Vishvanath Babu-Patil

Vishvanath Babu-Patil

A

Affectionately Dedicated to My

Beloved Mother

Late Sau. Seetamai

..... VINAYAK

Shri Babu-

STUDIES ON THE EFFECTS OF DIFFERENT TRAINING SYSTEMS AND SEASONS ON YIELD OF BITTER GOURD (Momordica charantia L.) cv. CO WHITE LONG

By

Vinayak Ramchandra Joshi

B. Sc. (Agri.) First Class

A Thesis submitted to the

MAHATMA PHULE AGRICULTURAL UNIVERSITY

RAHURI, 413 722 DIST - AHMEDNAGAR,
Maharashtra State (India).

in partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

HORTICULTURE

DEPARTMENT OF HORTICULTURE
POST - GRADUATE INSTITUTE.
MAHATMA PHULE AGRICULTURAL UNIVERSITY,
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Approved by :

Dr. K.E. Lawande

Chairman and Research Guide

Dr. P.N. Kale

Committee Member

Prof. P.S. Pol

Committee Member

Prof. A.N. Wagh

Committee Member

POST GRADUATE INSTITUTE

DEPARTMENT OF HORTICULTURE,

MAHATMA PHULE AGRICULTURAL UNIVERSITY, RAHURI 413 722

DIST:AHMEDNAGAR, MAHARASHTRA STATE, INDIA.

1991

CANDIDATE'S DECLARATION

I hereby declare that this thesis
or part thereof has not been
submitted by me to any other
University or Institute
for a Degree or
Diploma.

Rahuri

DATED : 29th Aug. 1991

Joshi

(V. R. JOSHI)

Dr. K.E. Lawande,
Senior Vegetable Breeder,
Department of Horticulture,
Mahatma Phule Agricultural
University, Rahuri 413 722,
Dist : Ahmednagar, M.S. (India).

CERTIFICATE

This is to certify that the thesis entitled, ***"Studies on the effects of different training systems and seasons on yield of Bitter gourd (Momordica charantia L.) cv. CO White Long"****, submitted to the* ***Mahatma Phule Agricultural University, Rahuri (Maharashtra)*** *for the award of the degree of* ***MASTER OF SCIENCE (AGRICULTURE)*** *in* ***Horticulture,*** *embodies the results of bona fide research work carried out by* ***SHRI VINAYAK RAMCHANDRA JOSHI*** *under my guidance and supervision and that no part of the thesis has been submitted for any degree or diploma.*

The assistance received by him is duly acknowledged.

RAHURI
DATED : 29th Aug 1991

(K.E. LAWANDE)
Research Guide

Dr. N.K. Umrani,
Associate Dean,
Post Graduate Institute,
Mahatma Phule Agricultural
University, Rahuri-413 722,
Dist: Ahmednagar (M.S.),
India.

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(N. K. UMRANI)
Associate Dean (PGI)

RAHURI

DATED : 9/1/91

Vinayak R. Joshi

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Acknowledgement (Contd.)

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Place : MPAU, Rahuri.

Dated : 29th August, 1991.

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ABSTRACT

STUDIES ON THE EFFECTS OF DIFFERENT TRAINING SYSTEMS AND SEASONS ON YIELD OF BITTER GOURD (*Memordica charantia* L.) cv. CO White Long

by

VINAYAK RAMCHANDRA JOSHI

1991

Research Guide : Dr. K.E. Lawande

Department : Horticulture

Productivity of bitter gourd cv. CO White Long as influenced by different systems of training in different seasons together with its economic feasibility was studied at Instructional-cum-Research-Farm of Horticulture Department of Mahatma Phule Agricultural University, Rahuri during Summer, *Kharif* and *Rabi* seasons of 1990-91. Four systems of training viz.; ground, bush, kniffin and bower were tested in simple randomised block design with five replications in each season in a plot size of 7.5mx 5m having three rows spaced at 2.5 m apart with five plants spaced at 1 m within row. Sowing of summer, *kharif* and *rabi* seasons was done on 5.2.90, 15.5.90 and 15.9.90, respectively.

Irrespective of the season of planting, the bower system of training was the most efficient in increasing the productivity of bitter gourd. There was 120, 107 and 25 per cent increase in yield due to bower system over ground, bush and kniffin system, respectively. An increase in yield was mainly due to vigorous vine growth, higher number of branches, proper distribution and exposure of fruiting area to sunshine which resulted in to the production of higher number of fruits with more length and diameter. Since the fruiting area in bower system remained sufficiently high above the ground, there was less incidence of fruit fly.

The bower system of training observed to be more stronger, durable and economically viable as it had given the highest return per rupee invested to its installation (Rs.2.44).

The summer crop sown on 5.2.90 recorded the highest yield than kharif and rabi season plantings. The major fruiting of summer planting was from June to September which availed congenial climatic conditions and as a result there were more number of pickings and, thus, higher yield. Despite of longer and thicker fruits in kharif season, the yield was less as the crop was heavily damaged by post-monsoon rains from the last week of

September to the first fortnight of October. The vine growth was rather restricted in rabi season. The low temperatures during fruiting seasons exercised adverse effects on fruitset and development, consequently there was reduction in yield.

The effect of training systems and planting seasons when compared together it was clearly observed that the summer planting with training of vines on bower system was the most ideal which recorded the highest fruit yield of 227.43 quintals per hectare.

(Pages : 1 to 77)

T. 2332

Introduction

1. INTRODUCTION

Cucurbitaceous vegetables constitute an important and the largest group of vegetable crops extensively cultivated in India. They have a high place in diet as a rich source of vitamins, mineral elements and carbohydrates. More than 16 types of cucurbits together form the largest group of summer vegetables. The diversified but mild climate of Western Maharashtra and Konkan facilitate year round cultivation of all cucurbitaceous vegetables.

Bitter gourd (Momordica charantia L.) is one of the important cucurbitaceous vegetables widely cultivated in Maharashtra. The importance of bitter gourd has long been recognised due to its high nutritive value and medicinal properties (Choudhury, 1967). Among the different cucurbitaceous vegetables, it provides a rich source of vitamin 'C', proteins, phosphorous, potassium and iron (Gopalan et al. 1980). It is also said to have anti-diebetic properties. Immature fruits are cooked as vegetable, as well as pickles can be made out of mature fruits. Due to substantially high yields, ease in cultivation, steady market demand and export potential, bitter gourd has become commercially important vegetable of the state.

So far bitter gourd is being cultivated as per the conventional method i.e. sowing the seeds in furrows opened

at wider distance and training the vines on ground. Sparse attempts are being made to grow the vines with the help of some supports. Some of the experienced cultivators do train the vines on either kniffin or bower. Any kind of training has many fold advantages over growing the vines on ground such as :

i) The training provides good opportunity for growth and expansion of fruiting area and as a results the number of fruits are more and thereby there is increase in yield.

ii) Since the complete vegetative growth and fruiting portion remain considerably high above the ground there is cleaner harvest, the incidence of fruit fly and fungal diseases is also low.

iii) The fruits remain pendent due to which they grow straight and slightly longer.

iv) Proper illumination of light enhances the growth and productivity of the vines.

v) The operations like spraying, dusting and harvesting have become more easier.

