	8.4	-	-
24-10-2015	6.8	15.2	-	-
25-10-2015	6.2	21.4	-	-
26-10-2015	5.4	26.8	-	-
27-10-2015	5.8	32.6	-	-
28-10-2015	5.0	37.6	-	-
29-10-2015	4.6	42.2	-	-
30-10-2015	4.5	46.7	-	-
31-10-2015	4.8	**51.5**	-	65.63

01-11-2015	5.4	6.9	-	-
02-11-2015	6.0	12.9	-	-
03-11-2015	5.8	18.7	-	-
04-11-2015	5.2	23.9	-	-
05-11-2015	5.6	29.5	-	-
06-11-2015	5.0	34.5	-	-
07-11-2015	5.8	40.3	-	-
08-11-2015	5.5	45.8	-	-
09-11-2015	5.4	**51.2**	-	65.63
10-11-2015	5.6	6.8	-	-
11-11-2015	6.0	12.8	-	-
12-11-2015	6.4	19.2	-	-
13-11-2015	6.6	25.8	-	-
14-11-2015	6.8	32.6	-	-
15-11-2015	6.4	39.0	-	-
16-11-2015	6.2	45.2	-	-
17-11-2015	5.8	**51.0**	-	65.63
18-11-2015	6.4	7.4	-	-
19-11-2015	5.4	12.8	-	-
20-11-2015	5.0	17.8	-	-
21-11-2015	4.4	22.2	-	-
22-11-2015	5.6	27.8	-	-
23-11-2015	4.0	27.8	4.0	-
24-11-2015	3.0	27.8	3.0	-
25-11-2015	3.8	27.8	3.8	-
26-11-2015	3.6	27.8	3.6	-
27-11-2015	5.6	33.4	5.6	-
28-11-2015	6.4	39.8	-	-
29-11-2015	6.8	46.6	-	-
30-11-2015	5.8	**52.4**	-	65.63
01-12-2015	5.5	7.9	-	-
02-12-2015	4.8	12.7	-	-
03-12-2015	5.8	18.5	-	-
04-12-2015	6.2	24.7	-	-
05-12-2015	6.0	30.7	-	-
06-12-2015	5.6	36.3	-	-
07-12-2015	5.8	42.1	-	-
08-12-2015	5.4	47.5	-	-
09-12-2015	5.0	**52.5**	-	65.63
10-12-2015	5.6	8.1	-	-
11-12-2015	6.0	14.1	-	-
12-12-2015	5.4	19.5	-	-
13-12-2015	5.2	24.7	-	-
14-12-2015	6.4	31.1	-	-
15-12-2015	6.0	37.1	-	-

Appendix – D

Emission uniformity of drip irrigation system

Table D.1. Determination of field emission uniformity under various treatments

Treatments	R-I				R-II				R-III				Average EU, %
	Q min, lit hr^{-1}	Q max, lit hr^{-1}	Q avg., lit hr^{-1}	EU, %	Q min, lit hr^{-1}	Q max, lit hr^{-1}	Q avg., lit hr^{-1}	EU, %	Q min, lit hr^{-1}	Q max, lit hr^{-1}	Q avg., lit hr^{-1}	EU, %	
T_1 (YBPM, 48% Ep)	3.760	3.980	3.900	**97.20**	3.645	3.972	3.840	**95.80**	3.594	3.960	3.812	**95.26**	**96.08**
T_2 (BBPM, 48% Ep)	3.582	3.972	3.824	**94.98**	3.552	3.936	3.816	**95.06**	3.501	3.930	3.801	**94.40**	**94.81**
T_3 (SBPM, 48% Ep)	3.669	3.990	3.884	**95.93**	3.711	3.990	3.902	**96.44**	3.615	3.996	3.885	**95.17**	**95.84**
T_4 (WBPM, 48% Ep)	3.609	3.960	3.827	**95.48**	3.561	3.972	3.840	**94.71**	3.615	3.972	3.840	**95.41**	**95.20**
T_5 (RBPM, 48% Ep)	3.684	3.978	3.919	**96.25**	3.570	3.954	3.859	**95.03**	3.651	3.960	3.865	**96.01**	**95.76**
T_6 (PPM, 48% Ep)	3.633	3.954	3.868	**95.89**	3.696	3.948	3.885	**96.75**	3.681	3.960	3.856	**96.39**	**96.34**
T_7 (NM, 48% Ep)	3.576	3.960	3.849	**95.05**	3.630	3.942	3.867	**95.96**	3.609	3.936	3.837	**95.76**	**95.59**
T_8 (NM, 100% ETc)	3.576	3.924	3.840	**95.48**	3.558	3.918	3.850	**95.36**	3.570	3.948	3.868	**95.17**	**95.33**

Appendix – E

Statistical analysis of biometric observations of banana

Table E.1. Statistical analysis of plant height (cm) for different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	234.45	253.34	243.56	243.78
T_2 (BBPM, 48% Ep)	228.21	204.44	219.98	217.54
T_3 (SBPM, 48% Ep)	267.45	278.10	254.66	266.74
T_4 (WBPM, 48% Ep)	223.89	236.90	250.77	237.19
T_5 (RBPM, 48% Ep)	233.88	227.17	247.92	236.32
T_6 (PPM, 48% Ep)	241.00	251.32	265.44	252.59
T_7 (NM, 48% Ep)	210.88	203.23	194.00	202.70
T_8 (NM, 100% ETc)	216.99	204.23	190.56	203.93
T_9 (SI, 1 IW/CPE)	185.46	207.48	191.22	194.72
	G. Mean= 228.39	S.E.m±= 7.00	C.D. at 5%= 20.99	C.V. %= 5.31

Table E.2. Statistical analysis of number of leaves per plant for different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	13.00	12.00	15.00	13.33
T_2 (BBPM, 48% Ep)	12.00	12.25	12.00	12.08
T_3 (SBPM, 48% Ep)	14.25	16.00	12.00	14.08
T_4 (WBPM, 48% Ep)	13.25	12.50	13.00	12.92
T_5 (RBPM, 48% Ep)	12.00	12.50	13.00	12.50
T_6 (PPM, 48% Ep)	13.00	13.50	13.75	13.42
T_7 (NM, 48% Ep)	12.00	11.50	11.00	11.50
T_8 (NM, 100% ETc)	12.00	11.50	12.50	12.00
T_9 (SI, 1 IW/CPE)	11.00	10.50	11.00	10.83
	G. Mean= 12.52	S.E.m±= 0.56	C.D. at 5%= 1.67	C.V. %= 7.72

Table E.3. Statistical analysis of stem girth (cm) for different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	61.56	59.91	57.91	59.79
T_2 (BBPM, 48% Ep)	55.56	55.77	59.45	56.93
T_3 (SBPM, 48% Ep)	67.40	64.35	60.22	63.99
T_4 (WBPM, 48% Ep)	60.39	60.78	56.03	59.07
T_5 (RBPM, 48% Ep)	64.00	57.80	54.50	58.77
T_6 (PPM, 48% Ep)	62.50	67.00	61.00	63.50
T_7 (NM, 48% Ep)	53.00	49.75	55.91	52.89
T_8 (NM, 100% ETc)	51.45	53.91	57.00	54.12
T_9 (SI, 1 IW/CPE)	53.45	51.12	49.45	51.34
	G. Mean= 57.82	S.E.m±= 1.75	C.D. at 5%= 5.25	C.V. %= 5.24

Appendix – F

Statistical analysis of duration parameters of banana

Table F.1. Statistical analysis of days required for flowering of banana under different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	219.00	232.00	240.00	230.33
T_2 (BBPM, 48% Ep)	239.00	255.00	270.00	254.67
T_3 (SBPM, 48% Ep)	220.00	230.00	211.00	220.33
T_4 (WBPM, 48% Ep)	245.00	232.00	239.00	238.67
T_5 (RBPM, 48% Ep)	260.00	241.00	245.00	248.67
T_6 (PPM, 48% Ep)	224.00	240.00	213.00	225.67
T_7 (NM, 48% Ep)	264.00	277.00	250.00	263.67
T_8 (NM, 100% ETc)	270.00	249.00	260.00	259.67
T_9 (SI, 1 IW/CPE)	288.00	295.00	277.00	286.67
	G. Mean= 247.59	S.E.m±= 6.73	C.D. at 5%= 20.17	C.V. %= 4.71

Table F.2. Statistical analysis of total duration of banana under different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	344.00	337.00	360.00	347.00
T_2 (BBPM, 48% Ep)	357.00	380.00	366.00	367.67
T_3 (SBPM, 48% Ep)	320.00	345.00	305.00	323.33
T_4 (WBPM, 48% Ep)	366.00	339.00	353.00	352.67
T_5 (RBPM, 48% Ep)	377.00	339.00	370.00	362.00
T_6 (PPM, 48% Ep)	320.00	368.00	330.00	339.33
T_7 (NM, 48% Ep)	375.00	369.00	377.00	373.67
T_8 (NM, 100% ETc)	371.00	358.00	380.00	369.67
T_9 (SI, 1 IW/CPE)	377.00	385.00	371.00	377.67
	G. Mean= 357.00	S.E.m±= 9.35	C.D. at 5%= 28.03	C.V. %= 4.54

Appendix – G

Statistical analysis of yield parameters of banana

Table G.1. Statistical analysis of average bunch weight (kg)

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	21.50	20.45	22.75	21.57
T_2 (BBPM, 48% Ep)	18.19	20.28	19.10	19.19
T_3 (SBPM, 48% Ep)	24.47	27.90	25.20	25.86
T_4 (WBPM, 48% Ep)	19.43	22.33	20.50	20.75
T_5 (RBPM, 48% Ep)	18.50	21.10	19.93	19.84
T_6 (PPM, 48% Ep)	24.50	23.40	26.34	24.75
T_7 (NM, 48% Ep)	17.85	16.90	18.50	17.75
T_8 (NM, 100% ETc)	18.44	17.90	19.04	18.46
T_9 (SI, 1 IW/CPE)	16.45	15.90	16.33	16.23
	G. Mean= 20.49	S.E.m±= 0.66	C.D. at 5%= 1.99	C.V. %= 5.62

Table G.2. Statistical analysis of average number of hands per bunch

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	7.50	8.00	8.50	8.00
T_2 (BBPM, 48% Ep)	7.50	6.50	6.75	6.92
T_3 (SBPM, 48% Ep)	9.25	9.50	9.00	9.25
T_4 (WBPM, 48% Ep)	7.50	7.75	7.33	7.53
T_5 (RBPM, 48% Ep)	7.33	7.25	7.50	7.36
T_6 (PPM, 48% Ep)	8.50	7.75	9.00	8.42
T_7 (NM, 48% Ep)	6.00	6.50	6.00	6.17
T_8 (NM, 100% ETc)	6.50	6.75	6.50	6.58
T_9 (SI, 1 IW/CPE)	5.50	6.00	5.50	5.67
	G. Mean= 7.32	S.E.m±= 0.23	C.D. at 5%= 0.68	C.V. %= 5.33

Table G.3. Statistical analysis of average number of fingers per bunch

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	128.45	119.85	113.25	120.52
T_2 (BBPM, 48% Ep)	120.00	110.00	114.00	114.67
T_3 (SBPM, 48% Ep)	128.35	120.50	141.60	130.15
T_4 (WBPM, 48% Ep)	115.50	110.20	127.00	117.57
T_5 (RBPM, 48% Ep)	115.00	122.00	110.00	115.67
T_6 (PPM, 48% Ep)	125.50	134.00	120.00	126.50
T_7 (NM, 48% Ep)	108.00	116.00	102.00	108.67
T_8 (NM, 100% ETc)	111.00	112.50	114.00	112.50
T_9 (SI, 1 IW/CPE)	108.50	102.00	105.50	105.33
	G. Mean= 116.84	S.E.m±= 4.15	C.D. at 5%= 12.43	C.V. %= 6.15

Table G.4 Statistically analysis of average weight of fruit (g) for different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	177.00	185.00	195.00	185.67
T_2 (BBPM, 48% Ep)	155.00	147.00	160.00	154.00
T_3 (SBPM, 48% Ep)	196.00	190.00	215.00	200.33
T_4 (WBPM, 48% Ep)	175.00	164.00	185.00	174.67
T_5 (RBPM, 48% Ep)	170.00	160.00	155.00	161.67
T_6 (PPM, 48% Ep)	195.00	201.00	185.00	193.67
T_7 (NM, 48% Ep)	155.50	145.50	150.50	150.50
T_8 (NM, 100% ETc)	160.50	155.50	144.40	153.47
T_9 (SI, 1 IW/CPE)	138.50	145.00	153.00	145.50
	G. Mean= 168.83	S.E.m±= 5.02	C.D. at 5%= 15.04	C.V. %= 5.15

Table G.5. Statistical analysis of average length of fruit (cm) for different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	18.00	17.50	18.75	18.08
T_2 (BBPM, 48% Ep)	17.00	17.50	16.75	17.08
T_3 (SBPM, 48% Ep)	20.00	18.50	21.75	20.08
T_4 (WBPM, 48% Ep)	16.00	17.50	19.00	17.50
T_5 (RBPM, 48% Ep)	16.33	18.25	17.50	17.36
T_6 (PPM, 48% Ep)	18.10	18.33	18.75	18.39
T_7 (NM, 48% Ep)	15.75	17.50	16.25	16.50
T_8 (NM, 100% ETc)	17.00	16.50	16.75	16.75
T_9 (SI, 1 IW/CPE)	14.50	15.50	16.50	15.50
	G. Mean= 17.47	S.E.m±= 0.50	C.D. at 5%= 1.49	C.V. %= 4.93

Table G.6. Statistical analysis of average girth of fruit (cm) for different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	12.25	13.75	12.00	12.67
T_2 (BBPM, 48% Ep)	12.00	12.50	12.00	12.17
T_3 (SBPM, 48% Ep)	13.00	13.75	15.33	14.03
T_4 (WBPM, 48% Ep)	12.33	13.50	11.75	12.53
T_5 (RBPM, 48% Ep)	12.29	13.33	11.50	12.37
T_6 (PPM, 48% Ep)	13.33	14.00	12.50	13.28
T_7 (NM, 48% Ep)	11.50	12.00	11.25	11.58
T_8 (NM, 100% ETc)	11.50	12.00	12.00	11.83
T_9 (SI, 1 IW/CPE)	11.00	10.50	10.00	10.50
	G. Mean= 12.33	S.E.m±= 0.38	C.D. at 5%= 1.14	C.V. %= 5.33

Table G.7. Statistical analysis of average yield of banana (t ha^{-1}) for different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	70.00	76.00	66.00	70.67
T_2 (BBPM, 48% Ep)	63.00	60.34	67.50	63.61
T_3 (SBPM, 48% Ep)	84.45	83.30	85.60	84.45
T_4 (WBPM, 48% Ep)	70.90	64.00	69.40	68.10
T_5 (RBPM, 48% Ep)	65.40	62.50	69.50	65.80
T_6 (PPM, 48% Ep)	86.00	78.00	81.00	81.67
T_7 (NM, 48% Ep)	57.70	61.00	54.50	57.73
T_8 (NM, 100% ETc)	60.01	62.23	58.11	60.12
T_9 (SI, 1 IW/CPE)	56.00	53.00	50.00	53.00
	G. Mean= 67.24	S.E.m±= 2.04	C.D. at 5%= 6.11	C.V. %= 5.25

Appendix – H

Statistical analysis of quality parameters of banana

Table H.1. Statistical analysis of TSS of fruit (^{0} Brix) for different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	18.40	19.50	17.50	18.47
T_2 (BBPM, 48% Ep)	18.32	17.34	19.38	18.35
T_3 (SBPM, 48% Ep)	18.53	19.52	17.54	18.53
T_4 (WBPM, 48% Ep)	18.44	19.39	17.47	18.43
T_5 (RBPM, 48% Ep)	18.41	17.37	19.43	18.40
T_6 (PPM, 48% Ep)	18.55	19.50	17.46	18.50
T_7 (NM, 48% Ep)	18.27	18.25	18.30	18.27
T_8 (NM, 100% ETc)	18.33	18.30	18.28	18.30
T_9 (SI, 1 IW/CPE)	18.00	18.10	17.91	18.00
	G. Mean= 18.36	S.E.m±= 0.48	C.D. at 5%= N.S.	C.V. %= 4.56

Table H.2. Statistical analysis of acidity of fruit (%) for different treatments

Treatments	R-I	R-II	R-III	Mean
T_1 (YBPM, 48% Ep)	0.28	0.25	0.27	0.27
T_2 (BBPM, 48% Ep)	0.29	0.3	0.25	0.28
T_3 (SBPM, 48% Ep)	0.22	0.25	0.27	0.25
T_4 (WBPM, 48% Ep)	0.28	0.25	0.28	0.27
T_5 (RBPM, 48% Ep)	0.27	0.27	0.26	0.27
T_6 (PPM, 48% Ep)	0.25	0.27	0.24	0.25
T_7 (NM, 48% Ep)	0.27	0.28	0.25	0.27
T_8 (NM, 100% ETc)	0.25	0.28	0.27	0.27
T_9 (SI, 1 IW/CPE)	0.27	0.28	0.28	0.28
	G. Mean= 0.27	S.E.m±= 0.01	C.D. at 5%= N. S.	C.V. %= 6.67

Appendix- I

Periodical data on plant height of banana

Table I.1. Plant height of banana 60 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	29	32	35	30	31.5	30	31	34	28	30.7	31	31	32	28	30.5	30.92
T_2 (BBPM, 48% Ep)	29	27	28	27	27.7	28	29	28	30	28.7	29	29	28	27	28.2	28.25
T_3 (SBPM, 48% Ep)	31	40	35	25	32.7	29	35	37	28	32.2	30	35	35	28	32.0	32.33
T_4 (WBPM, 48% Ep)	32	30	33	35	32.5	27	23	35	32	29.2	25	24	34	33	29.0	30.25
T_5 (RBPM, 48% Ep)	29	28	28	30	28.7	28	31	27.5	30	29.1	28	31	29	30	29.5	29.13
T_6 (PPM, 48% Ep)	40	15	38	30	30.7	35	29	32	31	31.7	33	29	33	31	31.5	31.33
T_7 (NM, 48% Ep)	18	30	31	20	24.7	20	25	32	22	24.7	21	24	31	22	24.5	24.67
T_8 (NM, 100% ETc)	24	30	20	32	26.5	25	25	23	31	26.0	25	27	24	30	26.5	26.33
T_9 (SI, 1 IW/CPE ratio)	23	20	23.5	19	21.3	23	21	22	20	21.5	23	21	21	20	21.2	21.38

Table I.2. Plant height of banana 120 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	122	120	117	109	117.0	121	120	108	115	116.0	120	120	108	116	116.0	116.33
T_2 (BBPM, 48% Ep)	103	110	107	114	108.5	102	101	115	107	106.3	102	100	115	109	106.5	107.10
T_3 (SBPM, 48% Ep)	140	130	144	129	135.8	141	138	123	139	135.3	141	138	123	139	135.3	135.46
T_4 (WBPM, 48% Ep)	120	112	125	108	116.3	108	115	125	114	115.5	108	117	125	114	116.0	115.93
T_5 (RBPM, 48% Ep)	112	114	120	115	115.3	113	114	110	115	113.0	113	115	120	115	115.8	114.70
T_6 (PPM, 48% Ep)	130	123	110	105	117.0	130	125	120	110	121.3	128	129	120	111	122.0	120.10
T_7 (NM, 48% Ep)	102	105	108	110	106.3	103	100	102	105	102.5	103	102	102	105	103.0	103.93
T_8 (NM, 100% ETc)	105	106	109	102	105.5	110	112	102	103	106.8	106	112	102	103	105.8	106.03
T_9 (SI, 1 IW/CPE ratio)	98	90	91	100	94.8	100	98	91	89	94.5	99	98	91	91	94.8	94.70

Table I.3. Plant height of banana 180 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	240	230	200	195	216.3	230	220	200	240	222.5	230	210	205	240	221.3	220.00
T_2 (BBPM, 48% Ep)	190	180	185	170	181.3	195	200	180	170	186.3	200	200	191	170	190.3	185.92
T_3 (SBPM, 48% Ep)	260	270	250	235	253.8	265	250	255	240	252.5	263	251	259	240	253.3	253.17
T_4 (WBPM, 48% Ep)	220	210	230	225	221.3	205	210	220	205	210.0	210	210	220	205	211.3	214.17
T_5 (RBPM, 48% Ep)	210	220	215	210	213.8	210	220	200	195	206.3	210	220	210	195	208.8	209.58
T_6 (PPM, 48% Ep)	220	210	200	240	217.5	230	225	235	225	228.8	225	225	230	230	227.5	224.58
T_7 (NM, 48% Ep)	180	190	175	170	178.8	195	175	150	160	170.0	199	173	150	155	169.3	172.67
T_8 (NM, 100% ETc)	180	185	175	185	181.3	185	175	190	170	180.0	185	185	190	170	182.5	181.25
T_9 (SI, 1 IW/CPE ratio)	150	155	145	160	152.5	155	160	165	140	155.0	160	160	165	150	158.8	155.42

