Chapter - III

MATERIAL & METHODS

MATERIALS AND METHODS

The present investigation entitled "Integrated nutrient management in papaya (*Carica papaya* L.) was carried out at Main Experiment Station as well as laboratory of Department of Horticulture, Udai Pratap Autonomous College Varanasi, (UP) during the years 2006-07 and 2007-08. The experiment was laid out in randomized block design with 11 treatments, 3 replications and 2 plants per unit of treatment. The details of the experiment procedures and techniques adopted are given below.

3.1Experimental site:

Geographically the experimental site lies under the course of Ganga river (Gangetic alluvium). The site is situated at Jaunpur-Varanasi road, Varanasi district headquarter (eastern UP).

3.2Meteorological conditions:

The climatic condition of Varanasi district comes under the semi-arid comprising three distinct seasons *viz.* rainy or wet, winter and summer or hot. The rainy season starts from the end of June and lasts in September or extends up to mid October with average annual rainfall of 1200 mm. Sporadic rains also occurs during winter. The winter season starts from November and continues up to first week March with mean temperature ranging from 15-25^{0}C. The months of December and January are very cold. January being the coldest month having lowest temperature. The hot seasons prevails from April to June, may normally being the hottest month of the year. The temperature during summer is intense and scorching, a little below 45^{0}C. The relative humidity during summer varies from 35 to 60 per cent. Severe

drought occurs quite frequently accompanied by very low relative humidity, more sunshine and wind velocity.

3.3 Experimental details:

Design used	:	Randomized Block Design
Total number of treatment	:	11
T_1	:	FYM+NPK (100%) – control
T_2	:	FYM + NPK (50%) +*Azotobacter*
T_3	:	FYM + NPK (50%) +*Azospirillum*
T_4	:	FYM + NPK (50%) +*Azotabacter*+**PSB**
T_5	:	FYM + NPK (50%) + *Azospirillum*+PSB
T_6	:	FYM + NPK (25%) + *Azotabacter*
T_7	:	FYM + NPK (25%) + *Azospirillum*
T_8	:	FYM + NPK (25%) + Azotabacter+PSB
T_9	:	FYM + NPK (25%) + *Azospirillum*+PSB
T_{10}	:	FYM + NPK (100%) + *Azotabacter*+PSB
T_{11}	:	FYM + NPK (100%) + *Azospirillum*+PSB
Dose of fertilizers (100%)	:	250g $N_1$250 g P_2O_5 and 500g K_2O/plant/year
Dose of bio-fertilizer	:	20g/plant/year.each
FYM dose	:	20 kg per plant/year
Replications	:	3
Plant unit	:	2 per treatment
Total number of plant	:	66
Year of sowing	:	August, 2006 and August , 2007
Year of transplanting	:	October, 2006,and October 2007
Planting distance	:	2x2 m
Test crop	:	Papaya *cv.* Ranchi dwarf

3.4Treatments application:

The recommended fertilizers dose@250:200:500g NPK plant^{-1} year^{-1} respectively (Tandon, 1987) was applied in the form of Urea, DAP and muriate of potash, Nitrogen and potassium were applied in three equal splits at three months intervals during Feb. –May-August, whereas, phosphorus was applied in two equal splits i.e. first dose at time of pit filling and dose along with the first dose of N and K application because phosphorus improves the bacterial growth and proliferation (Mishustin and Shilnikova, 1969). In bio-fertilizer application *Azotabacter, Azospirillum and* phosphorus solubilizing bacteria (PSB) were thoroughly mixed with FYM@ 20 g per prior to transplanting as per treatment.

3.5Test crop:

Papaya *cv.* Ranchi dwarf was used as test crop during both the years. This variety was developed through multiple crosses made at Tamilnadu Agriculture University, Coimbatore. The parents used were Pusa Delicious, CO-3, CP-75 and coorg Honey Dew. It can be down both in plains and up to an altitude of 1000m above mean sea level. It is a gynodioecious variety which produces female and hermaphrodite flowers on the separate plant. The fruits of papaya *cv.* Ranchi dwarf were found to be oblong in shape, sweet with attractive and firm red flesh. Being a high yielding cultivar it removes higher quantity of nutrients from the soil. Therefore, this cultivar was selected for the experiment.