Basically, all cucurbits are warm season crops and respond very well during kharif season. All Indian text books recommended planting of bitter gourd during kharif

season for better yields. Maharashtra has got mild but diversified climatic conditions which permit year round cultivation almost all vegetables.

Seshadri (1986) recommended growing of cucurbits in kharif as well as in summer season in Central and Southern India. The winter in Maharashtra is not so severe and, thus, the climatic condition can permit year round cultivation. However, this needs confirmation by experimentation.

The scientific approach towards this aspect of cultivation in all cucurbits except cucumber in glass house has been neglected so far. It was, therefore, felt necessary to standardise various systems of training and to study the effects of different planting seasons on yield of bitter gourd with the following objectives.

i) To study the effects of different training systems and planting seasons on yield of bitter gourd.

ii) To study the economic feasibility of training systems.

iii) To study the incidence of fruit fly.

Review of Literature

2. REVIEW OF LITERATURE

All the vine crops require support for their better growth and high yield of quality produce. Supporting of grape vines, pepper, bettle vine, passion fruits etc. have been widely accepted for obtaining high yields with superior quality. A lot of research has been published on this aspect. Some cucurbitaceous vegetables also respond to training, however, the research findings published are very meagre. Efforts have been made to review the suitable references pertaining to cucurbits as well as other similar plant ideotypes in this chapter.

I. Effect of planting season

Seaton and Kremer (1939) investigated the influence of climatological factors on anthesis and anther dehiscence in cucurbits. They observed that the optimum range of temperature for anther dehisence is 12 to 14°C.

The higher incidence of foliar diseases during warm and moist weather (Kharif season) has been reported by various workers and important amongst them are Mitra (1930), Verma et al. (1973), Abiko and Kishi (1979).

Cucurbits are essentially warm season crops grown mainly in tropical and sub-tropical regions. Long warm period, followed by dry weather and abundent sunshine favours the growth of cucurbitaceous vegetables. They are

not adopted to resist even light frost and required partial protection during hard winter months. The average temperature for growth could be around 30-35°C.

The gourds are grown mostly in summer as well as in rainy season in South and Central India. Most of them are grown round the year. The growing season is mainly determined by rainfall and temperature conditions. It is preferable to avoide the fruits of cucurbits maturing during spell of rainy weather or heavy downpour (Seshadri, 1986).

Srivastva (1987) studied the effects of the summer, kharif and rabi seasons on the yield of seed in bitter gourd var.CO.1 Long under Rahuri conditions; and reported that the number of fruits per vine was higher during kharif followed by summer season.

II. Effect of training

2.1 Grapes

Chaurey (1955), stated that bower system of training in grapes is ideal because of exposure of all leaf surface to the sunlight.

Marigowda and Gopal (1965) observed better performance of modified high pendal system of training in grape cultivation but the capital expenditure was found to be more.

Despite of high errection cost, the bower system appears good as it gives higher yield of grapes as compared to kniffin, telephone and head system (Randhawa, 1967; Bakhshi and Kanwar, 1969 and Bindra and Brar, 1978).

Sathiamoorthy and Bhakthvatsalu (1977) observed that the pendal system of training is more economical though the highest yield of grape was obtained in telephone system of training. They also obtained the highest cost benefit ratio with pendal system followed by telephone, kniffin and head system.

Daulta et al. (1981) advised that head system is good for average and marginal growers who are unable to invest high initial costs and bower system is good for progressive orchardist who can afford to spend higher initial investment in grape cultivation.

2.2 Tomato

Thompson (1949) has explained the methods of training tomato crop by providing sticks. The advantages claimed by the author include less disease injury, larger yields, clean fruits, more convenient harvesting and greater convenience for spraying.

Van Blommestein (1950) studied practical utility of training tomatoes and concluded that training of summer tomatoes is desirable as it increases the yield of

marketable fruits. The increase in yield is due to the reduction in injury from sun burn, rottling and damage by insects, more effective disease and pest control and reduction in mechanical injury to plants and fruits.

Burdeh and James (1952) reported that proper training and prunning of tomatoes and cucumber besides producing higher yields can be grown in limited space.

2.3 Cucumber

Persson et al. (1954) noted that training plants as espaliers proved superior to cordon culture when 8 strains of cucumber variety Bucher were compared.

Allen (1963) has worked out the labour input for growing cucumber crop on the cordon system. It was almost identical to that required for traditional system on equivalent area basis. Gross return from the first and second crop favoured the cordon plants by 9 per cent and 7 per cent.

Bafldie and Groenewegen (1965) suggested three stem system for cucumber training which has increased yields and improved quality of fruits as compared to the normal method.

Brain Furner (1967) has recommended trellis of 6 ft. height to harvest the fine crop of cucumber. This can be prepared from bamboo, but the plants grow equally well

on a trellis of scrap iron poles linked together with steel wires. It is advised to tie the vines regularly to the supports and pinch out the growing point when vines reach top.

Cordon system of training has been recommended by Wichold (1967) over espalier system by experimentation over several years. An increase in yield in cordon system was 15-20 per cent over espalier.

Konsler and Strider (1973) reported 100 per cent increase in yield by trellising the cucumber. Fruits were more uniform, dark green in colour and graded more fancy. It also gave better results against scab and soil rot. They also suggested that reasons for improved yield and quality from trellising include less damage to vines, greater photosynthetic efficiency, improved pest control and more efficient harvesting.

Stan et al. (1980) obtained the highest total and early yield of cucumber trained on pergola and other 6 training systems, while Nichols et al. (1982) observed the largest fruit size in training cucumbers on cordons or umbrellas.

Hanna and Adams (1985) observed that cucumber plants trained vertically gave higher marketable yield than plants trained on the ground. They also concluded that fruit

quality was improved with increased fruit-set, though the number of flowers was the same in staked and unstaked plants.

Bakker and Vooren (1985) obtained the highest productivity of cucumber when trained on 'V' system.

Daily harvesting increased fruit numbers and total yield per plant of cucumber when trained on a cordon of 2m high support (Botos et al. 1986).

2.4 Bottle gourd

It is stated (Anonymous, 1962) that vines of bottle gourd are allowed to trail on the ground or trained over walls, trees or other supports. Training the vines over the thatch of dwellings is reported to give higher yield of fruits.

John Organ (1963) observed that Lagenaria gourds, when grown in open garden, occasionally throw out nodal roots in addition to principal root system. This nodal rooting can be a great asset. He has further reported that cucurbits when encouraged to climb, obtain a benefit of a free air ciculation, as a result, the risk of stem rot is lessened and the fruit remains clean and healthy. He also observed that it is possible with little efforts to grow cucurbits in a surprisingly small area by training them up wires or sticks. It helps to keep the plants tidy and to

reap heavier yield of fruits.

Yawalkar (1969) reported that the rainy season crop of bottle gourd is usually staked, often trained on a bower made of bamboos and sticks. The late crop, usually trained on the thatch of dwellings, is believed to give better yield.

Magdum (1971) studied the effects of different training methods on growth and production of bottle gourd. He concluded that the bower system of training has produced significantly higher number of fruits of bottle gourd and the damage to fruits by soil was also prevented. He attributed this high productivity to better use of sunlight by maximum number of leaves and higher number of side branches resulting in better assimilation of carbohydrates. He further observed that the vertical system of training has brought reduction in growth and production due to the crowding of vines and overlapping of leaves resulting in comparatively reduced vine length, less photosynthetic activity and consequently less production of fruits. The local system of ground training of bottle gourd favoured the added vigour by nodal rooting which has proved to be a great asset in increasing growth and production. Finally, he concluded that bower and ground systems are superior to the vertical training system.