Table I.4. Plant height of banana 240 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	250	240	230	225	236.3	240	230	210	250	232.5	240	230	220	245	233.8	234.17
T_2 (BBPM, 48% Ep)	210	200	215	195	205.0	210	230	190	195	206.3	205	230	210	195	210.0	207.08
T_3 (SBPM, 48% Ep)	270	275	260	245	262.5	275	260	265	255	263.8	275	261	265	260	265.3	263.83
T_4 (WBPM, 48% Ep)	230	235	240	235	235.0	220	230	240	230	230.0	221	230	245	230	231.5	232.17
T_5 (RBPM, 48% Ep)	225	230	235	230	230.0	220	235	215	210	220.0	220	230	215	220	221.3	223.75
T_6 (PPM, 48% Ep)	230	240	240	250	240.0	240	235	255	235	241.3	240	230	250	235	238.8	240.00
T_7 (NM, 48% Ep)	195	200	190	195	195.0	200	190	200	185	193.8	200	192	205	187	196.0	194.92
T_8 (NM, 100% ETc)	200	210	190	195	198.8	190	210	185	190	193.8	200	201	185	190	194.0	195.50
T_9 (SI, 1 IW/CPE ratio)	180	170	170	185	176.3	175	185	195	165	180.0	181	185	195	170	182.8	179.67

Table I.5. Plant height of banana 300 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	260	250	240	230	245.0	245	235	220	260	240.0	245	240	235	255	243.7	242.92
T_2 (BBPM, 48% Ep)	215	210	220	210	213.8	215	235	200	200	212.5	210	235	215	210	217.5	214.58
T_3 (SBPM, 48% Ep)	275	280	265	250	267.5	276	265	265	260	266.5	277	261	266	260	266.1	266.71
T_4 (WBPM, 48% Ep)	235	240	242	238	238.8	225	232	245	235	234.3	225	235	250	240	237.5	236.83
T_5 (RBPM, 48% Ep)	230	240	245	245	240.0	225	240	220	220	226.3	235	245	230	235	236.2	234.17
T_6 (PPM, 48% Ep)	245	255	260	260	255.0	250	240	260	250	250.0	245	255	260	250	252.5	252.50
T_7 (NM, 48% Ep)	200	201	195	197	198.3	205	200	205	196	201.5	205	200	210	195	202.5	200.75
T_8 (NM, 100% ETc)	210	215	200	205	207.5	200	215	197	200	203.0	205	210	200	200	203.7	204.75
T_9 (SI, 1 IW/CPE ratio)	185	180	180	195	185.0	185	195	205	177	190.5	190	200	210	180	195.0	190.17

Table I.6. Plant height of banana at first harvest (320 DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	260	251	240	231	245.5	246	237	221	260	241.0	245	241	236	257	244.7	243.78
T_2 (BBPM, 48% Ep)	215	212	222	211	215.0	217	235	209	206	216.7	215	237	218	213	220.7	217.54
T_3 (SBPM, 48% Ep)	275	280	265	251	267.7	276	265	265	260	266.5	277	261	266	260	266.1	266.71
T_4 (WBPM, 48% Ep)	235	240	242	238	238.8	227	233	245	237	235.5	225	235	250	240	237.5	237.19
T_5 (RBPM, 48% Ep)	230	240	245	245	240.0	229	244	225	223	230.3	237	246	232	239	238.5	236.32
T_6 (PPM, 48% Ep)	245	255	260	260	255.0	250	240	260	250	250.0	245	255	260	251	252.7	252.59
T_7 (NM, 48% Ep)	202	203	198	200	200.7	207	202	209	198	204.0	207	202	210	195	203.5	202.70
T_8 (NM, 100% ETc)	209	214	200	203	206.5	198	214	197	200	202.2	203	209	200	200	203.0	203.93
T_9 (SI, 1 IW/CPE ratio)	189	188	191	195	190.7	191	195	205	185	194.0	194	202	210	191	199.2	194.72

Table I.7. Plant height of banana at second harvest (362 DAT)

Treatments	R-I					R-II					R-III					Average
	1	**2**	**3**	**4**	**Avg.**	**1**	**2**	**3**	**4**	**Avg.**	**1**	**2**	**3**	**4**	**Avg.**	
T_1 (YBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2 (BBPM, 48% Ep)	215	212	222	211	215.0	217	235	209	206	216.7	215	236	218	213	220.5	217.41
T_3 (SBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_4 (WBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_5 (RBPM, 48% Ep)	230	240	245	245	240.0	229	244	225	223	230.3	237	245	232	239	238.2	236.16
T_6 (PPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_7 (NM, 48% Ep)	202	203	198	200	200.7	207	202	209	198	204.0	207	202	210	195	203.5	202.70
T_8 (NM, 100% ETc)	209	214	200	203	206.5	198	214	197	200	202.2	203	209	200	200	203.0	203.93
T_9 (SI, 1 IW/CPE ratio)	189	188	191	194	190.5	191	195	205	185	194.0	194	202	210	191	199.2	194.58

Table I.8. Plant height of banana at third harvest (377 DAT)

Treatments	R-I					R-II					R-III					Average
	1	**2**	**3**	**4**	**Avg.**	**1**	**2**	**3**	**4**	**Avg.**	**1**	**2**	**3**	**4**	**Avg.**	
T_1 (YBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2 (BBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_3 (SBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_4 (WBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_5 (RBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_6 (PPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_7 (NM, 48% Ep)	202	203	198	200	200.7	207	202	209	198	204.0	207	202	210	195	203.5	202.70
T_8 (NM, 100% ETc)	209	214	200	203	206.5	198	214	197	200	202.2	203	209	200	200	203.0	203.93
T_9 (SI, 1 IW/CPE ratio)	189	188	191	194	190.5	191	195	205	185	194.0	194	202	210	191	199.2	194.58

Appendix- J

Periodical data on stem girth of banana

Table J.1. Stem girth of banana 60 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	8.0	7.0	7.5	9.0	7.9	7.0	8.0	9.0	8.5	8.1	7.0	8.0	9.0	9.0	8.3	8.08
T_2 (BBPM, 48% Ep)	6.5	5.5	3.5	5.0	5.1	6.0	7.0	6.0	4.0	5.8	8.0	7.0	6.0	4.0	6.3	5.71
T_3 (SBPM, 48% Ep)	7.5	10.5	4.5	9.5	8.0	8.0	10.0	9.0	9.0	9.0	9.0	10.0	9.0	10.0	9.5	8.83
T_4 (WBPM, 48% Ep)	10.0	9.0	6.5	5.0	7.6	9.0	8.0	6.0	7.0	7.5	9.0	8.0	8.0	7.0	8.0	7.71
T_5 (RBPM, 48% Ep)	6.0	6.0	8.5	7.0	6.9	5.0	7.0	8.0	7.0	6.8	8.0	7.0	8.0	7.0	7.5	7.04
T_6 (PPM, 48% Ep)	8.0	7.0	10.0	7.5	8.1	7.0	8.0	9.0	10.0	8.5	8.0	8.0	9.0	11.0	9.0	8.54
T_7 (NM, 48% Ep)	5.0	5.0	5.0	5.0	5.0	5.0	3.0	4.0	6.0	4.5	6.0	3.0	4.0	7.0	5.0	4.83
T_8 (NM, 100% ETc)	5.0	5.0	4.0	5.0	4.8	5.0	4.0	5.0	6.0	5.0	5.0	4.0	5.0	5.0	4.8	4.83
T_9 (SI, 1 IW/CPE ratio)	5.0	3.5	4.0	5.0	4.4	4.0	4.5	5.0	6.0	4.9	4.0	6.0	5.0	6.0	5.3	4.81

Table J.2. Stem girth of banana 120 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	28.0	29.0	30.0	27.0	28.5	31.0	32.0	27.0	25.0	28.8	30.0	35.0	27.0	30.0	30.5	29.25
T_2 (BBPM, 48% Ep)	25.0	21.0	22.5	23.0	22.9	25.0	27.0	23.5	22.5	24.5	27.0	27.0	25.0	22.0	25.3	24.21
T_3 (SBPM, 48% Ep)	32.0	34.0	31.0	29.5	31.6	32.0	37.5	34.0	30.0	33.4	34.0	37.0	34.0	32.0	34.3	33.08
T_4 (WBPM, 48% Ep)	30.0	28.0	28.5	29.0	28.9	30.0	25.5	30.5	31.0	29.3	30.0	27.0	30.0	31.0	29.5	29.21
T_5 (RBPM, 48% Ep)	24.0	27.0	24.5	25.0	25.1	23.5	24.5	25.0	27.0	25.0	27.0	28.0	29.0	33.0	29.3	26.46
T_6 (PPM, 48% Ep)	32.0	36.0	33.0	29.5	32.6	31.0	32.0	29.0	28.5	30.1	34.0	34.0	33.0	30.0	32.8	31.83
T_7 (NM, 48% Ep)	23.0	24.0	23.0	23.0	23.3	24.0	21.5	22.5	23.0	22.8	24.0	22.0	22.0	21.0	22.3	22.75
T_8 (NM, 100% ETc)	22.0	24.5	23.0	21.5	22.8	22.0	23.0	23.0	27.5	23.9	23.0	23.0	25.0	26.0	24.3	23.63
T_9 (SI, 1 IW/CPE ratio)	22.0	20.0	19.0	21.0	20.5	22.0	21.0	21.5	24.0	22.1	22.0	23.0	22.0	24.0	22.8	21.79

Table J.3. Stem girth of banana 180 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	53.0	50.0	55.0	54.0	53.0	52.0	51.0	44.0	59.0	51.5	51.0	51.0	45.0	58.0	51.3	51.92
T_2 (BBPM, 48% Ep)	46.0	45.0	43.0	50.0	46.0	44.0	49.0	50.0	42.0	46.3	45.0	48.0	51.0	43.0	46.8	46.33
T_3 (SBPM, 48% Ep)	57.0	59.0	60.0	55.0	57.8	61.0	58.0	56.0	54.0	57.3	60.0	59.0	57.0	54.0	57.5	57.50
T_4 (WBPM, 48% Ep)	50.0	45.0	50.0	55.0	50.0	50.0	55.0	45.0	40.0	47.5	51.0	54.0	48.0	42.0	48.8	48.75
T_5 (RBPM, 48% Ep)	51.0	50.0	51.0	45.0	49.3	44.0	43.0	50.0	49.0	46.5	48.0	49.0	50.0	49.0	49.0	48.25
T_6 (PPM, 48% Ep)	52.0	55.0	55.0	59.0	55.3	50.0	53.0	55.0	58.0	54.0	53.0	55.0	56.0	59.0	55.8	55.00
T_7 (NM, 48% Ep)	43.0	45.0	40.0	35.0	40.8	45.0	42.0	38.0	35.0	40.0	45.0	45.0	40.0	34.0	41.0	40.58
T_8 (NM, 100% ETc)	42.0	45.0	40.0	35.0	40.5	43.0	44.0	42.0	40.0	42.3	43.0	41.0	42.0	40.0	41.5	41.42
T_9 (SI, 1 IW/CPE ratio)	30.0	35.0	34.0	28.0	31.8	34.0	33.0	34.0	36.0	34.3	35.0	34.0	34.0	36.0	34.8	33.58

Table J.4. Stem girth of banana 240 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	57.0	59.0	60.0	55.0	57.8	55.0	56.0	58.0	59.0	57.0	60.0	56.0	58.0	59.0	58.3	57.67
T_2 (BBPM, 48% Ep)	59.0	55.0	53.0	54.0	55.3	54.0	55.0	53.0	51.0	53.3	54.0	55.0	53.0	59.0	55.3	54.58
T_3 (SBPM, 48% Ep)	60.0	62.0	64.0	60.0	61.5	63.0	59.0	59.0	60.0	60.3	63.0	59.0	61.0	60.0	60.8	60.83
T_4 (WBPM, 48% Ep)	58.0	59.0	58.0	59.0	58.5	55.5	51.0	55.0	60.0	55.4	56.0	58.0	55.0	60.0	57.3	57.04
T_5 (RBPM, 48% Ep)	57.0	55.0	59.0	60.0	57.8	60.0	55.0	57.0	52.0	56.0	59.0	55.0	57.0	55.0	56.5	56.75
T_6 (PPM, 48% Ep)	58.0	59.0	57.0	61.0	58.8	58.0	60.0	61.0	59.0	59.5	58.0	60.0	61.0	64.0	60.8	59.67
T_7 (NM, 48% Ep)	50.0	52.0	49.0	48.0	49.8	51.0	50.0	48.0	52.0	50.3	51.0	50.0	48.0	54.0	50.8	50.25
T_8 (NM, 100% ETc)	50.0	55.0	51.0	47.0	50.8	51.0	52.0	55.0	50.0	52.0	51.0	52.0	49.0	50.0	50.5	51.08
T_9 (SI, 1 IW/CPE ratio)	45.0	47.0	45.0	40.0	44.3	45.0	50.0	45.0	43.0	45.8	50.0	50.0	45.0	48.0	48.3	46.08

Table J.5. Stem girth of banana 300 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	59.0	60.0	61.0	62.0	60.5	62.0	59.0	59.0	55.0	58.8	60.0	59.0	59.0	59.0	59.3	59.50
T_2 (BBPM, 48% Ep)	60.0	55.0	54.0	55.0	56.0	57.0	60.0	55.0	52.0	56.0	55.0	57.0	56.0	60.0	57.0	56.33
T_3 (SBPM, 48% Ep)	63.0	63.0	64.0	62.0	63.0	64.0	60.0	59.0	62.0	61.3	65.0	64.0	65.0	63.0	64.3	62.83
T_4 (WBPM, 48% Ep)	58.0	59.0	61.0	56.0	58.5	56.0	59.0	60.0	62.0	59.3	61.0	57.0	59.0	59.0	59.0	58.92
T_5 (RBPM, 48% Ep)	58.0	60.0	58.0	59.0	58.8	57.0	55.0	56.0	61.0	57.3	58.0	60.0	60.0	62.0	60.0	58.67
T_6 (PPM, 48% Ep)	59.0	60.0	58.0	63.0	60.0	60.0	63.0	65.0	62.0	62.5	60.0	65.0	65.0	66.0	64.0	62.17
T_7 (NM, 48% Ep)	52.0	56.0	52.0	48.0	52.0	55.0	53.0	55.0	52.0	53.8	55.0	53.0	50.0	54.0	53.0	52.92
T_8 (NM, 100% ETc)	52.0	55.0	50.0	51.0	52.0	52.0	55.0	50.0	55.0	53.0	55.0	53.0	54.0	56.0	54.5	53.17
T_9 (SI, 1 IW/CPE ratio)	48.0	50.0	48.0	46.0	48.0	49.0	55.0	52.0	50.0	51.5	55.0	54.0	50.0	50.0	52.3	50.58

Table J.6. Stem girth of banana at first harvest (320 DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	59.0	60.0	61.0	62.0	60.5	62.0	59.0	59.0	58.0	59.5	60.0	59.0	59.0	59.0	59.3	59.79
T_2 (BBPM, 48% Ep)	60.0	55.0	54.0	55.0	56.0	57.0	60.0	55.0	52.0	56.0	58.0	59.0	58.0	60.0	58.7	56.93
T_3 (SBPM, 48% Ep)	63.0	63.0	64.0	63.0	63.2	64.0	63.0	64.0	63.0	63.5	65.0	64.0	65.0	66.0	65.0	63.99
T_4 (WBPM, 48% Ep)	58.0	59.0	61.0	56.0	58.5	56.0	59.0	60.0	62.0	59.3	61.0	57.0	60.0	60.0	59.5	59.07
T_5 (RBPM, 48% Ep)	58.0	60.0	58.0	59.0	58.8	57.0	56.0	56.0	61.0	57.5	58.0	60.0	60.0	62.0	60.0	58.77
T_6 (PPM, 48% Ep)	61.0	63.0	62.0	63.0	62.2	63.0	64.0	65.0	63.0	63.7	62.0	65.0	65.0	66.0	64.5	63.50
T_7 (NM, 48% Ep)	52.0	56.0	52.0	48.0	52.0	55.0	53.0	55.0	52.0	53.8	54.0	53.0	50.0	54.0	52.7	52.89
T_8 (NM, 100% ETc)	52.0	55.0	53.0	52.0	53.0	54.0	55.0	53.0	55.0	54.2	55.0	55.0	54.0	56.0	55.0	54.12
T_9 (SI, 1 IW/CPE ratio)	48.0	50.0	48.0	49.0	48.7	51.0	56.0	53.0	52.0	53.0	55.0	54.0	50.0	50.0	52.3	51.34

Table J.7. Stem girth of banana at second harvest (362 DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2 (BBPM, 48% Ep)	60.0	55.0	54.0	55.0	56.0	57.0	60.0	55.0	52.0	56.0	58.0	59.0	58.0	60.0	58.7	56.93
T_3 (SBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_4 (WBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_5 (RBPM, 48% Ep)	58.0	60.0	58.0	59.0	58.8	57.0	56.0	56.0	61.0	57.5	58.0	60.0	60.0	62.0	60.0	58.77
T_6 (PPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_7 (NM, 48% Ep)	52.0	56.0	52.0	48.0	52.0	55.0	53.0	55.0	52.0	53.8	54.0	53.0	50.0	54.0	52.7	52.89
T_8 (NM, 100% ETc)	52.0	55.0	53.0	52.0	53.0	54.0	55.0	53.0	55.0	54.2	55.0	55.0	54.0	56.0	55.0	54.12
T_9 (SI, 1 IW/CPE ratio)	48.0	50.0	48.0	49.0	48.7	51.0	54.0	53.0	52.0	52.5	55.0	54.0	50.0	50.0	52.3	51.17

Table J.8. Stem girth of banana at third harvest (377 DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2 (BBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_3 (SBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_4 (WBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_5 (RBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_6 (PPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_7 (NM, 48% Ep)	52.0	56.0	52.0	48.0	52.0	55.0	53.0	55.0	52.0	53.8	54.0	53.0	50.0	54.0	52.7	52.89
T_8 (NM, 100% ETc)	52.0	55.0	53.0	52.0	53.0	54.0	55.0	53.0	55.0	54.2	55.0	55.0	54.0	56.0	55.0	54.12
T_9 (SI, 1 IW/CPE ratio)	48.0	50.0	48.0	49.0	48.7	51.0	54.0	53.0	52.0	52.5	55.0	54.0	50.0	50.0	52.3	51.17

Appendix- K

Periodical data on number of leaves of banana

Table K.1. Number of leaves of banana 60 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	10	9	10	8	9.3	9	7	11	8	8.8	8	8	10	8	8.5	8.83
T_2 (BBPM, 48% Ep)	8	7	8	8	7.8	9	9	7	8	8.3	9	9	8	8	8.5	8.17
T_3 (SBPM, 48% Ep)	11	10	7	11	9.8	11	11	8	7	9.3	10	11	8	9	9.5	9.50
T_4 (WBPM, 48% Ep)	9	9	7	8	8.3	10	9	9	8	9.0	10	9	9	9	9.3	8.83
T_5 (RBPM, 48% Ep)	8	9	9	8	8.5	9	9	8	7	8.3	9	9	8	8	8.5	8.42
T_6 (PPM, 48% Ep)	9	10	8	12	9.8	9	9	11	8	9.3	9	9	10	8	9.0	9.33
T_7 (NM, 48% Ep)	7	7	8	6	7.0	8	7	7	9	7.8	8	7	8	7	7.5	7.42
T_8 (NM, 100% ETc)	7	11	9	7	8.5	7	10	7	7	7.8	8	9	7	8	8.0	8.08
T_9 (SI, 1 IW/CPE ratio)	4	5	7	6	5.5	6	8	5	5	6.0	6	8	5	6	6.3	5.92