3.6Cultural operations:

3.6.1 **Field Preparation:**

The experimental field was ploughed with tractor drawn mould bould plough to expose the weed seed and root stubbles during the month of May. Harrowing was done in the month of June to break the clods followed by cultivator. The field was pulverized by rotovator before digging of pits. The experiment was laid out as per plan with the help of measuring tape, rope and mark pegs, Demarked pits were dug in a dimension of 60 x60 x 60 cm at 2 x 2 m spacing. The top soil and sub soil of dugged pit were kept separately in two heaps near the pit.

3.6.2 Filling of pits:

The dug pits were exposed to sun for at least 15 days and filled back with well decomposed FYM @ 20 kg plant $^{-1}$ using top soil and subsoil separately in equal proportion and biofertilizers were also mixed thoroughly FYM. Top soil mixture is filled first at the bottom of the pit.

3.7Raising of papaya nursery:

Papaya seeds were sown in the month of August on raised seed bed (1.5 x 0.6 m size) provided with good drainage facility under playhouse condition. The soil of nursery bed was well prepared and manure with decomposed FYM. Seed were placed at 1-2 cm deep and 3-4 cm apart with row spacing of 15 cm. Seeds of papaya cultivar Ranchi dwarf were treated with carbendazim @ 3.0 g/kg seed to check fungal infection and proper germination. After sowing of seeds it was covered with a thin layer of fine dust of FYM and mulched with paddy straw. A frequent light irrigation was given for better germination and growth of seedlings.

3.8Transplanting:

Two months old papaya seedlings were transplanted during evening time in pre-determined location in the month of October. One seedling in each pit was planted followed by light irrigation. The planting distance was 2 x 2 meters. Eleven treatments were replicated three times in randomized block design.

3.9Irrigation:

Papaya field was given a light irrigation immediately after transplanting later. Irrigation was scheduled in summer at weekly intervals and in case of winter 10-15 day's interval

3.10 Weed management:

In order to avoid competition for growth in between crop and weed, the experimental plots were kept weed free by removing the weeds timely. The first weeding was done at one month after transplanting using Khurpi, in such a way that soil may be loosened to provide proper aeration to crop.

3.11 Plant protection:

Plant protection measures were adopted as and when needed during the crop growth period. Monocrotophos was sprayed during the growth period of the plant to reduce the infestation of aphid in order to control the yellow vein mosaic virus of papaya and other insects.

3.12 Harvesting:

The fully mature fruits of papaya were harvested when color changes from green to yellowish green. The fruits were harvested individually by hand picking, taking care to avoid all possible injuries. The mature fruit easily get

detached from stem either by turning it upward or by twisting. The fruits were harvested in the morning and kept in shade.

3.13 Observation recorded:

3.13.1 Growth parameters:

3.13.1.1Plant height (cm): The height of plants were recorded at the time of fruits maturity from ground level up to the first emerged leaf lf the growing point with the help of measuring tape and expressed in centimeter.

3.13.1.2Circumference (cm): Circumference of the plants was measured at the time of fruits maturity, 15 cm above the ground level at a market point with the help of measuring tape and expressed in centimeter.

3.13.1.3. Number of leaves per plant: The total number of leaves per plant was recorded at the time of fruit maturity and mean value was worked out.

Table 3.1: Initial vegetative growth of papaya plants

Treatment	Height (cm)	Circumference (cm)	Number of leaves plant $^{-1}$
T_1	57.25	12.20	17.50
T_2	66.50	10.80	16.33
T_3	59.33	10.00	12.00
T_4	68.50	11.80	16.50
T_5	64.54	12.60	12.66
T_6	55.25	10.00	12.50
T_7	60.50	9.60	14.50
T_8	62.50	10.50	16.33
T_9	60.00	10.00	12.50
T_{10}	67.50	10.80	15.50
T_{11}	62.00	11.20	17.33

3.13.2**Flowering and fruiting characters:**

3.13.2.1 Height at which first flower appeared: Height at which first flower appeared was recorded at flower initiation stage from the base of the plant to the height of the first flower appeared and expressed in centimeter.

3.13.2.2 Days for first flower appeared: The number of days required for first to appear was recorded by counting the days from transplanting to the appearance of first flower and average was worked out.