Singh (1989) recommended supporting of bottle gourd during rainy season. The bower made of bamboos and sticks helped the plant to grow vigorously. While narrating the advantages of growing bottle gourd on bower system, he stated that the fruits escape from direct contact with soil and, thus, avoide rotting, the growth and development of fruits is better than ground since the fruits remain hanging on bower system.

2.5 Bitter gourd

Yawalkar (1969) has advised to support the vines of bitter gourd by fixing stakes or tree branches in the middle of the beds while trailing, so that the plants can climb over them from sides.

Mishra and Sahu (1983) suggested the training of tetraploid Momordica dioica over a strong bower because of its heavy growth in one season.

Bitter gourd vines of summer crop should be allowed to grow on ground covered with a thin layer of dry grasses. This helps to avoid rotting of fruits as they do not come in the direct contact of the soil. Rainy crop is generally trained on 'Jhala' made of wooden sticks and jute string. In this method, fruit remains away from the direct contact of soil, rather they remain hanging, which ensures proper and quick development of fruits. This facilitates easy

spraying of insecticides and harvesting also becomes easy (Singh, 1989).

2.6 Other cucurbits

Wester et al. (1942) observed that the ground and trellis system had a little effect on fruit shape, in short fruited species of Luffa gourd. Most of the fruits of long fruited strains on the ground became very crooked, while the fruits hanging freely from the trellis were straight.

Snake gourd crop grown during rainy season needs staking. The crop is trained on pendals or trellis (Yawalkar, 1969).

Anon (1970) concluded that the melons vertically trained gave significantly higher yield than those trained on flat. This was due to the greater average fruit weight and more fruits per plant in the trained crop. The maturity of the crop was, however, delayed when vertically trained as compared to conventially grown crop.

Magdum (1971) concluded that yield of ridge gourd can nearly be doubled with bower system of training. Vertical trellis system has also favoured the vegetative growth of ridge gourd vines and has helped to reap a better yield than ground system of training.

Singh (1989) advised that,Chayote (Sechium endule swartz) being a climber with large tendrils, grows well when vines are trained on a trellis or over a fence, porch, tree etc. Heavy fruits and higher yield are obtained when vines are trained as compared to vines allowed to sprawl on the ground.

Yadav et al. (1990) advised close planting and bower system of training for higher and quality yield of pointed gourd.

Materials and Methods

3. MATERIALS AND METHODS

The present investigation entitled, "Studies on the effects of different training systems and seasons on the yield of bitter gourd (Momordica charantia L.) cv. CO White Long" was carried out at the Instructional Farm of Department of Horticulture, Mahatma Phule Agricultural University, Rahuri, during summer, kharif and rabi seasons of 1990-91. The details regarding the materials used and procedure adopted for investigation are given below.

Experimental site

The site selected for trial was well levelled and had a gentle slope from South to North which ensured perfect drainage. The soil was medium black. Geographically Rahuri is situated in semi-arid zone at 20° 10' North latitude and 74° 39' East longitude and at an altitude of 657 meters above mean sea level. The average annual rainfall of the place is 400 to 450 mm. The meteorological data recorded during the cropping season (February90 - February-1991) are given in Appendix-III.

Preparation of field

The experimental site was brought to a fine tilth by repeated ploughings harrowings and clod crushings. The ridges were opened at a distance of 2.5 meters.

Experimental layout

The experiment was laid out in a Randomised Block Design with 5 replications and 4 treatments in each season. The crop was sown in rows spaced 2.5 meter apart. While the vines were spaced 1 meter apart. Thus there were 15 plants in each treatment accomodated in 7.5mx 5 m (Fig.1).

Treatment details

The details of treatments are as under :

1. Ground training

This was the conventional method of training. In this method vines were allowed to trail on the ground surface (Fig.2).

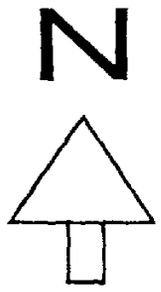
2. Bush training with the help of dry cotton plant

Waste bushes of dry cotton plants procured from Cotton Improvement Project, MPAU Rahuri @ Rs.0.25/kg were used for supporting the vines. Bushes were fixed near the plants (Fig.3).

3. Kniffin system

Kniffins were prepared with the help of wooden poles of Leucana sp. plants of diameter of 10 ft x 2 inch and 8 ft x 2 inch by Length x Breadth, respectively (The material was purchased @Rs.0.40 per kg from the NARP,

PLAN OF LAY OUT



RI	RII	RIII	RIV	RV
T_1	T_3	T_2	T_4	T_2
T_2	T_4	T_1	T_3	T_1
T_3	T_2	T_4	T_1	T_3
T_4	T_1	T_3	T_2	T_4

FIGURE : 1.

DESIGN: SIMPLE R.B.D.

REPLICATIONS : V

TREATMENT : IV

T_1 : GROUND SYSTEM.

T_2 : BUSH SYSTEM.

T_3 : KNIFFIN SYSTEM.

T_4 : BOWER SYSTEM.

SPACING : 2·5 X 1 m.