Table K.2. Number of leaves of banana 120 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	10	12	10	10	10.5	11	12	10	10	10.8	11	12	10	11	11.0	10.75
T_2 (BBPM, 48% Ep)	9	12	10	10	10.3	9	11	9	10	9.8	11	11	9	9	10.0	10.00
T_3 (SBPM, 48% Ep)	12	13	11	10	11.5	12	12	12	11	11.8	11	11	12	11	11.3	11.50
T_4 (WBPM, 48% Ep)	13	11	8	12	11.0	12	12	9	9	10.5	12	12	9	10	10.8	10.75
T_5 (RBPM, 48% Ep)	10	11	10	10	10.3	11	10	10	11	10.5	11	10	10	10	10.3	10.33
T_6 (PPM, 48% Ep)	10	11	10	13	11.0	10	10	12	11	10.8	12	10	11	11	11.0	10.92
T_7 (NM, 48% Ep)	9	8	9	8	8.5	10	9	9	9	9.3	10	8	9	9	9.0	8.92
T_8 (NM, 100% ETc)	10	10	9	8	9.3	10	11	9	8	9.5	10	10	9	9	9.5	9.42
T_9 (SI, 1 IW/CPE ratio)	9	8	7	8	8.0	8	8	10	9	8.8	8	9	10	9	9.0	8.58

Table K.3. Number of leaves of banana 180 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	16	15	15	14	15.0	16	16	14	15	15.3	15	15	14	15	14.8	15.00
T_2 (BBPM, 48% Ep)	15	12	13	14	13.5	14	14	13	13	13.5	14	13	13	13	13.3	13.42
T_3 (SBPM, 48% Ep)	15	14	16	17	15.5	17	17	15	14	15.8	15	16	15	14	15.0	15.42
T_4 (WBPM, 48% Ep)	14	15	16	16	15.3	15	14	16	14	14.8	15	14	15	14	14.5	14.83
T_5 (RBPM, 48% Ep)	14	13	14	15	14.0	14	13	13	14	13.5	14	15	14	14	14.3	13.92
T_6 (PPM, 48% Ep)	15	15	17	15	15.5	14	15	16	16	15.3	14	15	15	15	14.8	15.17
T_7 (NM, 48% Ep)	13	12	12	12	12.3	13	13	13	12	12.8	13	13	12	12	12.5	12.50
T_8 (NM, 100% ETc)	12	13	14	13	13.0	12	13	14	14	13.3	12	13	14	13	13.0	13.08
T_9 (SI, 1 IW/CPE ratio)	14	13	12	12	12.8	13	12	12	13	12.5	13	12	11	12	12.0	12.42

Table K.4. Number of leaves of banana 240 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	15	15	15	14	14.8	15	15	14	14	14.5	15	15	14	15	14.75	14.67
T_2 (BBPM, 48% Ep)	14	12	13	14	13.3	14	14	13	13	13.5	14	14	14	13	13.75	13.50
T_3 (SBPM, 48% Ep)	15	14	15	15	14.8	16	15	15	14	15.0	15	15	15	14	14.75	14.83
T_4 (WBPM, 48% Ep)	14	15	15	15	14.8	15	14	14	14	14.3	15	14	14	15	14.5	14.50
T_5 (RBPM, 48% Ep)	14	13	14	14	13.8	14	13	13	14	13.5	14	14	15	14	14.25	13.83
T_6 (PPM, 48% Ep)	14	14	15	15	14.5	14	15	15	15	14.8	15	15	15	15	15	14.75
T_7 (NM, 48% Ep)	12	13	12	13	12.5	12	13	13	13	12.8	12	14	13	12	12.75	12.67
T_8 (NM, 100% ETc)	13	12	12	12	12.3	13	13	13	12	12.8	13	13	13	13	13	12.67
T_9 (SI, 1 IW/CPE ratio)	13	13	12	12	12.5	13	12	12	13	12.5	13	12	12	12	12.25	12.42

Table K.5. Number of leaves of banana 300 days after transplanting (DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	15	16	15	14	15.0	15	15	15	14	14.8	15	15	15	15	15.0	14.92
T_2 (BBPM, 48% Ep)	14	12	13	14	13.3	14	14	13	13	13.5	14	13	14	13	13.5	13.42
T_3 (SBPM, 48% Ep)	15	16	15	15	15.3	16	15	16	15	15.5	15	15	15	16	15.3	15.33
T_4 (WBPM, 48% Ep)	14	15	16	15	15.0	15	14	14	14	14.3	15	15	14	15	14.8	14.67
T_5 (RBPM, 48% Ep)	14	13	14	14	13.8	14	13	13	13	13.3	14	15	15	14	14.5	13.83
T_6 (PPM, 48% Ep)	15	15	15	15	15.0	15	15	16	15	15.3	15	16	16	15	15.5	15.25
T_7 (NM, 48% Ep)	13	12	12	13	12.5	13	13	13	12	12.8	13	12	13	13	12.8	12.67
T_8 (NM, 100% ETc)	14	13	12	13	13.0	13	13	12	13	12.8	13	12	13	12	12.5	12.75
T_9 (SI, 1 IW/CPE ratio)	12	13	12	13	12.5	12	13	12	13	12.5	12	13	13	12	12.5	12.50

Table K.6. Number of leaves of banana at first harvest (320 DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	13	14	13	13	13.3	14	13	13	13	13.3	14	14	13	13	13.5	13.33
T_2 (BBPM, 48% Ep)	12	11	12	12	11.8	12	12	12	13	12.3	12	13	12	12	12.3	12.08
T_3 (SBPM, 48% Ep)	14	14	15	13	14.0	14	15	14	15	14.5	15	13	13	14	13.8	14.08
T_4 (WBPM, 48% Ep)	12	12	13	13	12.5	13	14	12	14	13.3	13	14	12	13	13.0	12.92
T_5 (RBPM, 48% Ep)	12	13	12	12	12.3	12	13	13	13	12.8	14	12	12	12	12.5	12.50
T_6 (PPM, 48% Ep)	14	13	13	14	13.5	13	15	13	13	13.5	12	13	13	15	13.3	13.42
T_7 (NM, 48% Ep)	12	12	12	11	11.8	12	11	11	12	11.5	11	12	11	11	11.3	11.50
T_8 (NM, 100% ETc)	12	13	12	11	12.0	13	13	12	13	12.8	11	12	11	11	11.3	12.00
T_9 (SI, 1 IW/CPE ratio)	12	11	10	11	11.0	10	10	12	11	10.8	11	11	11	10	10.8	10.83

Table K.7. Number of leaves of banana at second harvest (362 DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2 (BBPM, 48% Ep)	12	11	11	12	11.5	12	12	12	13	12.3	12	13	12	12	12.3	12.00
T_3 (SBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_4 (WBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_5 (RBPM, 48% Ep)	12	12	12	12	12.0	12	13	13	13	12.8	14	12	12	12	12.5	12.42
T_6 (PPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_7 (NM, 48% Ep)	11	12	12	11	11.5	12	11	11	12	11.5	11	12	11	11	11.3	11.42
T_8 (NM, 100% ETc)	12	13	12	11	12.0	13	13	12	13	12.8	11	12	11	11	11.3	12.00
T_9 (SI, 1 IW/CPE ratio)	12	11	10	11	11.0	10	10	12	11	10.8	11	11	11	10	10.8	10.83

Table K.8. Number of leaves of banana at third harvest (377 DAT)

Treatments	R-I					R-II					R-III					Average
	1	2	3	4	Avg.	1	2	3	4	Avg.	1	2	3	4	Avg.	
T_1 (YBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2 (BBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_3 (SBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_4 (WBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_5 (RBPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_6 (PPM, 48% Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_7 (NM, 48% Ep)	11	12	12	11	11.5	12	11	11	12	11.5	11	12	11	11	11.3	11.42
T_8 (NM, 100% ETc)	12	13	12	11	12.0	13	13	12	13	12.8	11	12	11	11	11.3	12.00
T_9 (SI, 1 IW/CPE ratio)	12	11	10	11	11.0	10	10	12	11	10.8	11	11	11	10	10.8	10.83

Appendix- L

Periodical data on Absorbed Photosynthetically Active Radiation (APAR) of banana crop

Table L.1. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana 30 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	912	188	634	177	267	900	189	603	165	273	907	167	631	154	263	267.67
T_2 (BBPM, 48%Ep)	910	105	698	78	185	902	100	688	75	189	901	110	699	79	171	181.67
T_3 (SBPM, 48%Ep)	924	280	610	260	294	897	210	591	185	281	918	248	602	209	277	284.00
T_4 (WBPM, 48%Ep)	915	158	621	145	281	905	169	607	138	267	917	169	622	145	271	273.00
T_5 (RBPM, 48%Ep)	930	86	721	71	194	891	90	664	73	210	900	78	691	65	196	200.00
T_6 (PPM, 48%Ep)	920	87	691	35	177	901	88	672	40	181	899	89	697	54	167	175.00
T_7 (NM, 48%Ep)	902	80	700	56	178	898	89	700	61	170	890	88	691	55	166	171.33
T_8 (NM, 100%ETc)	919	65	719	44	179	890	70	701	49	168	889	71	695	48	171	172.67
T_9 (SI, 1 IW/CPE)	927	91	750	67	153	890	90	709	66	157	890	97	690	51	154	154.67

Table L.2. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana 60 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	944	152	640	134	286	930	147	621	130	292	950	155	629	141	307	295.00

T_2 (BBPM, 48%Ep)	938	78	710	41	191	929	71	700	40	198	940	88	707	55	200	196.33
T_3 (SBPM, 48%Ep)	951	178	601	135	307	940	190	571	126	305	950	188	602	151	311	307.67
T_4 (WBPM, 48%Ep)	940	121	630	107	296	935	117	625	101	294	944	134	625	112	297	295.67
T_5 (RBPM, 48%Ep)	845	76	633	68	204	865	84	640	75	216	895	78	644	55	228	216.00
T_6 (PPM, 48%Ep)	936	71	711	32	186	932	67	699	30	196	912	78	698	59	195	192.33
T_7 (NM, 48%Ep)	956	64	755	49	186	945	66	765	56	170	914	66	720	49	177	177.67
T_8 (NM, 100%ETc)	830	68	625	51	188	855	69	655	55	186	868	69	661	51	189	187.67
T_9 (SI, 1 IW/CPE)	895	87	703	61	166	900	88	700	57	169	900	88	677	34	169	168.00

Table L.3. Absorbed Photosynthetically Active Radiations (APAR) (μmol m^{-2} s^{-1}) values for banana 90 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	1021	102	668	107	358	1031	110	670	116	367	1010	106	657	95	342	355.67
T_2 (BBPM, 48%Ep)	1050	72	786	39	231	1045	74	777	40	234	1055	81	793	68	249	238.00
T_3 (SBPM, 48%Ep)	1051	122	644	103	388	1048	119	644	110	395	1044	110	639	101	396	393.00
T_4 (WBPM, 48%Ep)	1055	96	665	79	373	1050	99	650	81	382	1041	101	641	88	387	380.67
T_5 (RBPM, 48%Ep)	1040	56	780	45	249	1042	60	771	44	255	1030	55	771	44	248	250.67

T_6 (PPM, 48%Ep)	1015	45	771	23	222	1029	52	776	25	226	1020	51	778	41	232	226.67
T_7 (NM, 48%Ep)	1075	50	847	31	209	1056	55	830	35	206	1009	55	783	43	214	209.67
T_8 (NM, 100%ETc)	1016	55	781	35	215	1025	44	801	40	220	1011	45	789	36	213	216.00
T_9 (SI, 1 IW/CPE)	1044	81	826	59	196	1044	90	808	53	199	1007	71	792	44	188	194.33

Table L.4. Absorbed Photosynthetically Active Radiations (APAR) (μmol m^{-2} s^{-1}) values for banana 120 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	1250	99	754	88	485	1245	102	755	90	478	1266	103	767	91	487	483.33
T_2 (BBPM, 48%Ep)	1252	71	910	60	331	1239	75	895	59	328	1262	77	919	61	327	328.67
T_3 (SBPM, 48%Ep)	1259	191	681	155	542	1244	187	667	140	530	1260	201	579	167	647	573.00
T_4 (WBPM, 48%Ep)	1260	141	740	131	510	1251	140	735	129	505	1266	145	734	133	520	511.67
T_5 (RBPM, 48%Ep)	1247	66	891	66	356	1238	70	881	60	347	1259	71	899	68	357	353.33
T_6 (PPM, 48%Ep)	1255	55	921	35	314	1240	59	903	34	312	1258	65	920	45	318	314.67
T_7 (NM, 48%Ep)	1263	41	955	25	292	1241	45	934	29	291	1271	39	981	38	289	290.67
T_8 (NM, 100%ETc)	1257	56	934	30	297	1236	60	913	27	290	1261	66	938	39	296	294.33
T_9 (SI, 1 IW/CPE)	1265	64	978	25	248	1240	55	966	28	247	1269	54	990	33	258	251.00

Table L.5. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana 150 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	1399	81	740	78	656	1414	78	750	68	654	1402	99	733	77	647	652.33
T_2 (BBPM, 48%Ep)	1402	59	880	31	494	1416	51	890	30	505	1403	61	882	40	500	499.67
T_3 (SBPM, 48%Ep)	1414	134	673	91	698	1429	122	694	90	703	1410	130	678	110	712	704.33
T_4 (WBPM, 48%Ep)	1410	165	660	90	675	1429	161	670	91	689	1412	144	692	130	706	690.00
T_5 (RBPM, 48%Ep)	1404	59	870	42	517	1420	55	880	40	525	1392	61	866	51	516	519.33
T_6 (PPM, 48%Ep)	1403	40	940	33	456	1418	37	950	30	461	1399	44	931	31	455	457.33
T_7 (NM, 48%Ep)	1398	33	944	26	447	1410	37	955	25	443	1391	35	945	28	439	443.00
T_8 (NM, 100%ETc)	1409	47	944	25	443	1423	44	955	21	445	1402	39	944	30	449	445.67
T_9 (SI, 1 IW/CPE)	1395	54	969	22	394	1405	56	989	21	381	1393	49	990	25	379	384.67

Table L.6. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana 180 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	1540	76	680	31	815	1550	75	678	33	830	1555	78	690	51	838	827.67
T_2 (BBPM, 48%Ep)	1550	51	830	21	690	1540	66	800	30	704	1559	59	840	45	705	699.67

T_3 (SBPM, 48%Ep)	1548	60	630	25	883	1556	70	640	24	870	1549	59	640	44	894	882.33
T_4 (WBPM, 48%Ep)	1545	142	599	60	864	1555	149	620	71	857	1555	133	644	99	877	866.00
T_5 (RBPM, 48%Ep)	1547	55	800	30	722	1550	61	789	33	733	1544	65	791	39	727	727.33
T_6 (PPM, 48%Ep)	1560	41	890	15	644	1551	40	870	18	659	1569	44	892	30	663	655.33
T_7 (NM, 48%Ep)	1538	38	900	15	615	1540	45	904	23	614	1540	41	913	29	615	614.67
T_8 (NM, 100%ETc)	1550	30	912	18	626	1533	33	901	24	623	1538	38	901	27	626	625.00
T_9 (SI, 1 IW/CPE)	1543	39	957	19	566	1559	47	968	24	568	1539	39	949	22	573	569.00

Table L.7. Absorbed Photosynthetically Active Radiations (APAR) (μmol m^{-2} s^{-1}) values for banana 210 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	1432	71	499	29	891	1420	70	496	32	886	1414	66	510	59	897	891.33
T_2 (BBPM, 48%Ep)	1431	55	650	21	747	1428	55	655	25	743	1432	59	677	39	735	741.67
T_3 (SBPM, 48%Ep)	1440	59	468	28	941	1430	56	466	31	939	1433	71	478	59	943	941.00
T_4 (WBPM, 48%Ep)	1428	135	426	55	922	1430	133	422	59	934	1440	114	468	78	936	930.67
T_5 (RBPM, 48%Ep)	1441	59	618	30	794	1439	51	622	33	799	1423	51	617	41	796	796.33
T_6 (PPM, 48%Ep)	1435	50	701	25	709	1410	55	670	21	706	1420	49	703	30	698	704.33

T_7 (NM, 48%Ep)	1430	29	738	25	688	1420	44	733	25	668	1419	41	740	29	667	674.33
T_8 (NM, 100%ETc)	1423	34	725	19	683	1409	34	722	25	678	1421	45	733	33	676	679.00
T_9 (SI, 1 IW/CPE)	1425	44	766	31	646	1399	49	751	33	632	1412	40	771	25	626	634.67

Table L.8. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana 240 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	1268	59	215	35	1029	1260	60	210	30	1020	1258	44	220	33	1027	1025.33
T_2 (BBPM, 48%Ep)	1269	71	328	31	901	1262	75	320	33	900	1254	68	325	33	894	898.33
T_3 (SBPM, 48%Ep)	1266	45	198	40	1063	1255	44	188	42	1065	1249	44	190	39	1054	1060.67
T_4 (WBPM, 48%Ep)	1262	88	182	49	1041	1271	81	189	44	1045	1265	81	199	51	1036	1040.67
T_5 (RBPM, 48%Ep)	1270	68	300	28	930	1266	61	310	25	920	1255	58	310	41	928	926.00
T_6 (PPM, 48%Ep)	1265	51	360	24	878	1255	50	352	23	876	1267	44	378	29	874	876.00
T_7 (NM, 48%Ep)	1260	32	391	21	858	1253	33	399	31	852	1253	30	392	25	856	855.33
T_8 (NM, 100%ETc)	1267	28	399	21	861	1257	31	390	24	860	1260	33	392	24	859	860.00
T_9 (SI, 1 IW/CPE)	1271	37	440	23	817	1251	35	420	30	826	1248	35	399	21	835	826.00

Table L.9. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana 270 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	1035	53	25	52	1009	1024	50	20	48	1002	1022	51	19	46	998	1003.00
T_2 (BBPM, 48%Ep)	1027	45	79	42	945	1020	44	57	21	940	1015	43	70	39	941	942.00
T_3 (SBPM, 48%Ep)	1037	37	15	35	1020	1040	33	18	28	1017	1029	39	14	33	1009	1015.33
T_4 (WBPM, 48%Ep)	1038	79	18	70	1011	1045	71	20	65	1019	1030	67	19	56	1000	1010.00
T_5 (RBPM, 48%Ep)	1030	42	30	40	998	1023	40	35	38	986	1023	44	31	41	989	991.00
T_6 (PPM, 48%Ep)	1023	39	90	22	916	1020	33	81	17	923	1025	30	99	27	923	920.67
T_7 (NM, 48%Ep)	1025	31	120	20	894	1018	34	114	23	893	1013	33	118	26	888	891.67
T_8 (NM, 100%ETc)	1027	25	122	18	898	1030	24	135	21	892	1024	29	123	21	893	894.33
T_9 (SI, 1 IW/CPE)	1031	27	155	21	870	1010	30	145	37	872	1012	28	133	19	870	870.67

Table L.10. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana 300 days after transplanting

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	1035	47	81	43	950	1024	51	78	49	944	1026	44	78	41	945	946.33
T_2 (BBPM, 48%Ep)	1027	50	89	44	932	1020	55	77	44	932	1030	41	86	31	934	932.67

T_3 (SBPM, 48%Ep)	1037	41	50	35	981	1040	40	56	30	974	1033	45	55	39	972	975.67
T_4 (WBPM, 48%Ep)	1038	90	59	81	970	1045	82	58	66	971	1028	78	39	65	976	972.33
T_5 (RBPM, 48%Ep)	1030	45	88	40	937	1023	46	85	40	932	1022	39	82	36	937	935.33
T_6 (PPM, 48%Ep)	1023	44	100	22	901	1020	45	101	19	893	1031	39	123	28	897	897.00
T_7 (NM, 48%Ep)	1027	32	144	19	870	1030	34	154	22	864	1036	31	169	22	858	864.00
T_8 (NM, 100%ETc)	1025	38	140	24	871	1018	35	144	27	866	1024	33	155	25	861	866.00
T_9 (SI, 1 IW/CPE)	1031	35	166	22	852	1010	33	168	25	834	1021	28	182	19	830	838.67

Table L.11. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana at first harvest (318 DAT)

Treatment	**R-I**					**R-II**					**R-III**					**Average APAR**
	Io	**Rc**	**Tc**	**Rs**	**APAR**	**Io**	**Rc**	**Tc**	**Rs**	**APAR**	**Io**	**Rc**	**Tc**	**Rs**	**APAR**	
T_1 (YBPM, 48%Ep)	991	55	99	45	882	999	55	96	50	898	991	48	93	44	894	891.35
T_2 (BBPM, 48%Ep)	978	65	121	56	848	982	57	118	45	852	983	54	135	46	840	846.65
T_3 (SBPM, 48%Ep)	988	40	80	33	901	981	43	76	33	895	998	42	88	37	905	900.27
T_4 (WBPM, 48%Ep)	991	100	84	91	898	992	83	83	68	894	981	91	79	82	893	895.17
T_5 (RBPM, 48%Ep)	990	49	122	43	862	987	48	117	41	863	992	46	119	42	869	864.61
T_6 (PPM, 48%Ep)	981	49	120	34	846	991	47	122	22	844	985	45	126	23	837	842.37