3.13.**2.3 Days for fruit maturity:** The number of days required for fruit maturity was calculated by recording the number of days from the fruit set the maturity of first fruit and average was worked out.

3.13.2.3 Physico-chemical characteristics:

3.13.3.1 Physical characteristics:

(i) Fruit size(cm): The length and width of three fruits were measured with the help of measuring scale and the average value was expressed in cm.

(ii) **Fruit weight (kg):** Weight of three fruits from each treatment was taken on the physical balance and the average value was expressed in kg.

(iii) **Number of fruits per plant:** The number of fruits per plant was recorded from each plant at each harvest. After the final harvest the number of fruits of every picking were counted and average value was calculated.

(iv) **Yield per plant (kg):** Fruit yield per plant (kg) was calculated by multiplying the number of fruits per plant to the average weight of fruit.

(v) Shelf life of fruits: Three fruits from each treatment were stored at room temperature for determining the shelf-life of fruits. Shelf life of fruit was determined by keeping the mature fruits of uniform size and free from injuries during September and October till it became very soft ad pulp became loose in structure.

3.13.3.2 Chemical characteristics:

(i) Total soluble solids: It was recorded with the help of hand refract meter of 0 to 32% range at 20 ^{0}C and mean value was expressed as per cent total soluble solids.

(ii) **Titrable acidity:** The acidity of fruit was estimated by titrating the aliquot against NaOH solution using phenolphthalein as an indicator. The total titrable acidity was expressed as per cent citric acid.

$$\text{Acidity (\%)} = \frac{\text{Titer value x Normality of NaOH x Volume made up x 64}}{\text{Aliquot taken x weight of sample x 1000}} \times 100$$

(iii) Ascorbic acid: To determined the ascorbic acid, 5 g fruit pulp was dissolved in 3% metaphosphoric acid and volume was made up to 100ml. Five ml aliquot was titrated against standardized 2, 6 dichloro endophenol dye. The end point was marked by the appearance of pink color persisted at least for 15 seconds. The ascorbic acid content was expressed as mg of ascorbic acid per 100g of pulp (**A.O.A.C., 1999).**

$$\text{Ascorbic acid (mg/100g of pulp)} = \frac{\text{Titer value x dye factor x Value made up}}{\text{Aliquot taken x weight of sample}} \times 100$$

(iv) **Sugars:**

a. **Reducing sugars:** To determine the reducing sugars 10g pulp was crushed with distilled water, filtered muslin cloth and volume was maintained upto 100ml. Five ml aliquot was taken with 5 ml Fehling solution 'A' and 'B' in 100 ml conical flak and was titrated against 1 per cent glucose solution while boiling by using methylene blue as indicator. The end point was marked by the appearance of brick red colour.

b. **Non-reducing sugars:** Non-reducing sugars was estimated by deducting the quantity of reducing sugars from total invert sugars and multiplied by factor 0.95. The results were expressed as per cent non-reducing sugars.

c. **Total Sugars:** Out of 100 ml sample, 5 ml aliquot was taken, mixed with 3 drop of HCL, and kept over night. Next day, 2-3 drop phenolphthalein indicator was added and neutralized with 30 per cent sodium hydroxide (NaOH) solution. It was titrated against 1.0 per cent glucose solution while boiling using methylene blue as indicator. The appearance of brick red colour was marked as the end point. The results were expressed as per cent total sugars.

3.13.3.3 Nutrients status of plants:

Leaf sampling: From each experimental plant leaves petiole were collected in paper bags. Sixth leaf petiole from the top at flowering stage was used for leaf nutrient analysis as suggested by Sanyal *et al.* 1990, .The samples were washed thoroughly with water and dried in the oven at 65 ^{0}C till the constant weight was obtained. After grinding, it was used for the analysis of nitrogen, phosphorus, potassium, calcium and magnesium contents and value was expressed on per cent dry weight basis. The initial nutrient status of papaya has been given in Table 3.2.