PLOT SIZE : 7·5 X 5 m^2

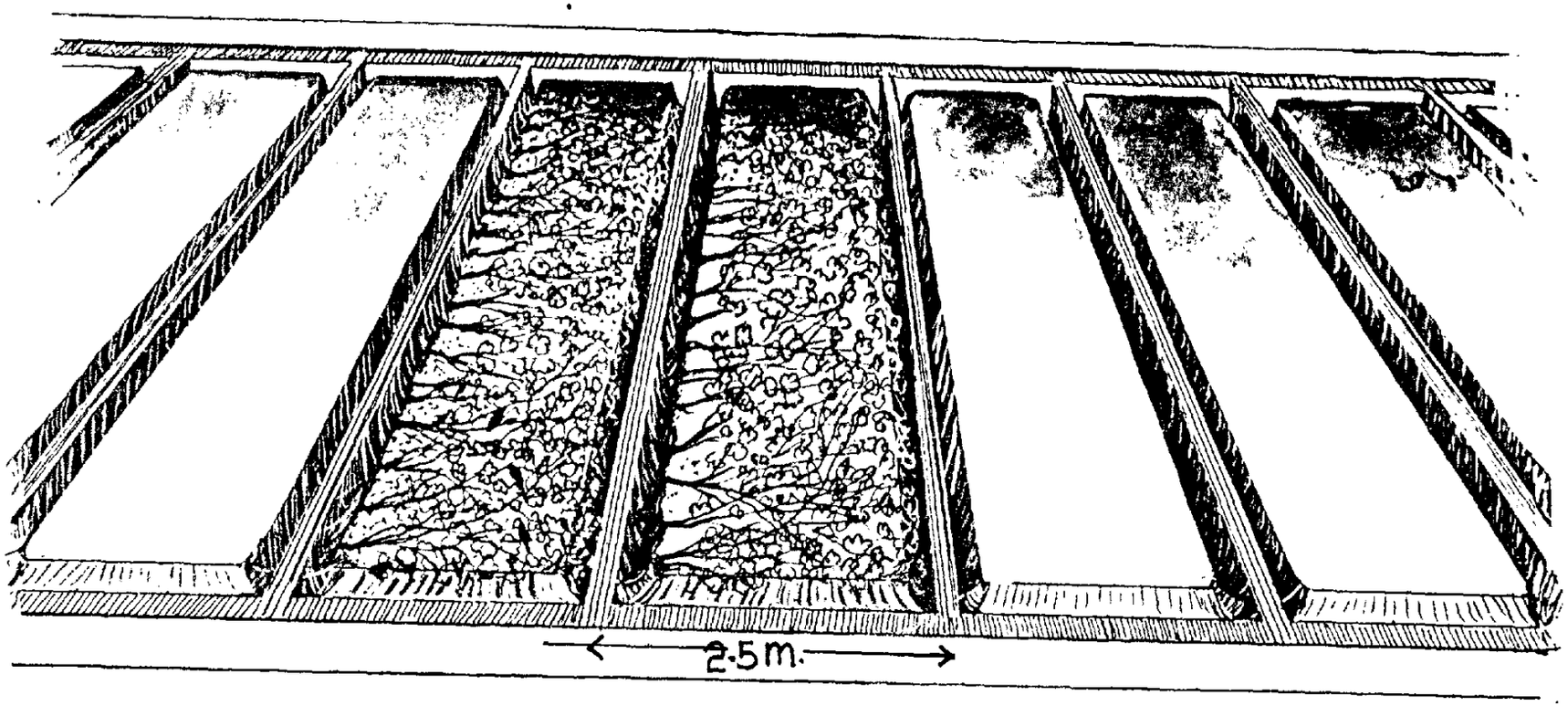


FIG. 2. GROUND TRAINING SYSTEM

FIG. 3. BUSH TRAINING SYSTEM

Agroforestry Scheme, MPAU, Rahuri.) and 10 guage and 16 guage of G.I.wire. The kniffins were errected as below :

The wooden poles were fixed in soil at 45 cm depth at 5 m apart along the length of the rows. The end poles used were of bigger diameter (10 ft x 2 inch L x B) for strengthening each kniffin. Sixteen guage G.I. wires were stretched and fastened on poles at 45, 90 and 135 cm height above the row. All the three wires were tied with the pegs fixed inclined in soil at the end of row as shown in Fig. 4.

4. Bower system

A complete bower was errected at a height of 6 feet from the ground level with the help of wooden poles of Leucana sp. plants (10 ft x 4 inch and 10 ft x 2 inch - L x B) and 10 and 16 guage of G.I. wire for uniform spreading of vine. For errecting bower, strong poles of 10' x 4" diameter were fixed 45 cm deep in soil at 5 meters apart around the border and pole of 10' x 2" diameter were fixed in middle portion of the bower. The border poles were tied with 10 guage double G.I. wire at the top of the pole and the other end of the wire was fastened to the pegs fixed in soil. Later on all the poles were connected by 10 guage G.I. single wire crosswise 6' above the ground. The wires were fastened with the help of a specially designed puller. After fixing the 10 guage wires crosswise, the 16 guage