T_7 (NM, 48%Ep)	976	39	160	28	805	988	36	174	23	801	977	35	166	20	796	800.53
T_8 (NM, 100%ETc)	983	44	156	30	813	993	38	165	29	819	978	39	149	25	815	816.18
T_9 (SI, 1 IW/CPE)	975	37	180	27	785	981	35	177	27	796	972	36	183	23	776	785.83

Table L.12. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana at second harvest (358 DAT)

Treatment	R-I					R-II					R-III					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2 (BBPM, 48%Ep)	982	49	120	34	846	991	47	122	22	844	985	45	126	23	837	842.33
T_3 (SBPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_4 (WBPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_5 (RBPM, 48%Ep)	989	48	122	42	861	988	47	117	42	866	991	45	119	39	866	864.33
T_6 (PPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_7 (NM, 48%Ep)	976	39	160	28	805	988	36	174	23	801	977	35	166	20	796	800.66
T_8 (NM, 100%ETc)	982	44	155	30	813	991	33	165	29	819	977	39	148	25	815	815.66
T_9 (SI, 1 IW/CPE)	971	37	176	27	785	980	34	177	27	796	972	36	183	23	776	785.67

Table L.13. Absorbed Photosynthetically Active Radiations (APAR) (µmol m^{-2} s^{-1}) values for banana at third harvest (374 DAT)

Treatment	RI					RII					RIII					Average APAR
	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	Io	Rc	Tc	Rs	APAR	
T_1 (YBPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_2 (BBPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_3 (SBPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_4 (WBPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_5 (RBPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_6 (PPM, 48%Ep)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T_7 (NM, 48%Ep)	971	38	156	28	805	975	36	161	23	801	976	35	166	20	796	800.33
T_8 (NM, 100%ETc)	980	43	154	30	813	989	35	163	29	819	981	41	150	25	815	816.00
T_9 (SI, 1 IW/CPE)	970	36	176	27	785	985	39	177	27	796	980	36	193	23	774	785.00

Appendix- M

Periodical data on photosynthesis rate of banana

Table M.1. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 30 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	1.86	2.78	2.67	2.43
T_2 (BBPM, 48% Ep)	1.92	2.84	2.01	2.25
T_3 (SBPM, 48% Ep)	2.15	3.21	2.74	2.70
T_4 (WBPM, 48% Ep)	2.07	3.01	2.51	2.53
T_5 (RBPM, 48% Ep)	2.01	2.99	1.91	2.30
T_6 (PPM, 48% Ep)	1.91	2.54	2.09	2.18
T_7 (NM, 48% Ep)	1.34	2.31	1.87	1.84
T_8 (NM, 100% ETc)	1.58	2.40	1.66	1.88
T_9 (SI, 1 IW/CPE ratio)	1.07	1.98	1.48	1.51

Table M.2. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 60 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	2.61	3.55	3.51	3.22
T_2 (BBPM, 48% Ep)	2.77	3.33	2.91	3.00
T_3 (SBPM, 48% Ep)	3.18	4.15	3.56	3.63
T_4 (WBPM, 48% Ep)	3.09	3.98	3.34	3.47
T_5 (RBPM, 48% Ep)	3.01	3.81	2.65	3.16
T_6 (PPM, 48% Ep)	2.68	3.40	2.78	2.95
T_7 (NM, 48% Ep)	2.19	2.91	2.11	2.40
T_8 (NM, 100% ETc)	2.51	2.94	2.01	2.49
T_9 (SI, 1 IW/CPE ratio)	2.02	2.19	1.99	2.07

Table M.3. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 90 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	4.89	5.38	5.56	5.28
T_2 (BBPM, 48% Ep)	4.99	5.09	4.81	4.96
T_3 (SBPM, 48% Ep)	5.81	6.31	6.01	6.04
T_4 (WBPM, 48% Ep)	5.66	5.98	5.71	5.78
T_5 (RBPM, 48% Ep)	5.05	5.25	4.57	4.96
T_6 (PPM, 48% Ep)	4.88	5.01	4.91	4.93
T_7 (NM, 48% Ep)	4.31	4.88	4.33	4.51
T_8 (NM, 100% ETc)	4.67	4.81	4.23	4.57
T_9 (SI, 1 IW/CPE ratio)	3.99	4.01	3.91	3.97

Table M.4. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 120 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	7.01	7.47	7.34	7.27
T_2 (BBPM, 48% Ep)	6.01	6.45	6.33	6.26
T_3 (SBPM, 48% Ep)	7.77	8.21	7.88	7.95
T_4 (WBPM, 48% Ep)	7.31	7.81	7.55	7.56
T_5 (RBPM, 48% Ep)	6.13	6.66	7.51	6.77
T_6 (PPM, 48% Ep)	5.98	6.51	6.09	6.19
T_7 (NM, 48% Ep)	5.37	5.88	5.55	5.60
T_8 (NM, 100% ETc)	5.50	5.89	5.34	5.58
T_9 (SI, 1 IW/CPE ratio)	4.88	4.99	5.02	4.96

Table M.5. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 150 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	9.91	9.99	10.01	9.97
T_2 (BBPM, 48% Ep)	8.81	8.88	8.91	8.87
T_3 (SBPM, 48% Ep)	10.24	10.35	10.57	10.39
T_4 (WBPM, 48% Ep)	10.10	10.15	10.33	10.19
T_5 (RBPM, 48% Ep)	9.27	9.33	9.61	9.40
T_6 (PPM, 48% Ep)	8.30	8.33	8.44	8.36
T_7 (NM, 48% Ep)	7.90	8.01	8.09	8.00
T_8 (NM, 100% ETc)	8.01	8.05	8.16	8.07
T_9 (SI, 1 IW/CPE ratio)	6.99	7.09	7.01	7.03

Table M.6. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 180 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	13.71	14.65	14.41	14.26
T_2 (BBPM, 48% Ep)	13.01	14.31	13.77	13.70
T_3 (SBPM, 48% Ep)	14.61	15.66	14.88	15.05
T_4 (WBPM, 48% Ep)	14.18	15.01	14.56	14.58
T_5 (RBPM, 48% Ep)	13.77	14.81	14.31	14.30
T_6 (PPM, 48% Ep)	12.10	12.91	12.44	12.48
T_7 (NM, 48% Ep)	11.88	12.37	12.09	12.11
T_8 (NM, 100% ETc)	12.02	12.41	12.12	12.18
T_9 (SI, 1 IW/CPE ratio)	10.90	11.89	11.23	11.34

Table M.7. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 210 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	17.11	17.29	17.88	17.43
T_2 (BBPM, 48% Ep)	16.98	17.14	17.09	17.07
T_3 (SBPM, 48% Ep)	18.19	18.33	18.50	18.34
T_4 (WBPM, 48% Ep)	17.89	18.10	18.19	18.06
T_5 (RBPM, 48% Ep)	17.09	17.33	17.01	17.14
T_6 (PPM, 48% Ep)	16.27	16.40	16.44	16.37
T_7 (NM, 48% Ep)	14.91	15.09	15.23	15.08
T_8 (NM, 100% ETc)	14.99	15.16	15.33	15.16
T_9 (SI, 1 IW/CPE ratio)	13.90	14.08	14.31	14.10

Table M.8. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 240 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	18.89	18.99	19.01	18.96
T_2 (BBPM, 48% Ep)	17.17	17.23	17.34	17.25
T_3 (SBPM, 48% Ep)	19.67	19.77	19.71	19.72
T_4 (WBPM, 48% Ep)	19.09	19.17	19.21	19.16
T_5 (RBPM, 48% Ep)	18.78	18.81	18.78	18.79
T_6 (PPM, 48% Ep)	17.01	17.15	17.23	17.13
T_7 (NM, 48% Ep)	16.34	16.42	16.41	16.39
T_8 (NM, 100% ETc)	16.51	16.57	16.44	16.51
T_9 (SI, 1 IW/CPE ratio)	14.39	14.58	14.67	14.55

Table M.9. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 270 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	25.34	26.01	25.66	25.67
T_2 (BBPM, 48% Ep)	24.78	25.71	24.91	25.13
T_3 (SBPM, 48% Ep)	26.10	26.99	26.54	26.54
T_4 (WBPM, 48% Ep)	25.61	26.50	25.89	26.00
T_5 (RBPM, 48% Ep)	25.22	25.91	25.41	25.51
T_6 (PPM, 48% Ep)	22.34	23.20	22.44	22.66
T_7 (NM, 48% Ep)	21.12	22.09	21.39	21.53
T_8 (NM, 100% ETc)	21.18	22.17	21.88	21.74
T_9 (SI, 1 IW/CPE ratio)	19.14	20.09	19.51	19.58

Table M.10. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments 300 days after transplanting

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	28.31	28.57	28.77	28.55
T_2 (BBPM, 48% Ep)	27.81	27.98	27.89	27.89
T_3 (SBPM, 48% Ep)	29.06	29.43	29.51	29.33
T_4 (WBPM, 48% Ep)	28.91	29.15	29.01	29.02
T_5 (RBPM, 48% Ep)	28.19	28.51	28.44	28.38
T_6 (PPM, 48% Ep)	25.71	25.97	26.02	25.90
T_7 (NM, 48% Ep)	25.14	25.33	25.24	25.24
T_8 (NM, 100% ETc)	25.19	25.44	25.32	25.32
T_9 (SI, 1 IW/CPE ratio)	23.26	23.59	23.30	23.38

Table M.11. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments at first harvest (319 DAT)

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	27.12	27.39	27.49	27.33
T_2 (BBPM, 48% Ep)	26.15	26.31	26.22	26.23
T_3 (SBPM, 48% Ep)	28.56	28.23	28.34	28.38
T_4 (WBPM, 48% Ep)	28.01	28.12	28.34	28.16
T_5 (RBPM, 48% Ep)	26.44	26.55	26.34	26.44
T_6 (PPM, 48% Ep)	23.89	24.01	24.12	24.01
T_7 (NM, 48% Ep)	23.91	23.88	23.81	23.87
T_8 (NM, 100% ETc)	23.99	23.89	23.84	23.91
T_9 (SI, 1 IW/CPE ratio)	22.91	22.99	23.08	22.99

Table M.12. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments at second harvest (360 DAT)

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	-	-	-	-
T_2 (BBPM, 48% Ep)	23.44	23.39	23.51	23.45
T_3 (SBPM, 48% Ep)	-	-	-	-
T_4 (WBPM, 48% Ep)	-	-	-	-
T_5 (RBPM, 48% Ep)	24.82	25.25	24.98	25.02
T_6 (PPM, 48% Ep)	-	-	-	-
T_7 (NM, 48% Ep)	22.10	22.75	22.64	22.50
T_8 (NM, 100% ETc)	22.55	22.60	22.84	22.66
T_9 (SI, 1 IW/CPE ratio)	21.95	22.19	22.15	22.10

Table M.13. Photosynthesis rate (µmol CO_2 m^{-2} s^{-1}) of banana as influenced by different treatments at third harvest (375 DAT)

Treatment	R-I	R-II	R-III	Average
T_1 (YBPM, 48% Ep)	-	-	-	-
T_2 (BBPM, 48% Ep)	-	-	-	-
T_3 (SBPM, 48% Ep)	-	-	-	-
T_4 (WBPM, 48% Ep)	-	-	-	-
T_5 (RBPM, 48% Ep)	-	-	-	-
T_6 (PPM, 48% Ep)	-	-	-	-
T_7 (NM, 48% Ep)	22.01	22.10	22.05	22.05
T_8 (NM, 100% ETc)	22.18	22.05	22.44	22.22
T_9 (SI, 1 IW/CPE ratio)	21.44	21.78	21.53	21.58

Appendix – N

Spectroradiometer HR 1024 and Operating Procedure

This appendix presents the details of the instrument Spectroradiometer HR 1024 and operating procedure.

N.1 Spectroradiometer HR 1024

The HR-1024 covers the UV, Visible, and NIR wavelengths from 350 nm to 2500 nm. It uses 3 diffraction grating spectrometers with 1.silicon and 2. In Ga, As diode arrays. The silicon array has 512 discrete detectors and the In Ga, As arrays each have 256 discrete detectors that provide the capability to read 1024 spectral bands.

The spectroradiometer includes memory for stand-alone operation as well as capability for computer assisted and PDA assisted operation. Communications to the instrument are available through its RS232 serial port, USB client port or Bluetooth wireless connection. Up to 500 spectral readings can be stored in the instrument for subsequent down loading and analysis using a personal computer. All spectroradiometer identification and calibration information is stored on board, so there are no external files to manage. The instrument is shown in Fig. N.1.

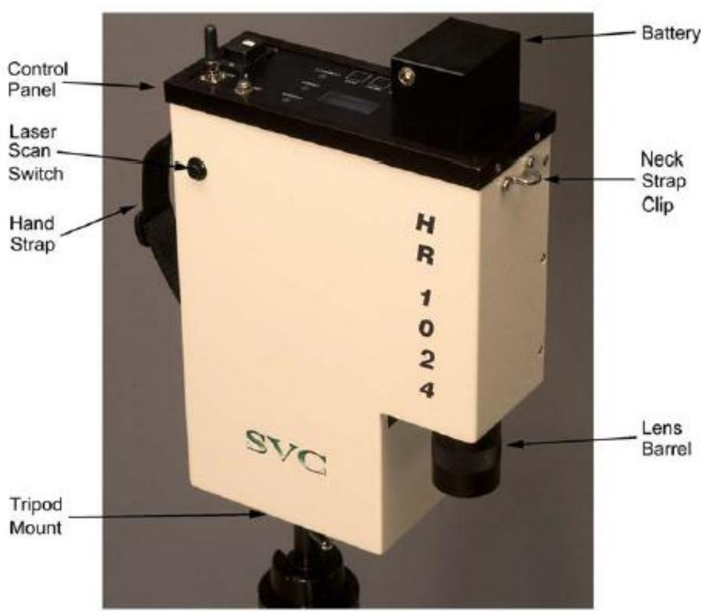


Fig. N.1. HR 1024 Spectroradiometer

An optional external GPS device may be connected via a Windows PDA device. When so configured, the PDA records the latitude, longitude, and time of each spectral reading. This instrument is self-contained and incorporates an easily replaceable battery called a SMARTPACK. The battery charger supplied with the instrument has the capability to charge the LIIon battery from line voltage with the AC adapter. The computer based operation allows for real time data display and data analysis. Radiance and percent reflectance are provided within the acquisition software. A full range of options are available. These options include alternate collection optics, fiber optic light guides, a diffuser, and a tripod.

N.2 Procedure

The procedure to operate the instrument is described below. 1) Remove the HR 1024 Spectroradiometer from the case and attach it with the neck strap. 2) As the instrument is very delicate and costly handling it with lot of care is very important. 3) Now attach battery to the HR 1024 and attach Bluetooth antenna. If connection is to be made by using cable then cable need to be plugged to Spectroradiometer and PDA both. 4) Switch on PDA and Spectroradiometer both. Sufficient warm up time should be given to the Spectroradiometer of 15 min (Fig. N.2).

Fig. N.2. Startup screen of PDA of HR 1024

5) Start the PDA data acquisition software and go to “devCntrl” menu. Click on connect button (Fig. N.3).

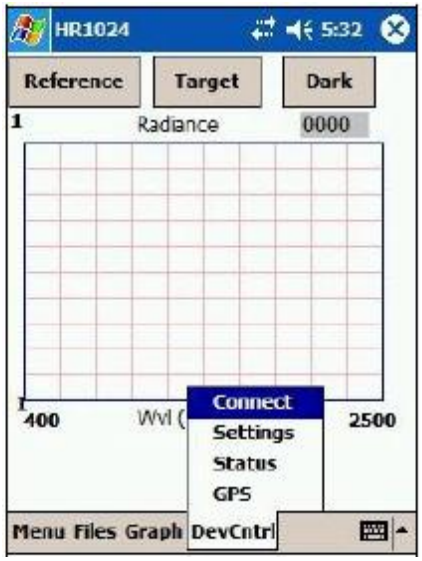


Fig. N.3. Selection of the COM port for connection in HR 1024 PDA data acquisition software

7) Select Optic to Lens 4 if four optics drum is in use or fibre 1 if fibre optic cable is in use. Usually keep the integration settings to factory default (Fig. N.4).

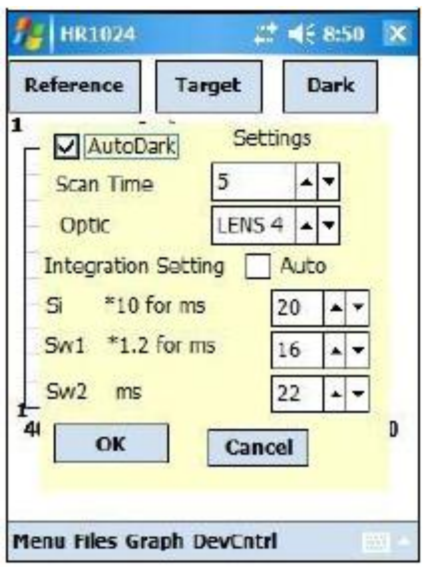


Fig. N.4. Selection of the scan time and optics

8) Switch on the GPS by clicking on the GPS option in Dev Ctrl menu (Fig. N.5).

Fig. N.5. Starting GPS

9) Select the graph type from the Graph menu. Reflectance is measured for this study (Fig. N.6).

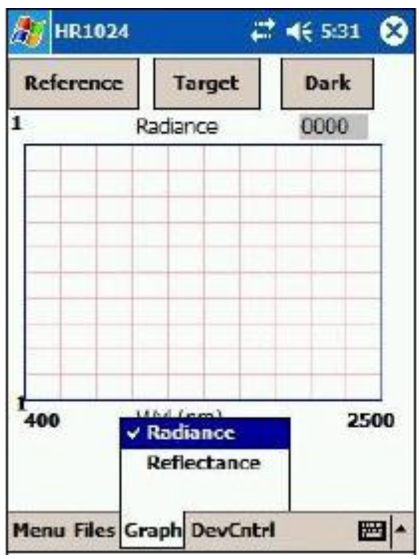


Fig. N.6. Selection of the graph type

9) In the files menu check the auto save option due to this signature files will be saved automatically after the data acquisition (Fig. N.7).

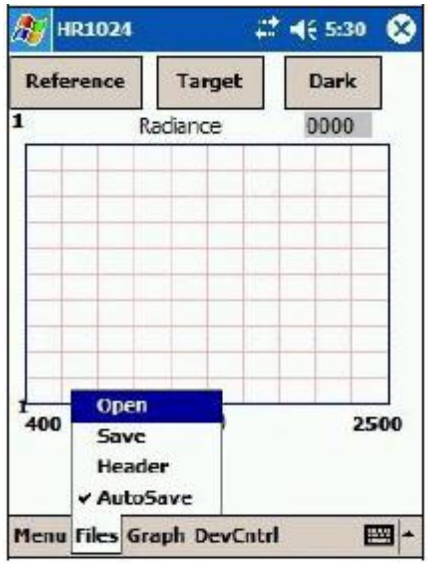


Fig. N.7. Files menu and selection of autosave option

10) Now focus the spectroradiometer on the "Spectral Lawn" and click on the reference button after reference is complete click on the "Target" at the same spot. This will record the reference reading at the present condition. For all next readings up to next reference scan this reading will be used as reference (Fig. N.8).

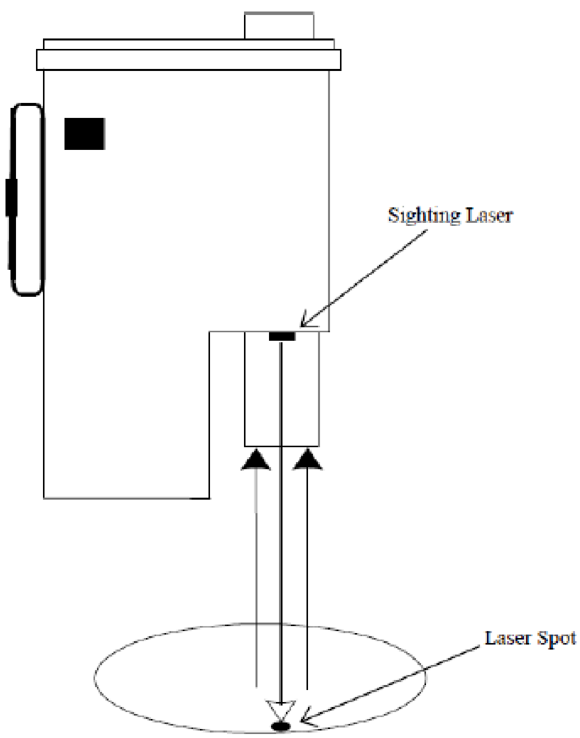


Fig. N.8. Focusing of the spectroradiometer HR 1024

11) Spectroradiometer is provided with the laser beam for perfect focusing to desired spot. Above figure shows laser spot and the area under observation. 12) After the reference scan just go on clicking on the "Target" button for every scan (Fig. N.9).