Table 3.2: Initial nutritional status of papaya leaf petiole

S. No.	Nutrient	Content (%)
1.	Nitrogen	1.26
2.	Phosphorus	0.23
3.	Potassium	2.76
4.	Calcium	1.37
5.	Magnesium	0.32

(i) **Nitrogen:** The nitrogen content in papaya petiole was determined by Microkjeldhal method as advocated by **Peach and Tracy (1956).**

(ii) Phosphorus: The phosphorus content in petiole was determined by wet digestion method by developing Vanadomalybdo colour as given by **Richards (1954).**

(iii) **Potassium:** The potassium content was analyzed with the help of flame photometer as given by **Jackson (1973).**

(iv) **Calcium and Magnesium:** Calcium and magnesium content in leaf petiole was analysed by EDTA Titration method as suggested by **Black (1965).**

3.13.3.4 Soil characters:

Soil sampling: Soil sample from the basin of papaya plants were collected before the start and at the termination of the experiment at 0-15 and 15-30 depths with the help of soil auger. These were dried in the oven at a temperature of 105 ^{0}C till the constant weight was obtained. It was then subjected to chemical analysis. The initial values obtained for the different chemical properties of soil have been presented in Table 3.3

Table 3.3: Soil characteristics before the experimentation

Soil character	Depth (cm)	
	0-15	15-30
(A) Soil reaction		
(a) Soil reaction (pH)	7.84	7.81
(b) Electrical conductivity	0.77	0.75
(c) Organic carbon (%)	0.24	0.25
(d) Exchangeable Sodium per cent (ESP)	19.60	19.55
(B) Available nutrients		
(a) Nitrogen (kg ha^{-1})	242.60	258.50
(b) Phosphorus (kg ha^{-1})	18.38	17.70
(c) Potassium (kg ha^{-1})	260.55	258.50
(C) Soluble cation (me 100 g^{-1})		
(a) Calcium (Ca^{++})	4.44	4.38
(b) Magnesium (Mg^{++})	6.75	6.70

(i) **Soil pH**: It was obtained with the help of digital pH meter, using 1:2.5 soil water suspensions as advocated by **Sing *et al.* (1999).**

(ii) EC (Electrical carbon: It was estimated by digital conductivity meter **(Singh *et al* 1999).**

(iii) Organic carbon: It was estimated by **Walkley and Black (1934).** Rapid titration method as described by **Baruah and Borthakur (1998)**

(iv) Exchangeable sodium per cent (ESP): It was estimated by the method as suggested by Jackson (1973) with the help of following formula.

$$ESP = \frac{\text{Exchangeable sodium (me 100 g}^{-1}\text{soil)}}{\text{Total cation exchange capacity}}$$

(v)**Available nitrogen:** It was estimated by alkaline potassium per magnate method (**Subbiah and Asija, 1956**) as suggested by **Baruah and Borthakur (1998).**

(vi) Available phosphorus : It was estimated by Olsen's method as described by **Baruah and Borthakur (1998).**

(vii) Available potassium: It was estimated by flame photometer with the use of saturation extract as soil as described by **Baruah and Borthakur (1998).**

(viii) Calcium and magnesium: Available calcium and magnesium in the extract of soil water (1:5) suspension were determined by 'Versenate' method as described by **Chopra and Kanwar (1999).**

3.14. Economic analysis:

(i) **Gross income (Rs ha^{-1}):** The yield of papaya (treatment wise)was converted into gross income based on the prevalent market price.

(ii) **Net income (Rs ha $^{-1}$):** The best income was calculated for each treatment by deducting the cost of production from the gross income obtained in each treatment.

(iii) **Cost of cultivation (Rs. Ha^{-1}):** The cost of cultivation of papaya (treatment wise) was cultivated separately by adding the value of each inputs i.e. labor charges, cost of chemicals etc. In each treatments during the experimental period.

(iv) **Cost: Benefit ratio:** The cost: benefit ratio of different treatment was calculated by dividing the net income by respective cost of cultivation of different treatments using the following formula.

$$\text{Cost Benefit ratio} = \frac{\text{Net income}}{\text{Total cost of cultivation}}$$

3.14 **Analysis of data:** The two years data obtained during experimentation were statistically analysed as per method given by **Panse and Sukhatme (1985)** and results were evaluated at 5% level of significance.

The standard error (S. Em ±) for the difference of treatment means were computed as fallows.

$$S.Em \pm = \sqrt{MSE/R}$$

Where,

MSE = Mean sum of squares due to error

R = Number of replication

The following of C.D. at 5% of table value was carried out with the hep of following formula.

C. D. = S. Em ± 2 x t value at 5%

C. D. = Critical difference

S. Em ± = Standard error of mean