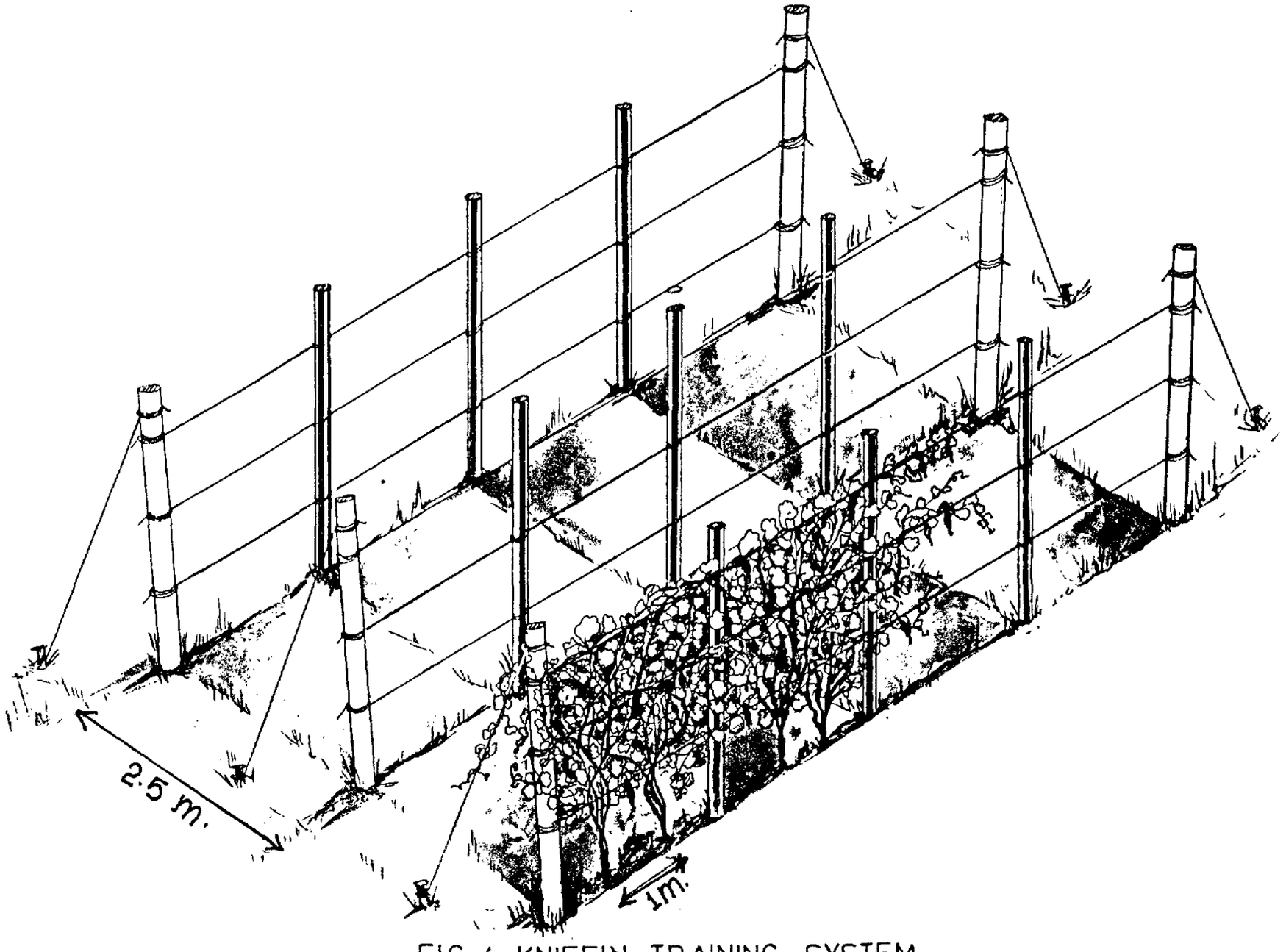


FIG. 4 - KNIFFIN TRAINING SYSTEM

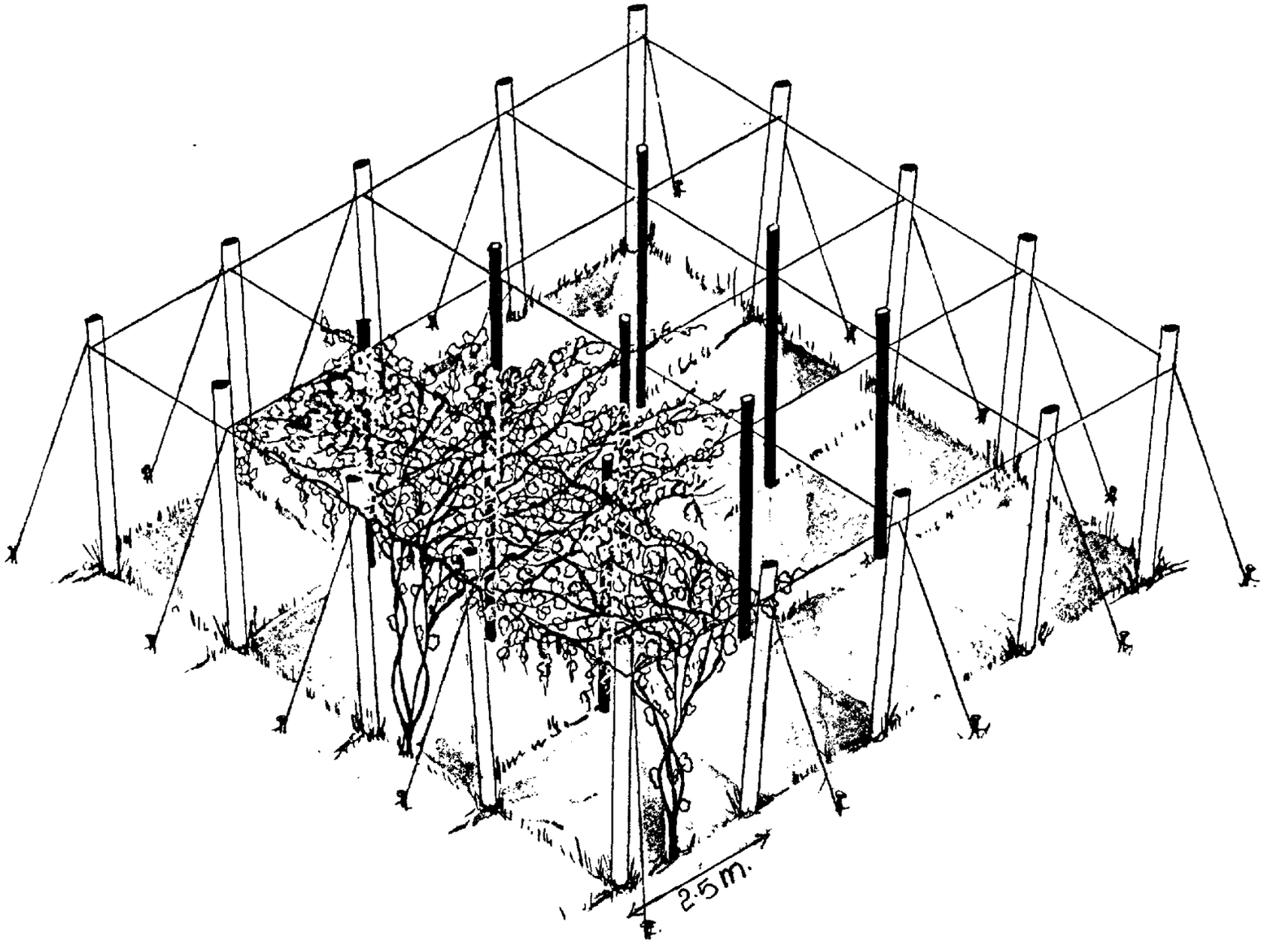


FIG. 5. BOWER TRAINING SYSTEM

wires were stretched over the 10 guage wires at 60 cm apart crosswise as shown in Fig.5.

Planting material

Seeds of CO White Long variety of bitter gourd was obtained from Senior Vegetable Breeder, A.I.C.V.I.P., Mahatma Phule Agricultural University, Rahuri.

Preparation of plot for planting

According to the plan of layout, marking was done in the plots at desired distance and rings and basins were prepared. The recommended dose of farm yard manure and inorganic fertilizers was incorporated in the basins just before dibbling of seeds.

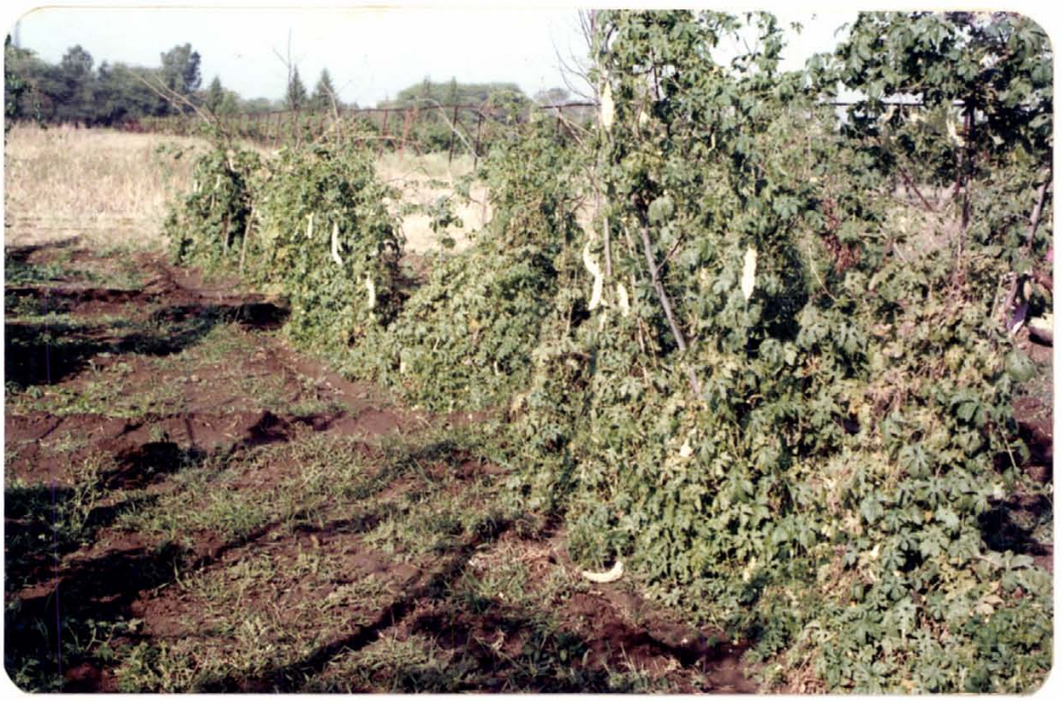
Dibbling of seeds

Dibbling of seeds in the respective plots was done on 5th February 1990 for summer, 15th May 1990 for Kharif and for Rabi season on 15th September 1990. Three seeds were sown per basin, one cm deep in the soil. Seeds were sown 10 cms apart from one another in the basin.

Thinning

Thinning of excess plants was done, three weeks after sowing and only one healthy plant was retained per basin.

1. GROUND TRAINING SYSTEM.



2. BUSH TRAINING SYSTEM.

Plant protection measures

Neessary sprays of Blitox, Dithane M-45, Wettable sulphur, Nuvacron, Endosulphan and soil application of Thimet were given as per recommendations.