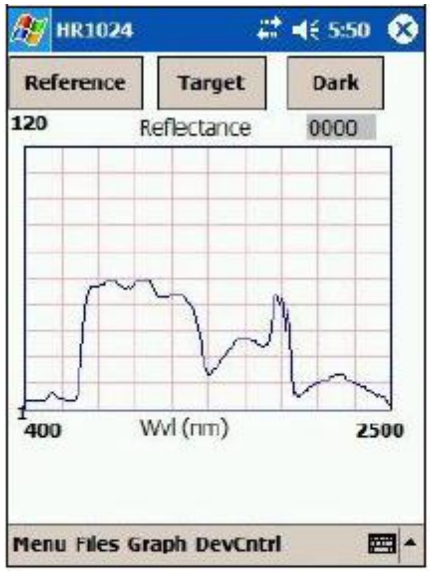
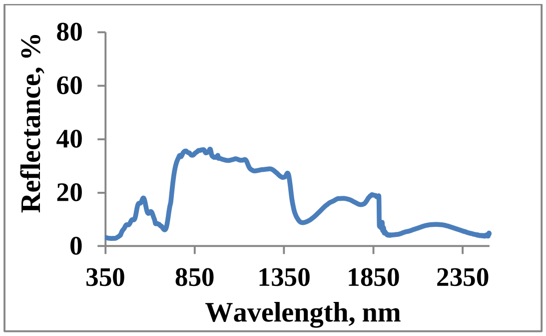


Fig. N.9. Data acquired using Spectroradiometer HR 1024

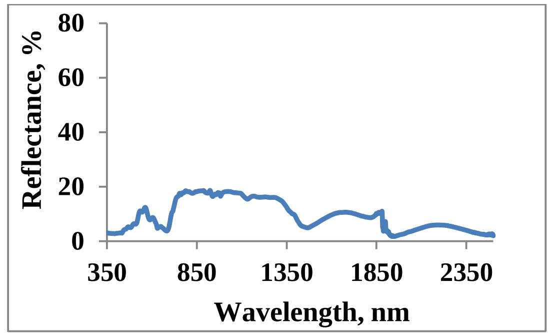
13) After the completion of experiment go to "DevCntrl" menu and click on "Disconnect" option. Device will be disconnected from PDA. Dismantle all accessories in reverse order.

Appendix- O

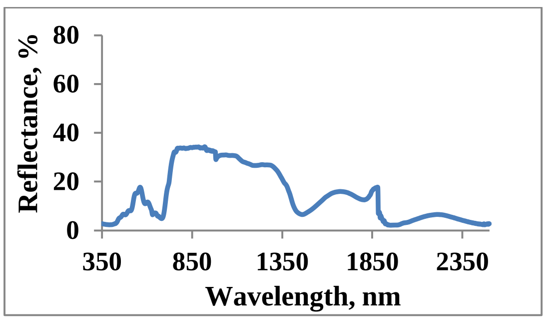
Spectral signatures of banana crop under various treatments



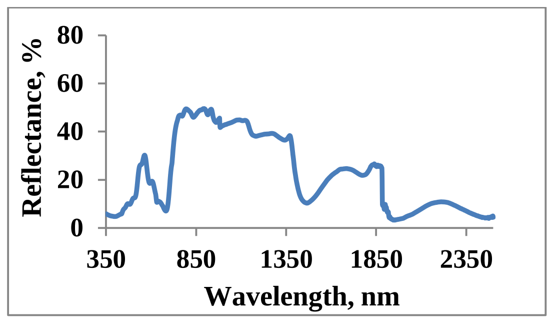
(a) T_1 (YBPM, 48%Ep)



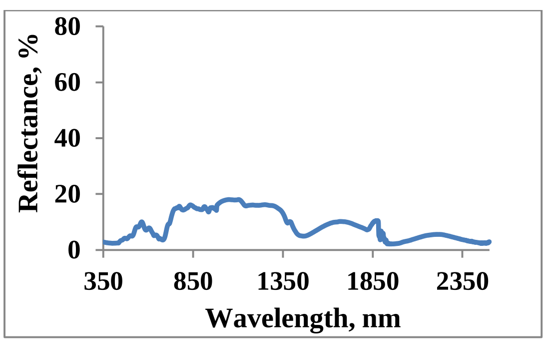
(b) T_2 (BBPM, 48%Ep)



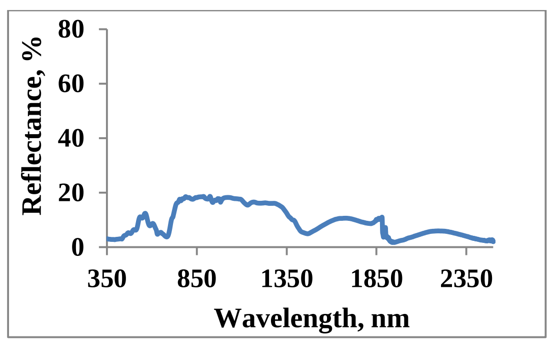
(g) T_3 (SBPM, 48%Ep)



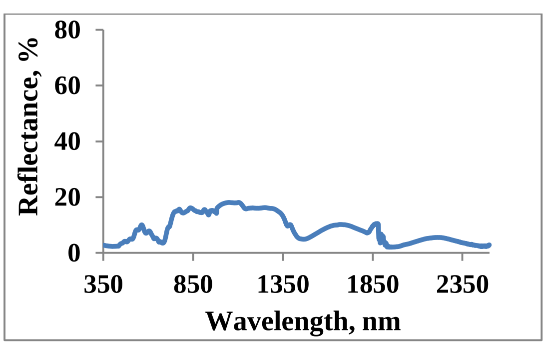
(h) T_4 (WBPM, 48%%Ep)



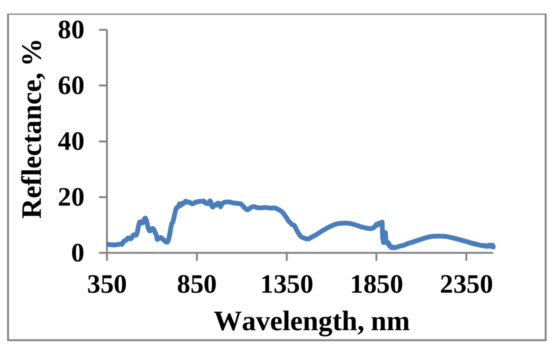
(e) T_5 (RBPM, 48%Ep)



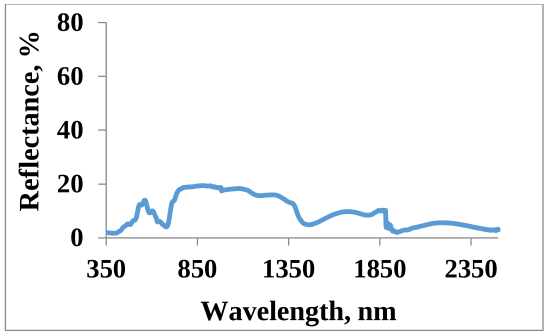
(f) T_6 (PPM, 48%Ep)



(c) T_7 (NM, 48%Ep)

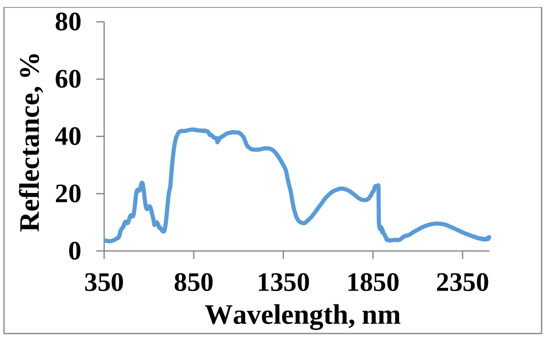


(d) T_8 (NM, 100%ETc)

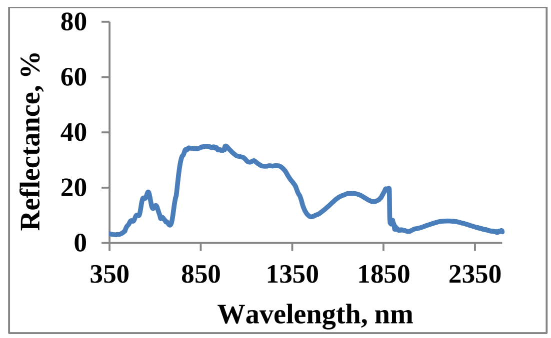


(i) T_9 (SI, 1.00 IW/CPE)

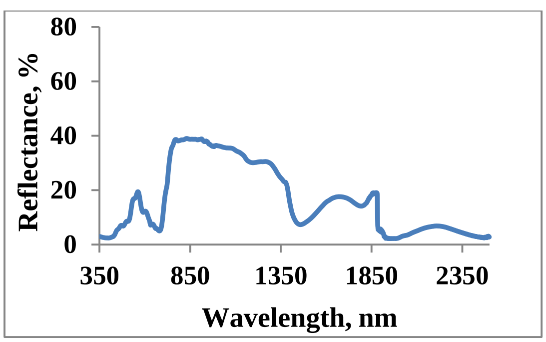
Fig. O.1. Spectral signatures of banana crop under various treatments 30 DAT



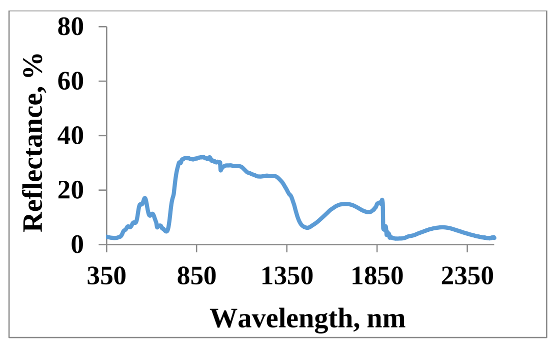
(a) T_1 (YBPM, 48%Ep)



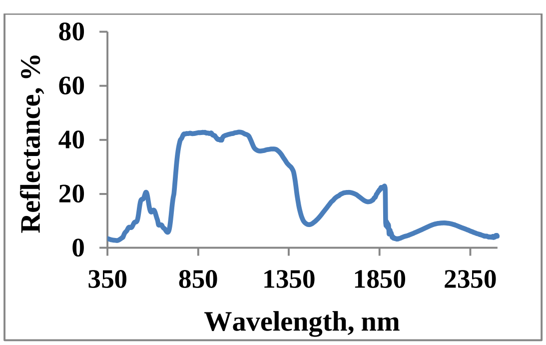
(b) T_2 (BBPM, 48%Ep)



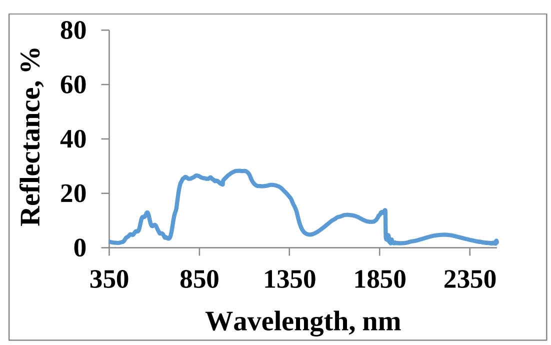
(c) T_3 (SBPM, 48%Ep)



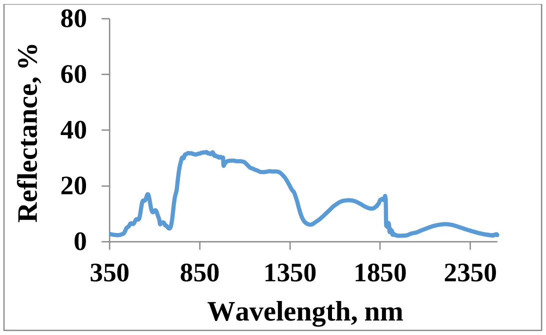
(d) T_4 (WBPM, 48%Ep)



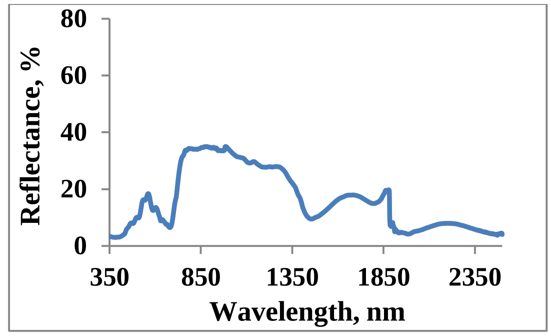
(e) T_5 (RBPM, 48%Ep)



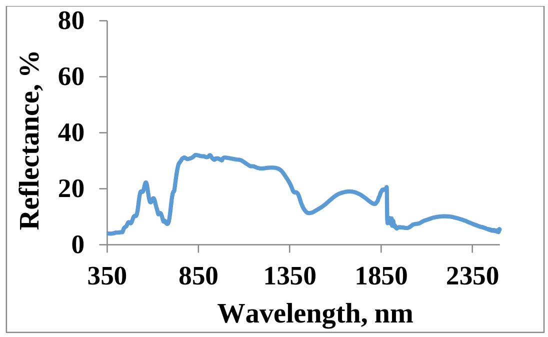
(f) T_6 (PPM, 48%Ep)



(g) T7 (NM, 48%Ep)

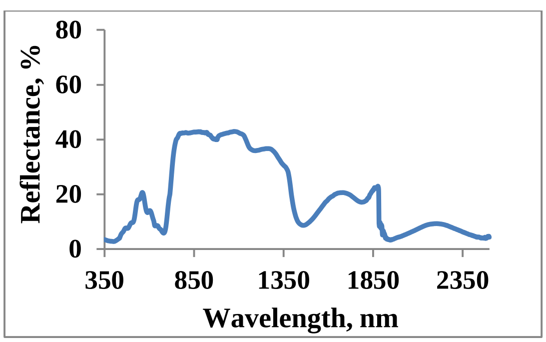


(h) T8 (NM, 100%ETc)

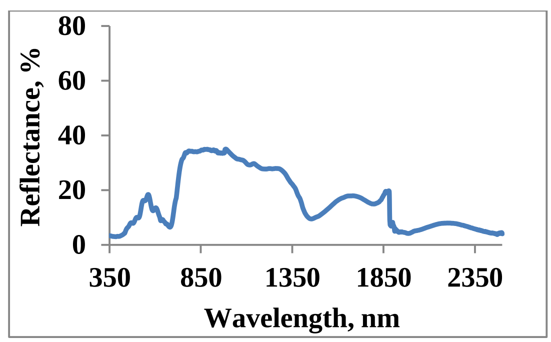


(i) T9 (SI, 1.00 IW/CPE)

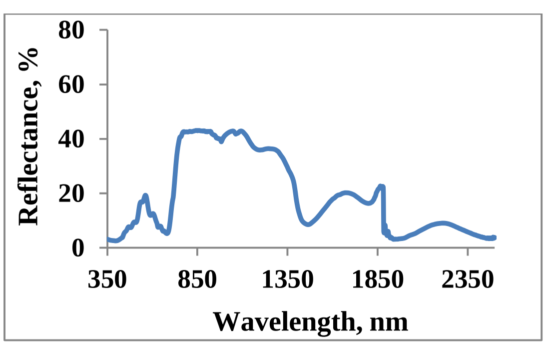
Fig. O.2. Spectral signatures of banana crop under various treatments 60 DAT



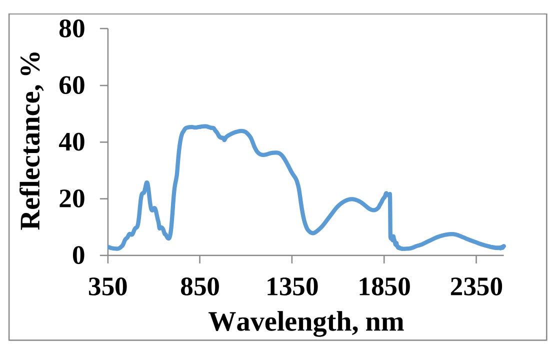
(a) T1 (YBPM, 48%Ep)



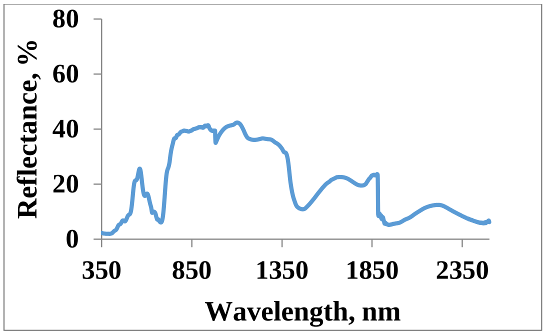
(b) T2 (BBPM, 48%Ep)



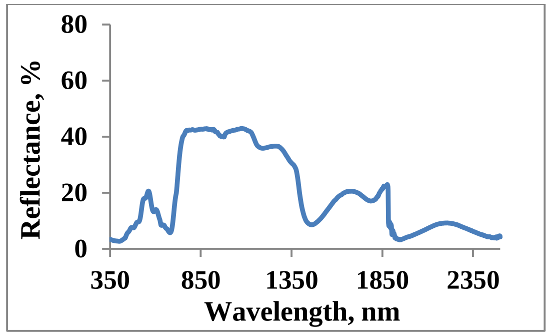
(c) T3 (SBPM, 48%Ep)



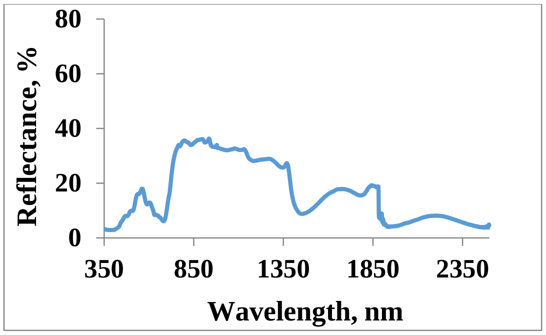
(d) T4 (WBPM, 48%Ep)



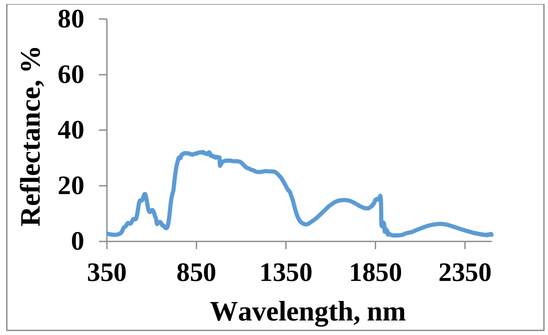
(e) T_5 (RBPM, 48%Ep)



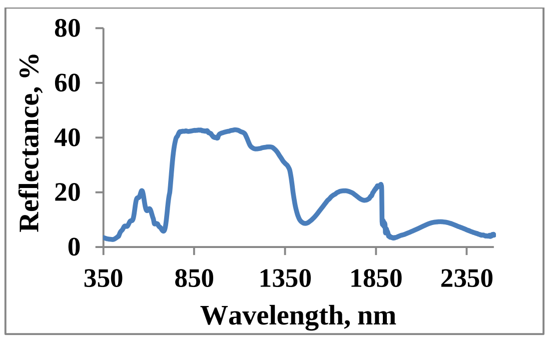
(f) T_6 (PPM, 48%Ep)



(g) T_7 (NM, 48%Ep)

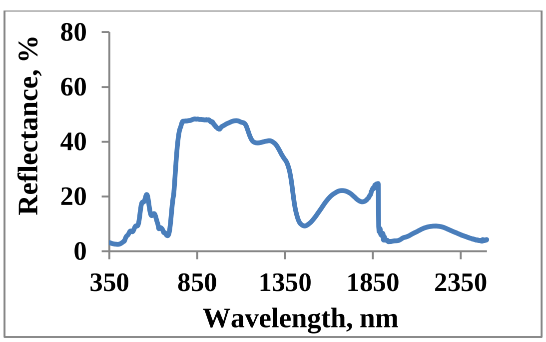


(h) T_8 (NM, 100%ETc)