Training of vines

Except ground, vines were trained on the support. In case of bush training the plants were allowed to grow without disturbing, on the bushes fixed nearby the plants. For kniffin and bower system, jute strings were used. One end of the string was tied with wire right above the plant, while other end was tied to small stick fixed nearby the plant. The main growing shoot was allowed to twist along the string. In case of kniffin, the side shoots were removed upto first horizontal wire from ground level, while for bower system the side shoots were removed till the main shoot reached the bower. Four side shoots were retained near bower and main growing tip of vine was pinched. Four branches, developed out of shoots, were spread in four directions so as to have uniform cover on the bower.

Details of observations

Although the yield formed the most important subject of the study, the observations were recorded on different yield contributing characters such as growth, flowering, fruiting, fruit number, fruit size, yield etc.

3. KNIFFIN TRAINING SYSTEM.

4. BOWER TRAINING SYSTEM.

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A) Growth observations

i) Average length of vine (cm)

The length of vine, in centimetres, was recorded after the last harvest of the crop. It was measured from the ground level to the tip of main branch.

ii) Average number of branches per vine

After the final harvest, the vines were untied and carefully lowered down from the bower, kniffin and bushes and the branches arising from the main stem were counted and the average was worked out.

iii) Node number at which first female flower appeared

The node from ground level at which first female flower appeared was noted on each plant and the average was worked out.

iv) Days required for first female flowering

After some initial growth, the vines were inspected every day and the date on which the first female flower appeared was recorded and the days required for the appearance of first female flower were calculated since the date of sowing.

B) Yield and post harvest studies

i) Average weight of fruit (g)

The average weight of fruit was calculated by dividing total yield of fifteen plants by total number of marketable fruits harvested from fifteen plants.

ii) Average length of fruit (cm)

Ten fruits from each replication were selected for recording observation on length and diameters of fruit.

The fruits were harvested at edible maturity and length was recorded from base of pedicel to blossom end of fruit and the average length of fruit was worked out.

iii) Average diameter of fruit (cm)

The diameter was measured at maximum thickness of fruit with the help of vernier caliper.

iv) Average number of marketable fruits per vine

The number of fruits free from fruit fly attack were recorded for each picking from all the replications separately and summed up after final picking. The average number was worked out.

v) Average yield per vine and per plot (kg)

The weight of marketable fruits harvested periodically from each replication was summed up after the last picking and the average yield per vine and per plot was calculated.

vi) Average yield per hectare (q)

The average yield per hectare was calculated by multiplying the plot yield by hectare factor.

vii) Percentage of fruits affected by fruit fly

At every picking the fruits affected by fruit fly were noted separately and after the last harvest the number was summed up. The affected fruits were weighed separately. Finally, the percentage of fruit affected by fruit fly was calculated on number basis and on weight basis separately.

Statistical analysis

The data recorded for each character for each replication were averaged and the mean values obtained were subjected to statistical analysis.

The means of all the three seasons were used for pooled analysis.

Economic feasibility of training system

For the study of economics, the record of additional expenditure of training material, cost of errection and training of vines, required under each treatment was recorded. The gross returns were calculated by considering average selling rate i.e. Rs. 4 per kg.

Additional yield and percentage increase in yield due to various training systems over ground was calculated. The net additional income was calculated by substacting the cost of training from additional income accrued due to various training system.

Results

4. RESULTS

The results obtained in the present investigations are presented here in brief and under appropriate headings.

4.1 Average length of vine (cm)

The vine length was significantly influenced by the season of planting as well as training system (Table 4.1). Considerably longer vines were produced during the summer season (456.53) than kharif (370.04), and rabi (324.24) seasons. During the summer season, the vines trained on kniffin (474.70) and bower (479.68) were significantly longer than trained on bush (450.20) and ground (421.56). During the kharif season, bower system produced significantly longer vines (376.96) than the remaining training systems. In general, the same trend was observed during the rabi season also. On pooling the data over three seasons, it was observed that the bower system recorded the highest vine length (404.45) which was significantly more than that recorded in the rest of the systems.

4.2 Average number of branches per vine

The number of branches produced per vine were more influenced by season rather than the training methods (Table 4.2). Number of branches recorded during summer season was the highest (8.81), while it was the lowest

Table 4.1 : Average length of vine (cm)

Seasons / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	421.56	366.80	273.28	353.88
Bush	450.20	366.60	321.04	379.28
Kniffin	474.70	369.82	345.92	396.81
Bower	479.68	376.96	356.72	404.45
Mean	456.53	370.04	324.24	383.60
S.E. ±	2.459	1.313	3.150	0.701
C.D. at 5% level	7.579	4.048	9.710	2.002
S.E. ± for interaction				3.87
C.D.at 5% level for interaction				13.41

Table 4.2 : Average number of branches per vine

Seasons / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	8.36	6.08	5.44	6.63
Bush	8.32	6.08	5.64	6.68
Kniffin	8.72	6.04	5.72	6.83
Bower	9.84	6.24	6.16	7.41
Mean	8.81	6.11	5.74	6.89
S.E. ±	0.151	0.072	0.206	0.0441
C.D.at 5% level	0.465	N.S.	N.S.	0.1261
S.E.± for interaction				0.072
C.D. at 5 % level for interaction				0.252

during rabi season (5.74). Number of branches produced on bower system, during summer season (9.84) was significantly more than that registered in other systems and seasons.The effects of training systems on number of branches, during kharif and rabi were non-significant. However, on pooling the data over seasons the significant influence of bower system was observed (7.41). The interaction effects were significant and the number of branches produced in summer in bower system was the highest (9.84) and was significantly more than those registered in rest of the combinations of systems and seasons.

4.3 First female flowering node number

The emergence of first female flower was influenced by season of planting (Table 4.3), whereas the training systems did not exhibit significant effects on the node number at which first female flower appeared. During summer season the emergence of female flower was at 20.77th node, while it was at 22.78th and 25.25th node during kharif and rabi seasons, respectively.

4.4 Days required for first female flowering

The season of planting as well as different systems of training have very little effect on the days required for appearance of first female flower (Table 4.4). During summer season, the emergence of female flowering was little

Table 4.3 : First female flowering node number

Seasons / Treatments	Summer	Kharif	Rabi	Pooled Mean
Ground	20.99	22.81	26.44	23.41
Bush	20.76	22.56	24.06	22.46
Kniffin	20.60	22.54	25.29	22.81
Bower	20.72	23.20	25.21	23.04
Mean	20.77	22.78	25.25	22.93
S.E. ±	0.491	0.378	0.311	0.122
C.D.at 5% level	N.S.	N.S.	N.S.	N.S.
S.E. ± for interaction				N.S.
C.D. at 5% level for interaction				N.S.

Table 4.4 : Days required for first female flowering

Season / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	61.37	56.00	57.96	58.44
Bush	56.89	58.80	57.56	57.75
Kniffin	53.58	55.20	56.60	55.13
Bower	52.65	56.40	58.36	55.80
Mean	56.12	56.60	57.62	56.78
S.E. ±	1.414	2.42	1.056	0.390
C.D.at 5% level	4.358	N.S.	N.S.	N.S.
S.E. ± for interaction				0.527
C.D. at 5% level for interaction				1.826

bit early in the plants trained on bower system (52.65 days) than rest of the treatments. The results were non-significant during kharif, rabi and also when the data were pooled over seasons.

4.5 Average weight of fruit (g)

The systems of training as well as seasons of planting influenced the fruit weight significantly (Table 4.5). In general, the fruit weight was maximum during the kharif season (79.88) followed by summer (62.45) and rabi (55.60). During the summer season, the kniffin (72.02) and bower system (68.72) were on par with each other produced significantly higher fruit weight, than bush (55.39) and ground systems (53.66). The ground and bush systems were on par with each other. In the kharif season, the results were exactly similar to those of summer. However, during the rabi season, the fruit weight was not influenced significantly by the training systems. On pooling the data, it was seen that kniffin (69.57) and bower systems (71.22) recorded significantly higher fruit weight than bush (62.22) and ground (60.89). The bower and kniffin systems were on par with each other.

4.6 Average length of fruit (cm)

The data presented in Table 4.6 indicated effects of training as well as seasons on fruit length were significant. Comparatively longer fruits were produced

Table 4.5 : Average weight of fruit (g)

Season / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	53.66	74.52	54.49	60.89
Bush	55.39	74.54	56.75	62.22
Kniffin	72.02	81.42	55.28	69.57
Bower	68.72	89.04	55.90	71.22
Mean	62.45	79.88	55.60	65.97
S.E. ±	1.847	1.964	1.410	0.507
C.D.at 5% level	5.692	6.054	N.S.	1.448
S.E. ± for interaction				1.165
C.D.at 5% level for interaction				4.038

Table 4.6 : Average length of fruit (cm)

Season / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	15.75	19.78	17.59	17.71
Bush	18.00	23.38	19.85	20.41
Kniffin	21.44	27.78	21.06	23.42
Bower	21.24	30.08	22.92	24.75
Mean	19.11	25.25	20.35	21.57
S.E. ±	0.401	0.418	0.451	0.122
C.D.at 5% level	1.235	1.289	1.391	0.349
S.E. ± for interaction				0.305
C.D.at 5% level for interaction				1.057

during the kharif season (25.25) than rabi (20.35) and summer seasons (19.11). The bower system of training recorded significantly more fruit length during all the three seasons as well as on pooling data (24.75) than rest of the training systems. This was closely followed by kniffin system (23.42). In general, shorter fruits were produced (17.71) when the vines were trained on ground.

4.7 Average diameter per fruit (cm)

The season of planting as well as training system played no significant role on the fruit diameter (Table 4.7). However, the fruits were slightly broader on kniffin and bower systems during the summer and kharif seasons.

4.8 Average number of fruits per vine

The fruit number per vine was maximum during the summer season (58.79) followed by rabi (33.86) and kharif (18.16) (Table 4.8). Significantly higher number of fruits (89.29) were obtained on bower system during the summer season, while during the kharif and rabi seasons, the bower and kniffin systems, were on par with each other and produced significantly more fruits per vine than bush and ground systems. On the basis of pooled means, bower system (51.03) observed to be superior to the rest of the three systems.

Table 4.7 : Average diameter per fruit (cm)

Season / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	3.28	3.76	3.51	3.52
Bush	3.31	3.78	3.55	3.55
Kniffin	3.48	4.00	3.52	3.67
Bower	3.48	3.20	3.42	3.70
Mean	3.39	3.68	3.50	3.61
S.E. ±	0.037	0.051	0.049	0.0134
C.D.at 5% level	0.115	0.159	N.S.	N.S.
S.E. ± for interaction				0.028
C.D.at 5% level for interaction				0.0989

Table 4.8 : Average number of fruits per vine

Seasons / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	45.39	15.82	20.01	27.08
Bush	40.51	15.97	29.62	28.70
Kniffin	59.99	20.13	42.75	40.96
Bower	89.29	20.73	43.06	51.03
Mean	58.79	18.16	33.86	36.94
S.E. ±	1.495	0.743	1.030	0.327
C.D.at 5% level	4.609	2.29	3.174	0.934
S.E. ± for interaction				2.41
C.D. at 5% level for interaction				8.36

4.9 Fruit yield

Data in respect of average yield per plant, per plot and per hectare are presented in Tables 4.9, 4.10 and 4.11, respectively.

It can be seen from the results that the yield was significantly influenced by the seasons of planting as well as training systems. The highest yield per hectare was recorded during the summer season (141.33 q/ha) followed by rabi (67.93 q/ha) and kharif (56.77 q/ha). During the summer season, the bower system of training recorded the highest and significantly more fruit yield (227.43 q/ha), while during kharif and rabi, the kniffin and bower system were on par with each other and recorded significantly more yield than bush and ground systems. On pooling the data over seasons, the bower system observed to be significantly superior which recorded the highest fruit yield (129.57 q/ha). The lowest and significantly less fruit yield was recorded in bush (82.47 q/ha) and ground (93.50 q/ha) systems of training and both the systems were on par with each other. The bower system of training recorded 119.72 per cent higher yield than ground system, while kniffin system registered 75.78 per cent higher yield. The per cent increase in yield in bush system over ground was hardly 5.98.

Table 4.9 : Average yield per vine (kg)

Seasons / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	2.43	1.18	1.08	1.56
Bush	2.24	1.19	1.72	1.72
Kniffin	4.32	1.63	2.36	2.77
Bower	6.17	1.90	2.40	3.49
Mean	3.79	1.47	1.89	2.38
S.E. ±	0.110	0.061	0.060	0.0232
C.D. at 5% level	0.338	0.0188	0.186	0.0663
S.E. ± for interaction				0.188
C.D. at 5% level for interaction				0.652

Table 4.10 : Average yield per plot (kg)

Seasons / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	35.07	16.64	14.80	22.11
Bush	31.00	17.03	22.36	23.46
Kniffin	60.72	24.23	31.68	38.87
Bower	85.31	27.44	33.05	48.60
Mean	53.02	21.33	25.47	33.26
S.E. ±	2.684	1.310	0.807	0.515
C.D. at 5% level	8.273	4.037	2.488	1.472
S.E. ± for interaction				2.51
C.D. at 5% level for interaction				8.69

Table 4.11 : Average yield per hectare (q)

Seasons / Treatments	Summer	Kharif	Rabi	Pooled mean	% increase over ground
Ground	93.50	43.89	39.48	58.97	-
Bush	82.47	45.41	59.64	62.50	5.98
Kniffin	161.91	64.61	84.48	103.66	75.78
Bower	227.43	73.17	88.13	129.57	119.72
Mean	141.33	56.77	67.93	88.67	
S.E. ±	7.185	3.493	2.154	1.379	
C.D.at 5% level	22.147	10.765	6.639	3.938	
S.E. ± for interaction				6.59	
C.D.at 5% level for interaction				22.82	

Yield per hectare was very low in kharif season because the crop was seviourly affected by the continuous and the heavy rainfall (342 mm) during the last week of September and the first fortnight of October 1990.

4.10 Fruit fly incidence

The data regarding percentage of fruits affected by fruit fly on number basis and weight basis are presented in Table 4.12 and 4.13, respectively.

Despite adoption of regular plant protection measures against fruit fly the cognigeable incidence of fruit fly was noticed in different training systems. However, the influence of planting seasons was not so conspicuous. The lowest and significantly less percentage of incidence on number as well as on weight basis was recorded in bower system (20.09 and 17.77%, respectively). The incidence of fruit fly was significantly more in ground system of training during all the three seasons as well as on basis of pooled means.