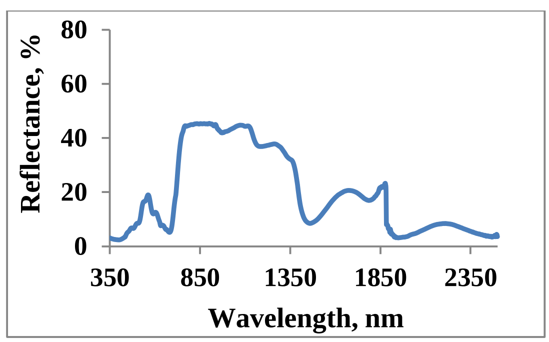


(i) T_9 (SI, 1.00 IW/CPE)

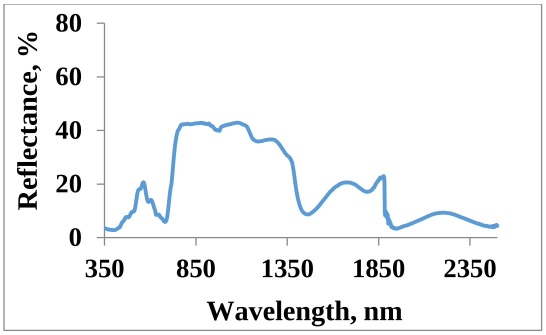
Fig. O.3. Spectral signatures of banana crop under various treatments 90 DAT



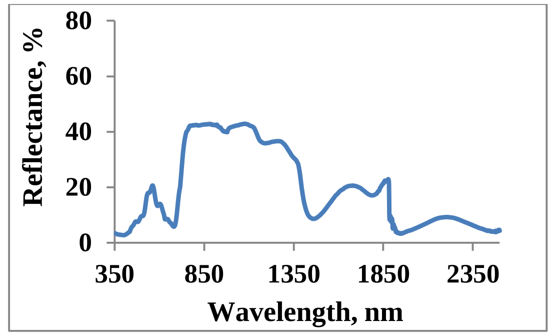
(a) T_1 (YBPM, 48%Ep)



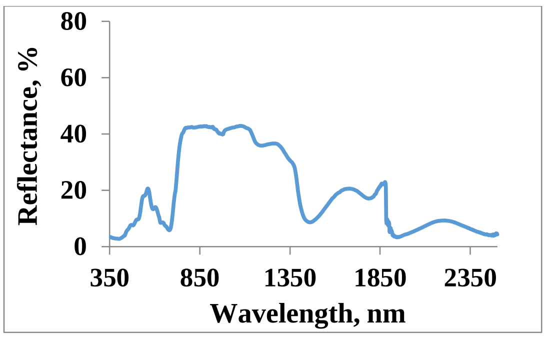
(b) T_2 (BBPM, 48%Ep)



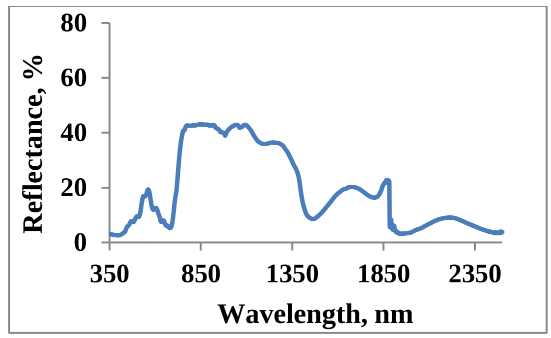
(c) T_3 (SBPM, 48%Ep)



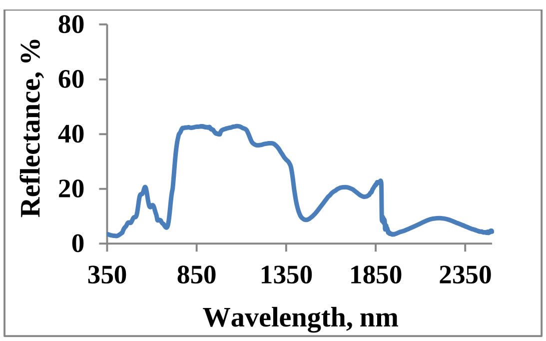
(d) T_4 (WBPM, 48%Ep)



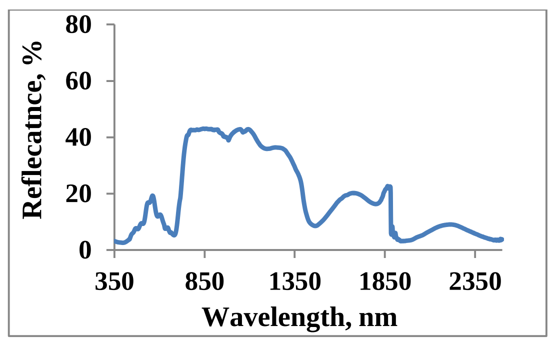
(e) T_5 (RBPM, 48%Ep)



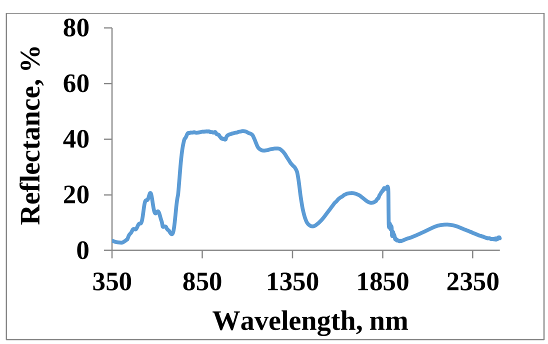
(f) T_6 (PPM, 48%Ep)



(g) T_7 (NM, 48%Ep)

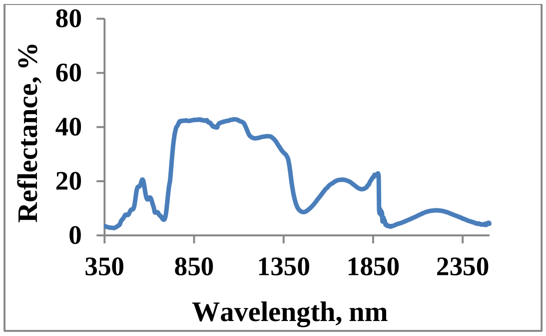


(h) T_8 (NM, 100%ETc)

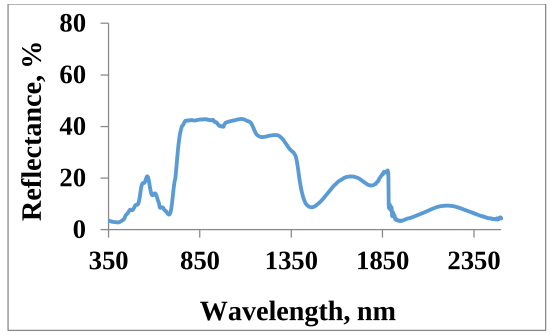


(i) T_9 (SI, 1.00 IW/CPE)

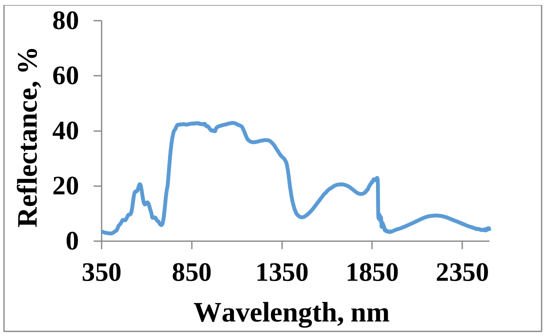
Fig. O.4. Spectral signatures of banana crop under various treatments 120 DAT



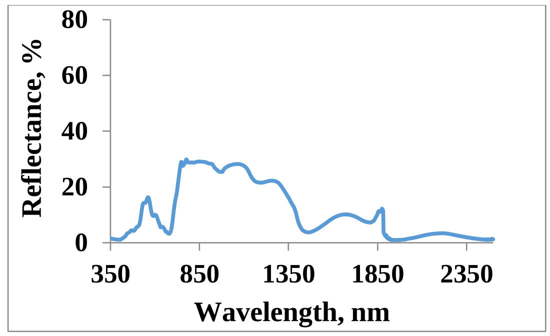
(a) T_1 (YBPM, 48%Ep)



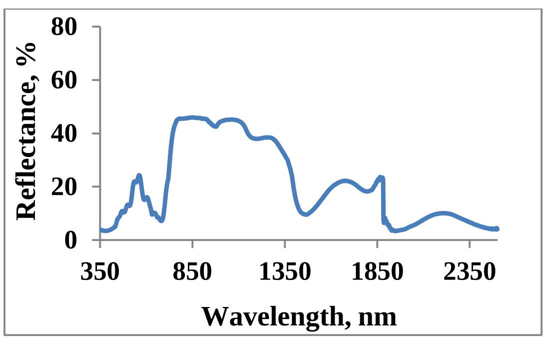
(b) T_2 (BBPM, 48%Ep)



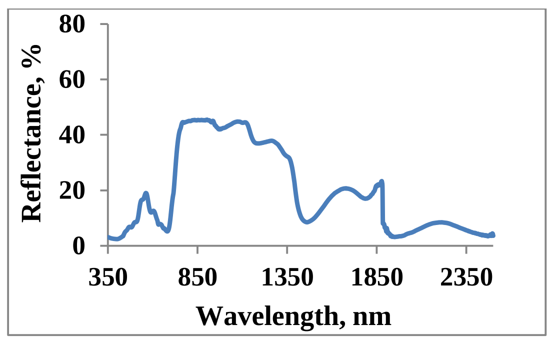
(c) T_3 (SBPM, 48%Ep)



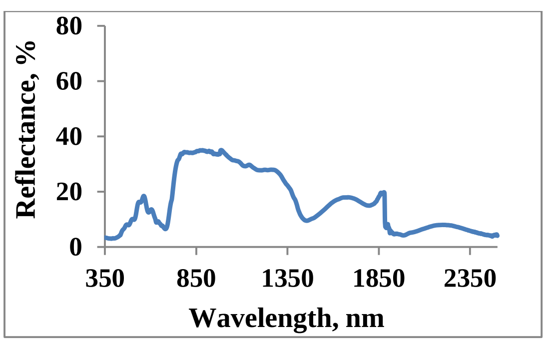
(d) T_4 (WBPM, 48%Ep)



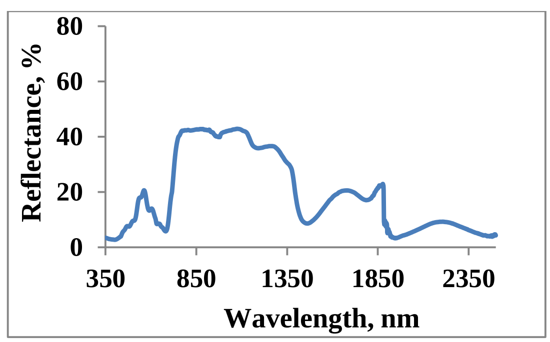
(e) T_5 (RBPM, 48%Ep)



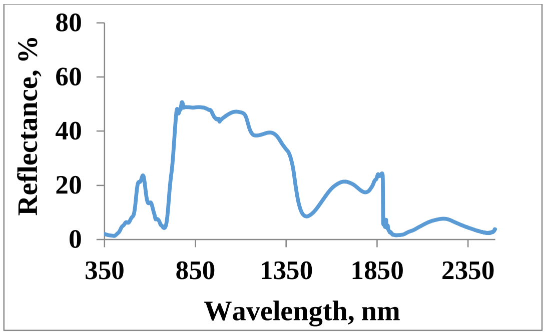
(f) T_6 (PPM, 48%Ep)



(g) T_7 (NM, 48%Ep)

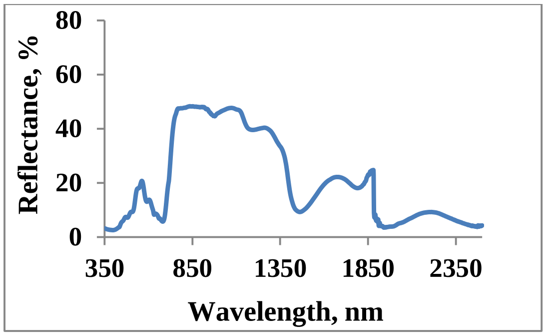


(h) T_8 (NM, 100%ETc)

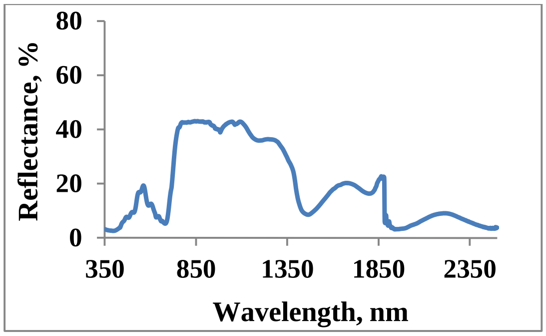


(i) T_9 (SI, 1.00 IW/CPE)

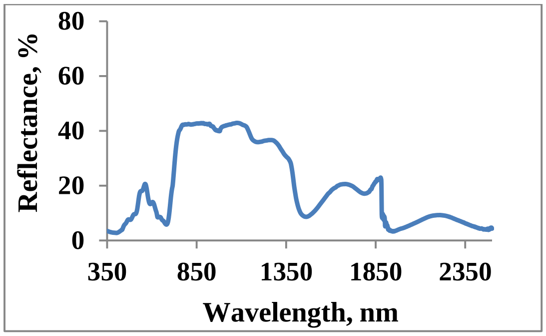
Fig. O.5. Spectral signatures of banana crop under various treatments 150 DAT



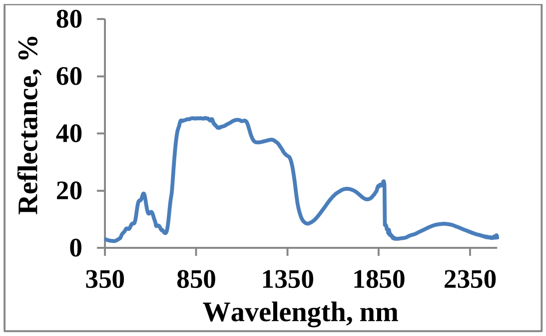
(a) T_1 (YBPM, 48%Ep)



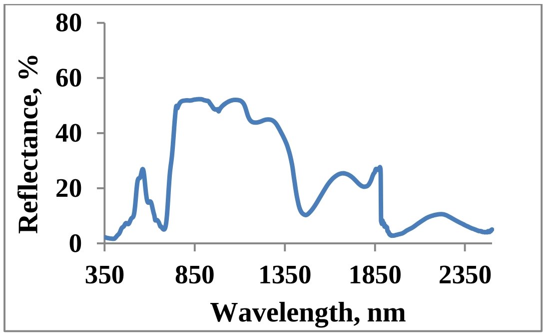
(b) T_2 (BBPM, 48%Ep)



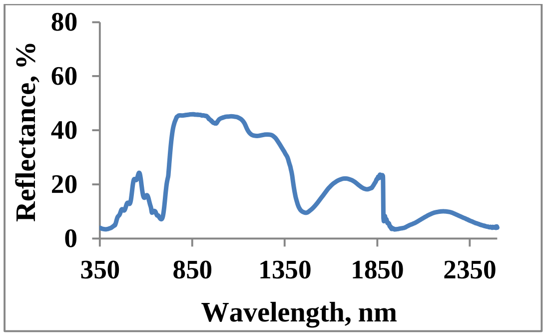
(c) T_3 (SBPM, 48%Ep)



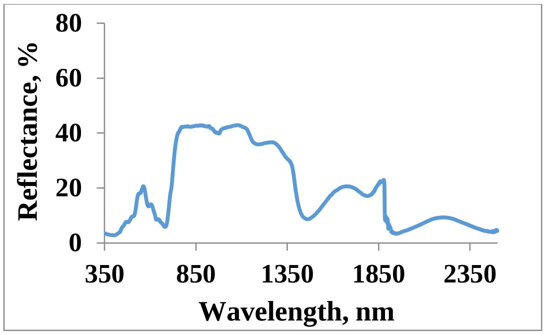
(d) T_4 (WBPM, 48%Ep)



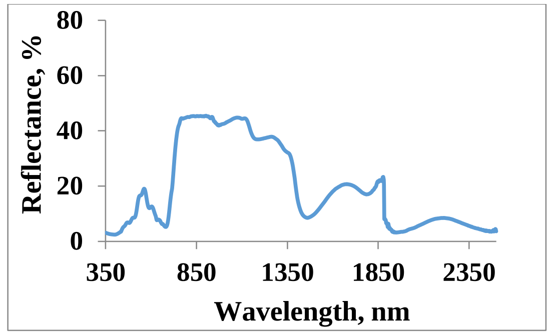
(e) T_5 (RBPM, 48%Ep)



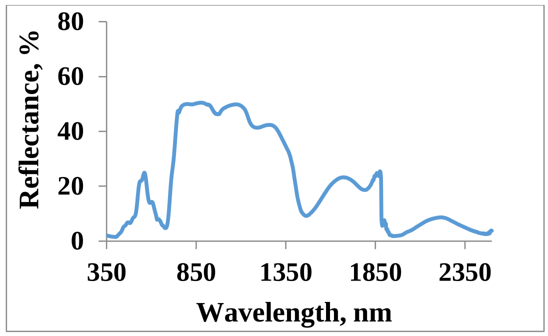
(f) T_6 (PPM, 48%Ep)



(g) T_7 (NM, 48%Ep)

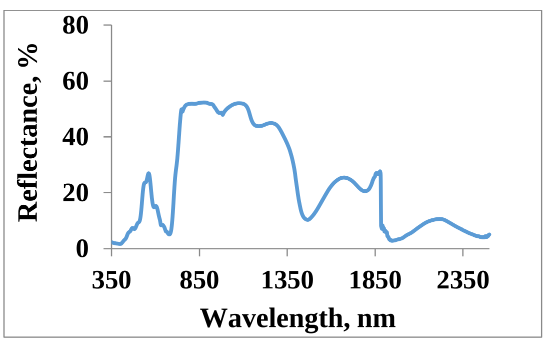


(h) T_8 (NM, 100%ETc)

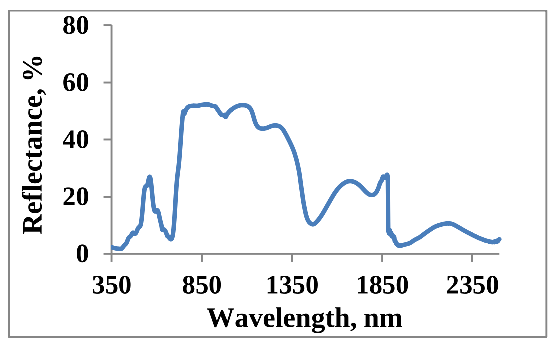


(i) T_9 (SI, 1.00 IW/CPE)

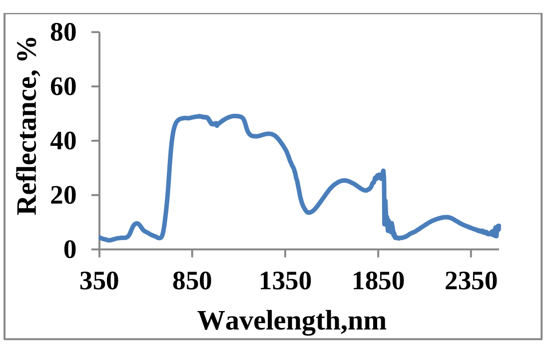
Fig. O.6. Spectral signatures of banana crop under various treatments 180 DAT



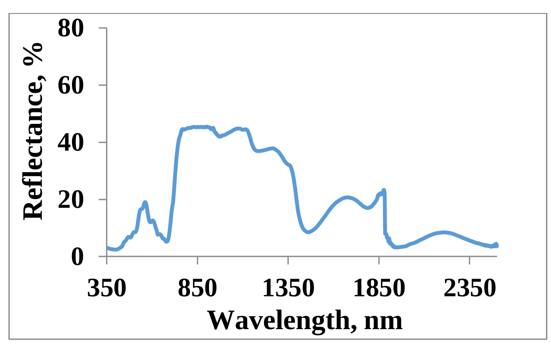
(a) T_1 (YBPM, 48%Ep)



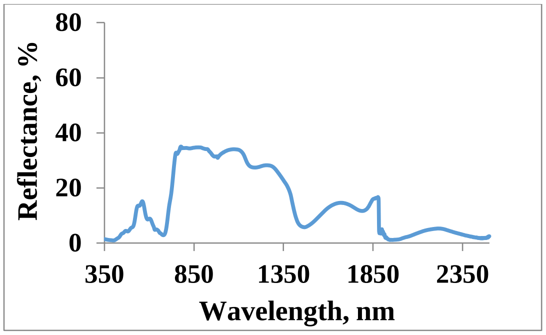
(b) T_2 (BBPM, 48%Ep)



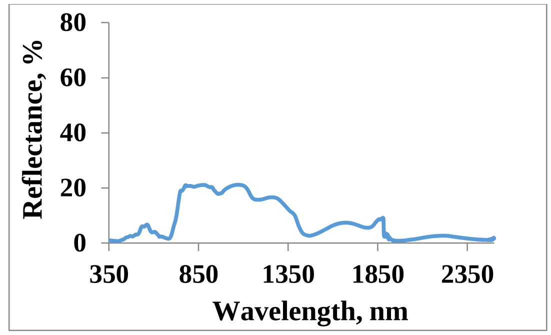
(c) T_3 (SBPM, 48%Ep)



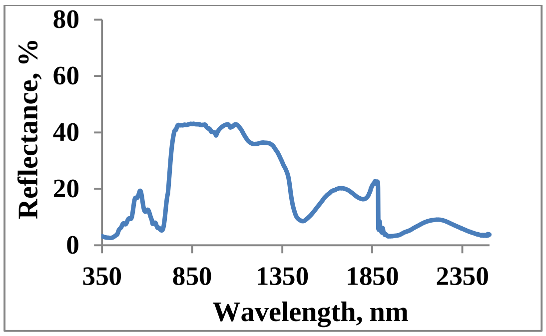
(d) T_4 (WBPM, 48%Ep)



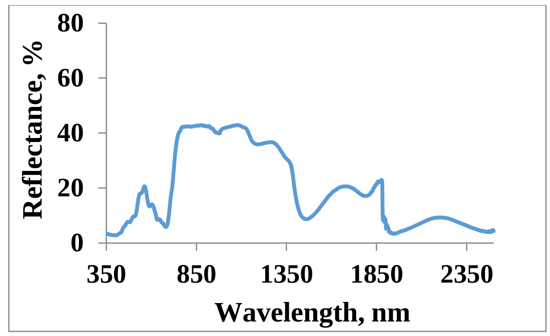
(e) T_5 (RBPM, 48%Ep)



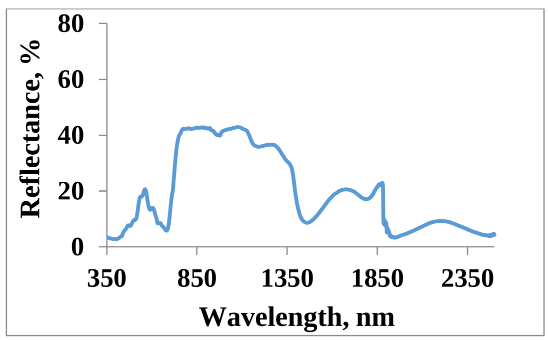
(f) T_6 (PPM, 48%Ep)



(g) T_7 (NM, 48%Ep)

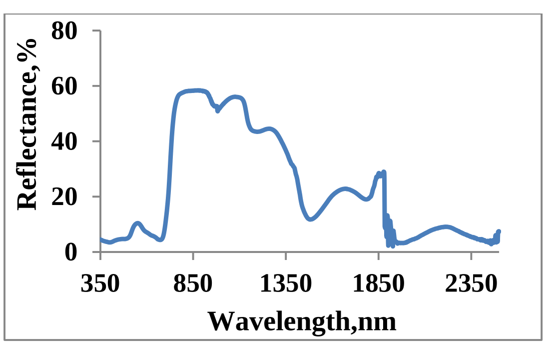


(h) T_8 (NM, 100%ETc)

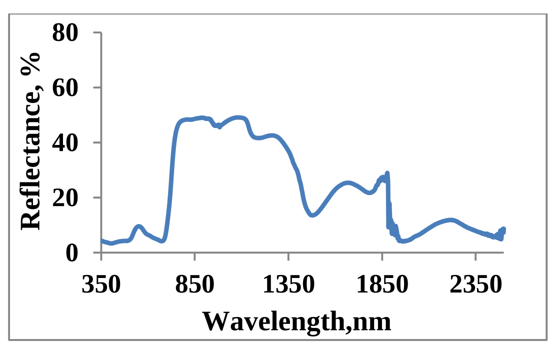


(i) T_9 (SI, 1.00 IW/CPE)

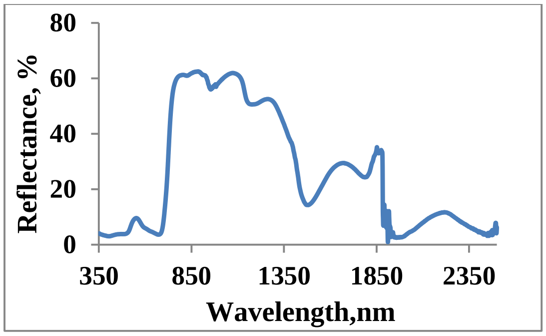
Fig. O.7. Spectral signatures of banana crop under various treatments 210 DAT



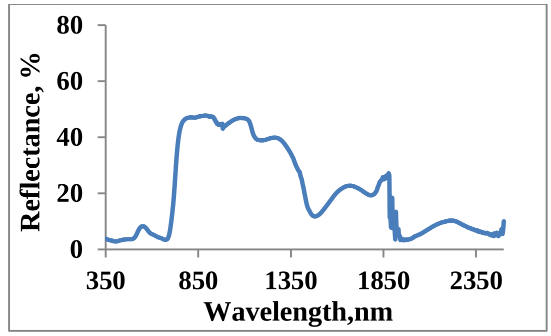
(a) T_1 (YBPM, 48%Ep)



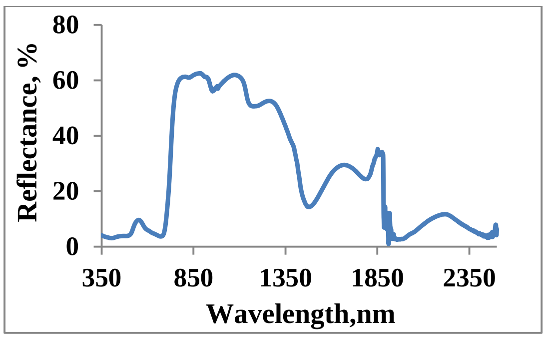
(b) T_2 (BBPM, 48%Ep)



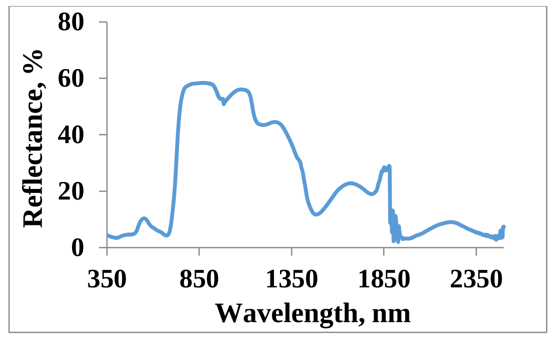
(c) T_3 (SBPM, 48%Ep)



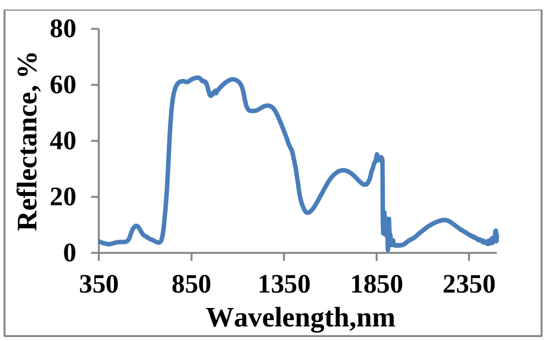
(d) T_4 (WBPM, 48%Ep)



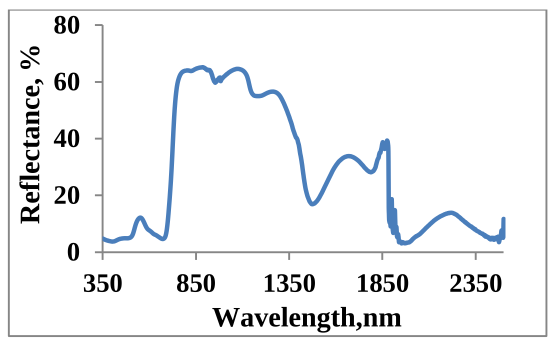
(e) T_5 (RBPM, 48%Ep)



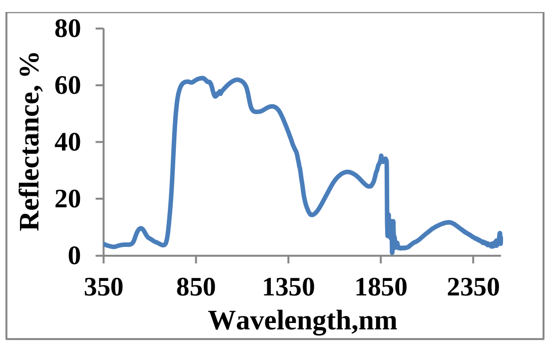
(f) T_6 (PPM, 48%Ep)



(g) T_7 (NM, 48%Ep)

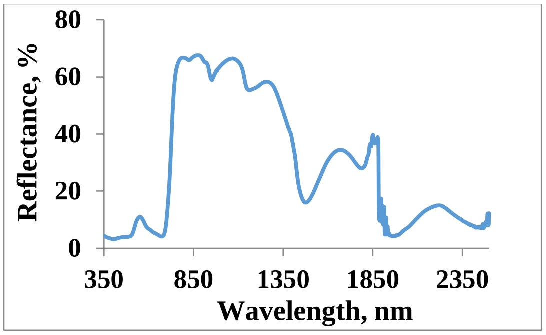


(h) T_8 (NM, 100%ETc)

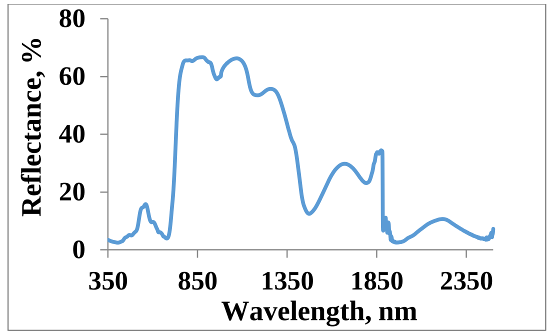


(i) T_9 (SI, 1.00 IW/CPE)

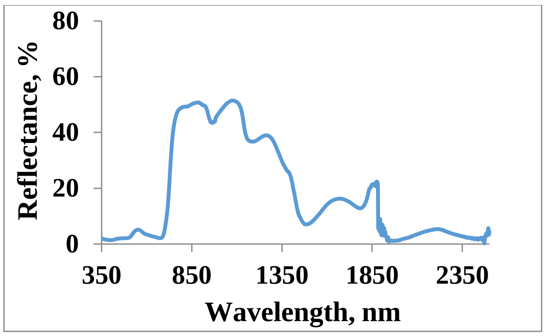
Fig. O.8. Spectral signatures of banana crop under various treatments 240 DAT



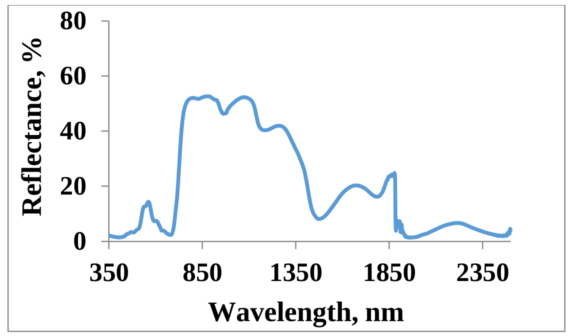
(a) T_1 (YBPM, 48%Ep)



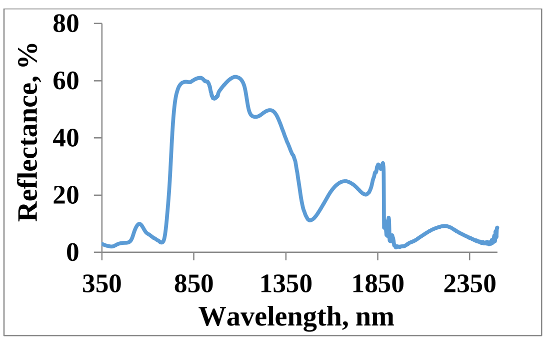
(b) T_2 (BBPM, 48%Ep)



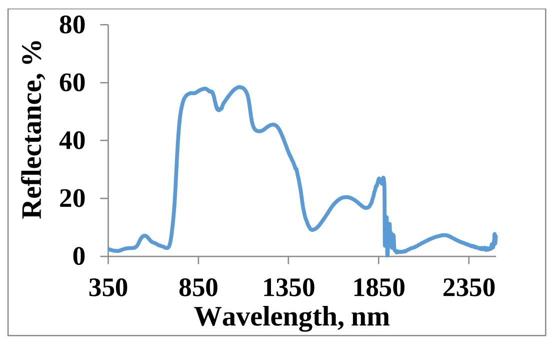
(c) T_3 (SBPM, 48%Ep)



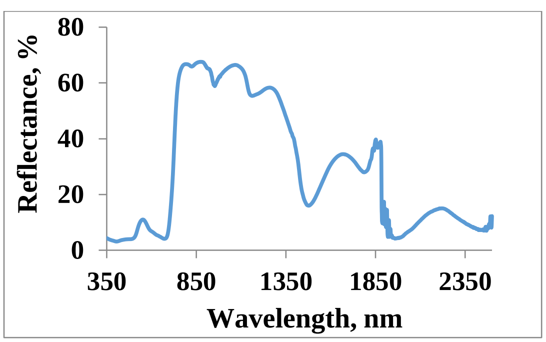
(d) T_4 (WBPM, 48%Ep)



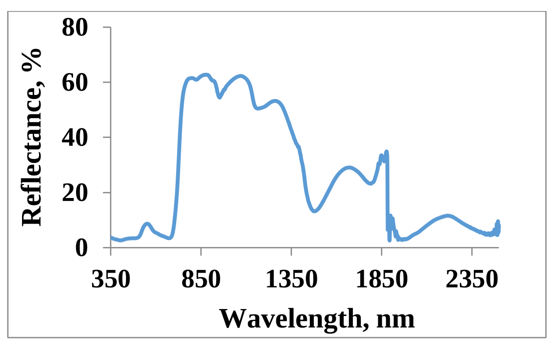
(e) T_5 (RBPM, 48%Ep)



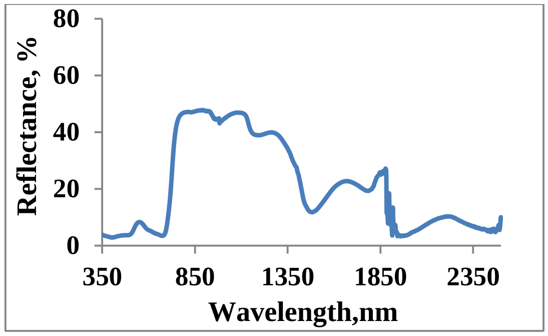
(f) T_6 (PPM, 48%Ep)



(g) T_7 (NM, 48%Ep)

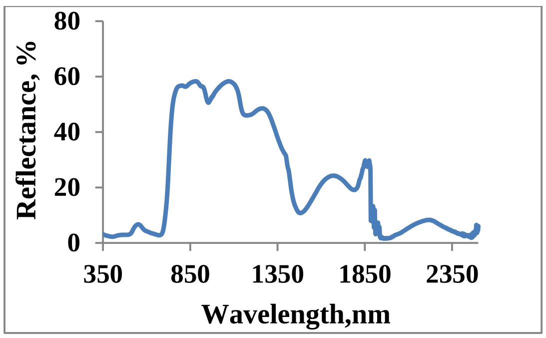


(h) T_8 (NM, 100%ETc)

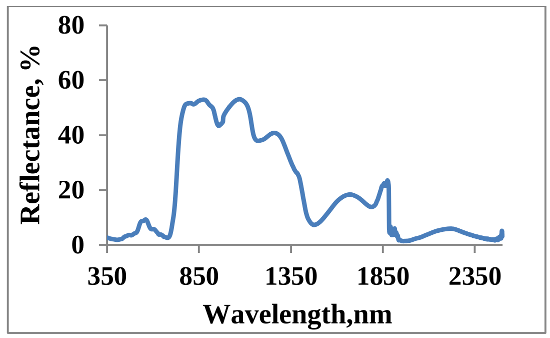


(i) T_9 (SI, 1.00 IW/CPE)

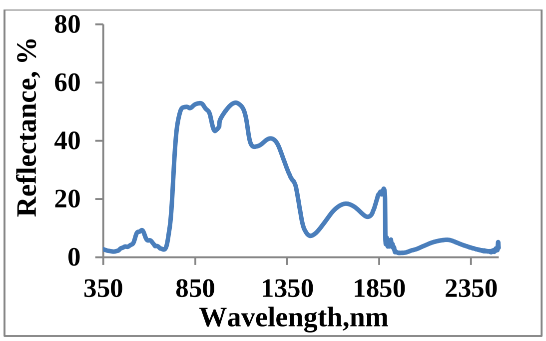
Fig. O.9. Spectral signatures of banana crop under various treatments 270 DAT



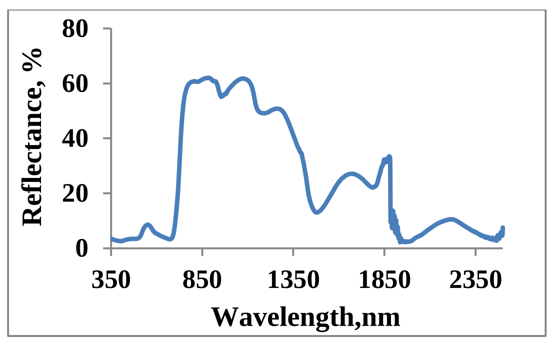
(a) T_1 (YBPM, 48%Ep)



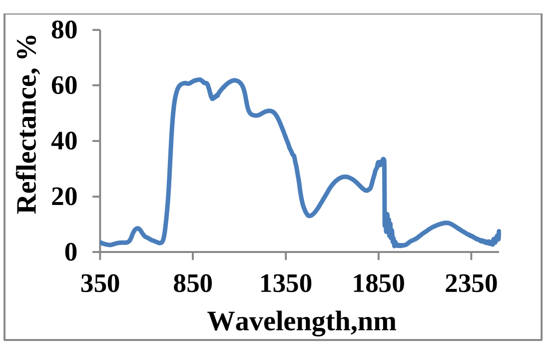
(b) T_2 (BBPM, 48%Ep)



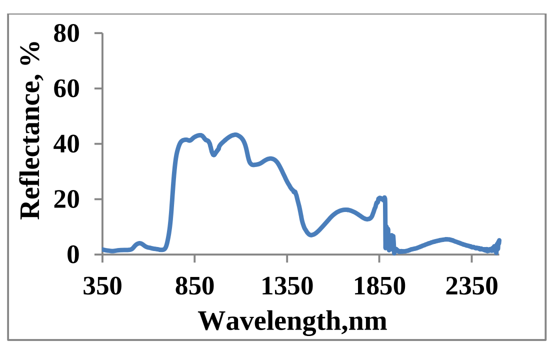
(c) T_3 (SBPM, 48%Ep)



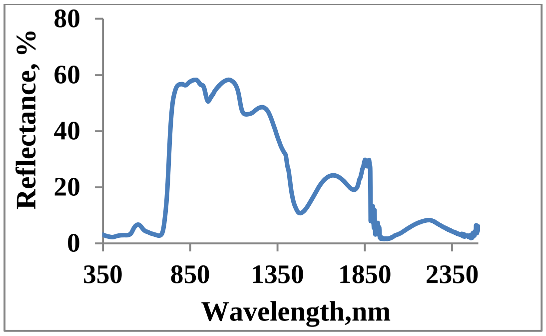
(d) T_4 (WBPM, 48%Ep)



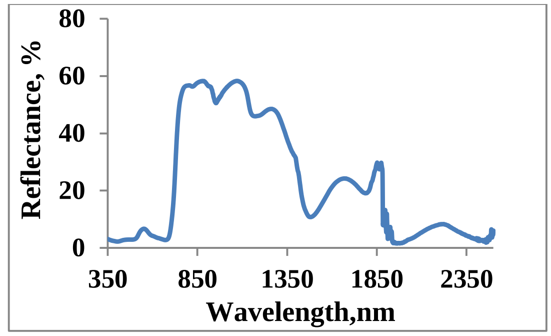
(e) T_5 (RBPM, 48%Ep)



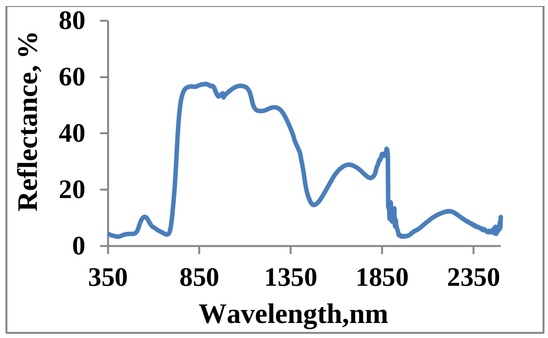
(f) T_6 (PPM, 48%Ep)



(g) T_7 (NM, 48%Ep)

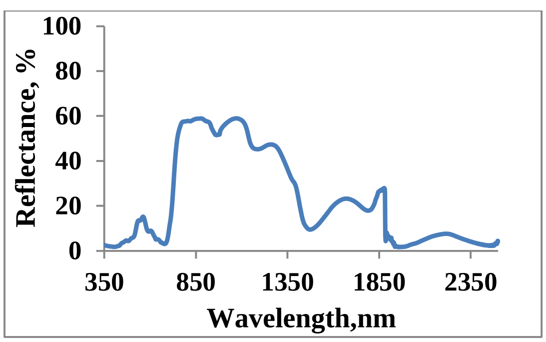


(h) T_8 (NM, 100%ETc)

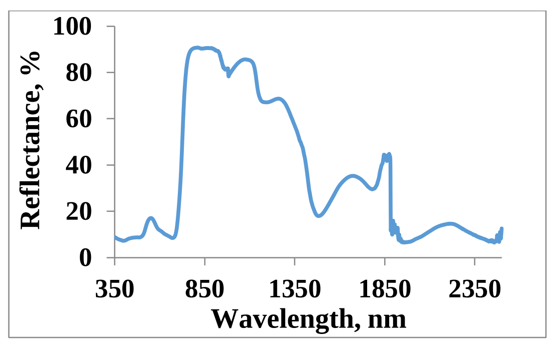


(i) T_9 (SI, 1.00 IW/CPE)

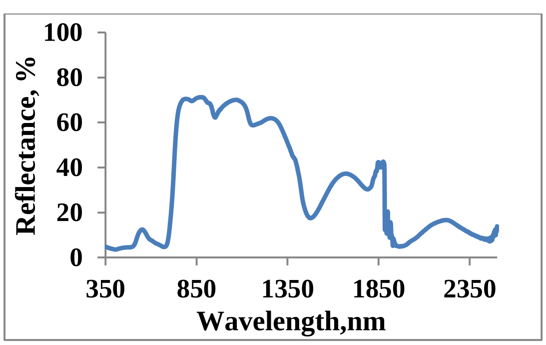
Fig. O.10. Spectral signatures of banana crop under various treatments 300 DAT



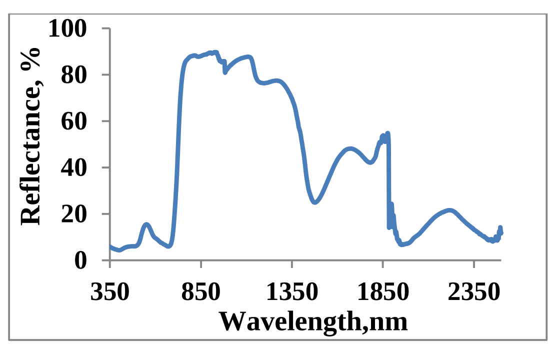
(a) T_1 (YBPM, 48%Ep)



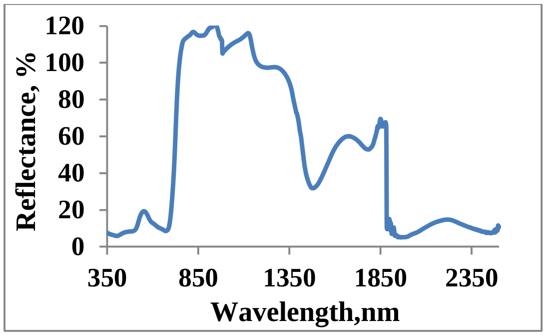
(b) T_2 (BBPM, 48%Ep)



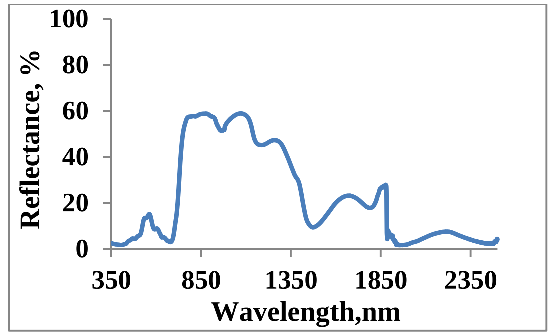
(c) T_3 (SBPM, 48%Ep)



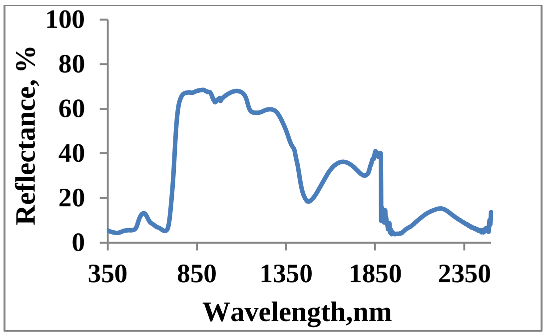
(d) T_4 (WBPM, 48%Ep)



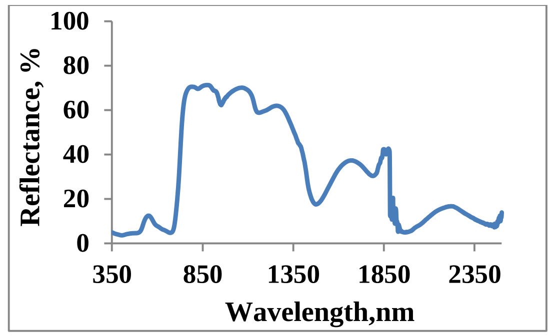
(e) T_5 (RBPM, 48%Ep)



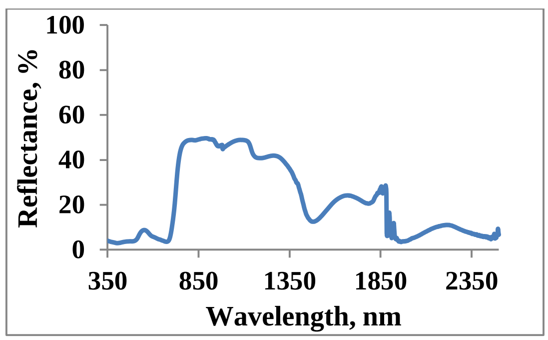
(f) T_6 (PPM, 48%Ep)



(g) T_7 (NM, 48%Ep)

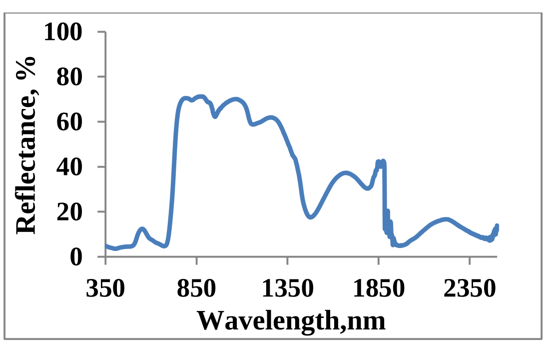


(h) T_8 (NM, 100%ETc)

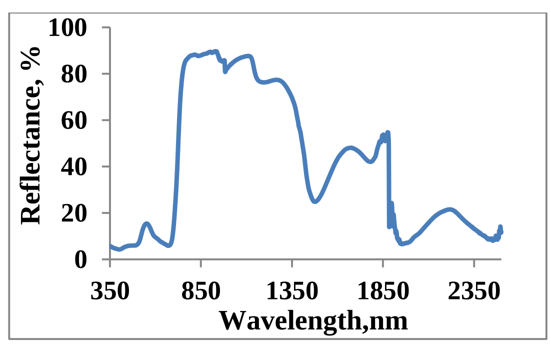


(i) T_9 (SI, 1.00 IW/CPE)

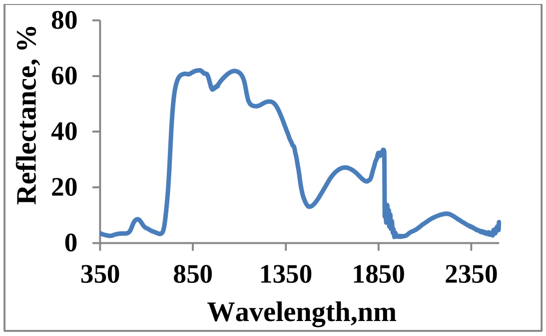
Fig. O.11. Spectral signatures of banana crop under various treatments at first harvest (320 DAT)



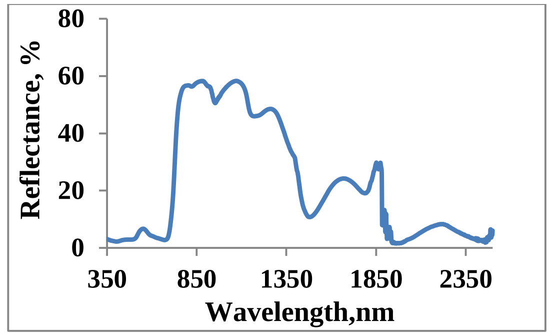
(a) T_2 (NM, 48% Ep)



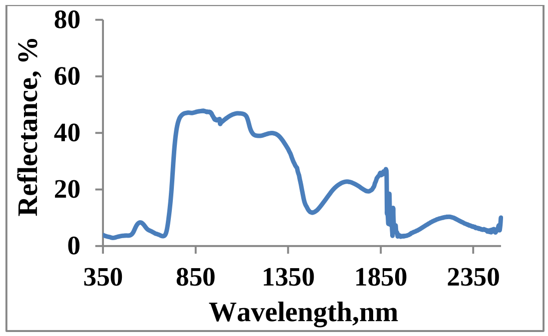
(b) T_5 (RBPM, 48%Ep)



(c) T_7 (NM, 48%Ep)

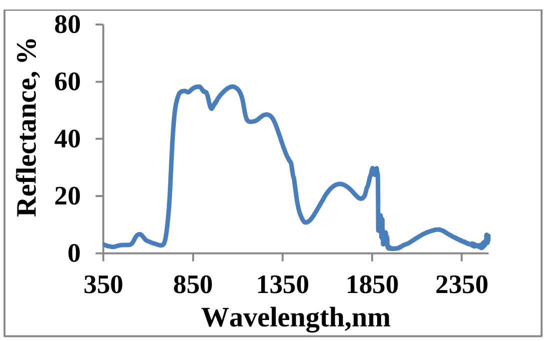


(d) T_8 (NM, 100%ETc)

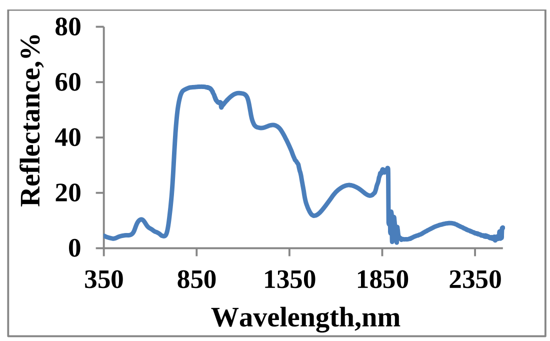


(e) T_9 (SI, 1.00 IW/CPE)

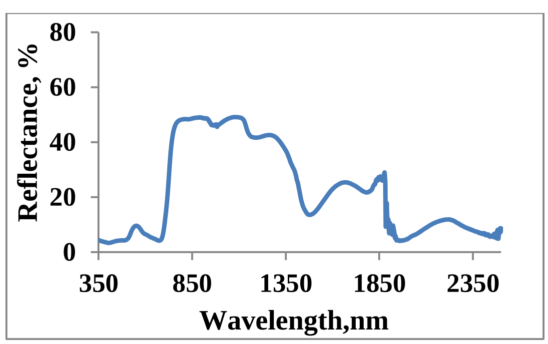
Fig. O.12. Spectral signatures of banana crop under various treatments at second harvest (362 DAT)



(a) T_7 (NM, 48%Ep)



(b) T_8 (NM, 100%ETc)



(c) T_9 (SI, 1.00 IW/CPE)

Fig. O.13. Spectral signatures of banana crop under various treatments at third harvest (377 DAT)

Appendix- P

Cost economics of banana cultivation under various treatments

Table P.1. Cost of cultivation per hectare of banana crop under different treatments

Sr. No.	Operations	Treatments								
A.	**Material cost, ₹**	**T_1 (YBPM, 48% Ep)**	**T_2 (BBPM, 48% Ep)**	**T_3 (SBPM, 48% Ep)**	**T_4 (WBPM, 48% Ep)**	**T_5 (RBPM, 48% Ep)**	**T_6 (PPM, 48% Ep)**	**T_7 (NM, 48%Ep)**	**T_8 (NM, 100%ETc**	**T_9 (SI, 1.00 IW/CPE)**
1.	Planting material at the rate of ₹ 12 per plant (3265 plants)	39180	39180	39180	39180	39180	39180	39180	39180	39180
2.	Soluble fertilizer applied per hectare	132619	132619	132619	132619	132619	132619	132619	132619	27923
3.	Basal dose	10634	10634	10634	10634	10634	10634	10634	10634	10634
4.	Colour plastic mulches (30µ)	46170	46170	46170	46170	46170	150480	0	0	0
5.	Pesticides and insecticides	746.7	746.7	746.7	746.7	746.7	746.7	1374.84	1374.84	1374.84
B.	**Labour charges, ₹**									
1.	Ploughing charges	3000	3000	3000	3000	3000	3000	3000	3000	3000

Table P.1. contd…

2.	Harrowing charges	2000	2000	2000	2000	2000	2000	2000	2000	2000
3.	Bed preparation and basal dose	2672	2672	2672	2672	2672	2672	2672	2672	2672
4.	Laying of mulch film	3507	3507	3507	3507	3507	3507	0	0	0
5.	Planting	1336	1336	1336	1336	1336	1336	1336	1336	1336
6.	Drenching application	83.5	83.5	83.5	83.5	83.5	83.5	167	167	167
7.	Spraying application	83.5	83.5	83.5	83.5	83.5	83.5	167	167	167
8.	weeding	501	501	501	501	501	501	2672	2672	4008
9.	Supporting to plants	1336	1336	1336	1336	1336	1336	1336	1336	1336
10.	Desuckering	2672	2672	2672	2672	2672	2672	3006	3006	3674
11.	Harvesting	2672	2672	2672	2672	2672	2672	2672	2672	2672
C.	**Electricity charges (3 HP) per season, ₹**	10230	10230	10230	10230	10230	10230	10230	10230	25575
D.	**Land revenue per season, ₹**	100	100	100	100	100	100	100	100	100
	Total cost, ₹	**259543**	**259543**	**259543**	**259543**	**259543**	**363853**	**213166**	**213166**	**125819**

Table P.2. Cost of drip system components per hectare of banana crop

Sr. No.	Name of component	No. of items	Cost per unit, ₹	Total cost, ₹	Life, years	Depreciation per season
1.	Sand filter, 20 m^3 hr^{-1}	1	15000	15000	20	675
2.	Pressure gauge	1	500	500	12	38
3.	Lateral end cap (16 mm)	114	1.90	217	6	32
4.	GTO (16 mm)	114	2.85	325	6	49
5.	Fertilizer injection unit	1	5250	5250	12	394
6.	Main (50 mm), 100 m length	-	37.90	3790	12	284
7.	Submain (50 mm), 100 m length	-	37.90	3790	12	284
8.	Lateral (16 mm), 5700 m length	-	5	28500	6	4275
9.	Emitters (4 lit hr^{-1})	6530	4	26120	6	3918
10.	Bypass assembly	1	1000	1000	12	75
11.	Ball valve	2	440	880	12	66
12.	Installation cost of drip system, ₹ 1000 per acre	-	-	2500	-	-
13.	Total cost of drip system, ₹	-	-	87872	-	10090

Table P.3. Cost economics of banana production per hectare under different treatments

Sr. No.	Operations	Treatments								
		T_1 (YBPM, 48%Ep)	T_2 (BBPM, 48%Ep)	T_3 (SBPM, 48% Ep)	T_4 (WBPM, 48% Ep)	T_5 (RBPM, 48% Ep)	T_6 (Pervious, 48% Ep)	T_7 (NM, 48%Ep)	T_8 (NM, 100%ETc	T_9 (SI, 1.00 IW/CPE)
1.	**Fixed cost, ₹**									
a)	Wooden support system (Shevari)	10000	10000	10000	10000	10000	10000	10000	10000	10000
b)	Life of support system (years)	2	2	2	2	2	2	2	2	2
c)	Depreciation per season	4500	4500	4500	4500	4500	4500	4500	4500	4500
d)	Drip System (details-Table P.2)	87872	87872	87872	87872	87872	87872	87872	87872	0
e)	Depreciation per season (details-Table P.2)	10090	10090	10090	10090	10090	10090	10090	10090	0
f)	Centrifugal pump (3 hp) for drip irrigation	20000	20000	20000	20000	20000	20000	20000	20000	0
g)	Life of pump, years	20	20	20	20	20	20	20	20	0
h)	Depreciation per season	900	900	900	900	900	900	900	900	0
i)	Centrifugal pump (7.5 hp) for surface irrigation	-	-	-	-	-	-	-	-	32000
j)	Life of pump, years	-	-	-	-	-	-	-	-	20

Table P.3. contd…

k)	Depreciation per season	-	-	-	-	-	-	-	-	1440
2.	**Repairs and maintenance per season cost, ₹ @ 2%**	2357	2357	2357	2357	2357	2357	2357	2357	840
3.	**Interest cost, ₹ @ 10%**	11787	11787	11787	11787	11787	11787	11787	11787	4200
4.	**Total operational cost, ₹ (1c+1f+2+3)**	29635	29635	29635	29635	29635	29635	29635	29635	10980
5.	**Cost of cultivation, ₹**	259543	259543	259543	259543	259543	363853	213166	213166	125819
6.	**Total cost of cultivation, ₹ (5+6)**	289177	289177	289177	289177	289177	393487	242801	242801	136799
7.	**Avg. yield produce, kg**	70667	63613	84450	68100	65800	81667	57733	59129	53007
8.	**Avg. market price, ₹ kg^{-1})**	7.5	7.5	8	7.5	7.5	8	6.5	6.5	3.5
9.	**Revenue, ₹ (7x8)**	527706	475515	675463	510600	493418	652000	375505	390780	185524
10.	**Net profit, ₹ (9-6)**	238528	186338	386286	221423	204240	258513	132704	147979	48725
11.	**B: C ratio (9/6)**	1.82	1.64	2.34	1.77	1.71	1.66	1.55	1.61	1.36

Table P.3. contd…

13.	**Seasonal water requirement, mm**	1113.64	1130.40	1015.24	1087.10	1080.57	1059.50	1141.94	1323.31	2204.40
14.	**Water saving over surface irrigation, %**	49.48	48.72	53.94	50.68	50.98	51.94	48.20	39.97	-
15.	**Additional area cultivated due to water saving, ha**	0.98	0.95	1.17	1.03	1.04	1.08	0.93	0.67	-
16.	**Additional expenditure due to additional area, ₹**	283236	274749	338716	297211	300754	425204	225901	161662	-
17.	**Additional income due to additional area, ₹ (9x15)**	516864	451790	791176	524785	513171	704554	349370	260190	-
18.	**Additional net income, ₹ (17-16)**	233628	177040	452460	227574	212417	279350	123468	98528	-
19.	**Total cost of production, ₹ (6+16)**	572414	563927	627894	586388	589932	818692	468702	404463	136799
20.	**Gross income, ₹ (9+17)**	1044569	927305	1466639	1035385	1006589	1356554	724875	650970	185524
21.	**Net income (20-19), ₹**	472156	363378	838746	448996	416657	537862	256173	246508	48725
22.	**Gross B: C ratio, ₹ (20/19)**	1.82	1.64	2.34	1.77	1.71	1.66	1.55	1.61	1.36

8. Vita

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