4.11 Economics of training system

The data regarding particulars of additional expenditure incurred for various training systems worked out on hectare basis are presented in Table 4.14. Similarly, the additional returns realised due to various training systems are presented in Table 4.15. One third cost of material, particularly wooden poles and G.I. wire required for kniffin and bower systems, was considered for working out cost as the material which can be used conveniently for the three seasons. Whereas, for bush system, the cost of material was considered 100 per cent as cotton stakes

Table 4.12 : Percentage of fruits affected by fruit fly (Number basis)

Seasons / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	26.02	26.29	31.89	28.07
Bush	25.36	23.74	26.57	25.22
Kniffin	22.93	20.62	24.68	22.74
Bower	19.03	18.41	22.83	20.09
Mean	23.33	22.26	26.49	24.03
S.E. ±	0.657	0.863	1.055	0.261
C.D. at 5% level	2.025	2.660	3.250	0.747
S.E. ± for interaction				N.S.
C.D. at 5% level for interaction				N.S.

Table 4.13 : Percentage of fruits affected by fruit fly (Weight basis)

Seasons / Treatments	Summer	Kharif	Rabi	Pooled mean
Ground	26.40	23.80	28.92	26.37
Bush	25.57	20.12	23.51	23.07
Kniffin	19.50	18.35	22.12	19.99
Bower	16.36	15.15	21.85	17.77
Mean	21.96	19.35	24.10	21.80
S.E. ±	0.649	1.042	0.867	0.250
C.D.at 5% level	2.000	3.213	2.671	0.716
S.E. ± for interaction				0.365
C.D. at 5% for interaction				1.267

Table 4.14: Particulars of additional expenditure for training systems (Rs/ha)

Sr. No.	Material	Rate (Rs.)	Bush system		Kniffin system		Bower system	
			Material required	Expenditure (Rs.)	Material required	Expenditure (Rs.)	Material required	Expenditure (Rs.)
1.	Wodden poles (10'x4")	6.80 per no.	-	-	-	-	400 No.	2720
2.	Wooden poles (10'x2")	3.20 -"-	-	-	670 No.	2144	940 No.	3008
3.	Wooden poles (8' x2")	2.20 -"-	-	-	670 No.	1474	-	-
4.	GI. wire (10 guage)	15.50 per kg	-	-	67 kg.	1038	200 kg.	3100
5.	G.I.wire (16 guage)	15.50 -"-	-	-	938 kg.	14539	400 kg.	6200
6.	Dry cotton bush	0.25 -"-	2667 kg.	666	-	-	-	-
				666		19195		15028
	1/3 rd cost*			-		6398		5009
7.	Jute string	17.00 per kg.		-	25 kg	425	20 kg.	340
	Labour charges							
	1. Errection	20.10 per day	30 Man days	603	100 Man days	2001	100 Man days	2001
	2. Training of vines	20.10 per day	-	-	150 Man days	3015	210 Man days	4221
	Total			1269		11839		11571

* The material once purchased can be used conveniently for three planting seasons and hence one third (1/3) cost of the wooden poles and G.I. wires is taken for calculation of cost of training system, where ever they are used.

collapsed even before the life of vines and laterpn decomposed. The expenditure for bush training was Rs.1269/-, for kniffin system Rs. 11839/- and for bower system Rs. 11571/- per hectare.

From the data in Table 4.15, it can be observed that the system of training increased the productivity over ground system and the increase was from 5.98 to 119.72 per cent in different systems which in tern fetched additional income ranging from Rs. 1412/- to Rs. 28240/- per hectare when compared to that from ground system.

The expenditure incurred on training in different system ranged from Rs.1269/- to Rs. 11839/- per hectare and kniffin system required the highest investment. Bower was second and was closely followed by kniffin requiring Rs. 11571/- per hectare and the bush system was the cheapest (Rs.1269/- per hectare) amongst the systems tried.

Since the cost on training system is only the variable, the net returns among the systems is compared on the basis of additional income accrued due to training as against the expenses involved in different training systems and, thus, the income per rupee investment was arrived to judge the economic viability of the system. Training systems had a marked advantage in increasing the return. Bush system had 11 per cent economic advantage over non-training condition (ground) and this advantage goes on

4.15 : Additional returns due to different training systems (Rs/ha)

Treatments	Yield (q/ha)	Gross returns (Rs)	Additional yield due to training (q/ha)	% increase in the yield due to training over ground	Additional income due to training (Rs/ha)	Expenditure of training (Rs/ha)	Net Additional income (Rs/ha)	Return per rupee invested (Rs
Ground	58.97	23588	-	-	-	-	-	-
Bush	62.50	25000	3.53	5.98	1412	1269	143	1.11
Kniffin	103.66	41464	44.69	75.78	17876	11839	6037	1.51
Bower	129.57	51828	70.60	119.72	28240	11571	16669	2.44

increasing as the system becomes stronger and durable. Bower system was capable to turn a single rupee invested in its installation to Rs.2.44 on an average and was the most capable return earning system. The net additional income due to training was Rs.143/- in bush system, Rs. 6037/- in kniffin system and Rs. 16669/- in bower system. The per cent increase in yield over ground was 5.98, 75.78 and 119.72 in bush, kniffin and bower systems, respectively. Similarly, the income per rupee invested for training system was Rs.1.11, Rs.1.51, Rs.2.44, respectively. The highest additional monetory returns were obtained with bower system followed by kniffin system.

Discussion

5. DISCUSSION

The experimental results obtained during the present investigation and presented in Chapter 4 are discussed here under.

I) Effect of season

The various characters such as vine length, number of branches, days to female flowering, first female flowering node, fruit weight, length and diameter of fruit, fruit number and yield were highly influenced by season of planting. During the summer season, the longer vines were produced with higher number of branches per vine and the production of female flower was slightly early at the earliest node. However, the growth and flowering were restricted during the rabi season. Heavier and longer fruits were produced during the kharif season followed by the summer and rabi seasons. There was about 30 per cent reduction in fruit weight during the rabi season as compared to the summer season. The fruit number per plant was maximum during the summer season followed by the rabi and kharif seasons. About 43 per cent and 69 per cent higher fruit number was recorded in the summer season than in the rabi and kharif seasons, respectively. The yield per plant as well as per hectare was also higher during summer season followed by rabi and kharif seasons. An increase in yield during the summer season was about 52

per cent and 59 per cent higher than rabi and kharif seasons, respectively.

Although heavier and longer fruits were produced during the kharif season, the total yield was higher during the summer season. The increase in yield during the summer season was mainly because of higher number of fruits per vine. As a general principle, the kharif season in Maharashtra is more favourable for growth, fruiting and yield of all cucurbitaceous vegetables. During the present investigation, the growth and flowering were laxurient during the summer season and thereby there was increase in yield. The heavy rainfall during the last week of September and the first fortnight of October exercised severe adverse effects on foliage and fruiting. The climate was more congenial for development of foliar diseases which restricted the growth as compared to the summer season. During the summer season, major flowering and fruiting period was from May to September. The average maximum temperature during this period ranged from 27.3 to 39.8^{o}C, while minimum temperatures ranged from 15.5 to 22.2^{o}C. There was good distribution of rainfall during this period. The mild climate, thus, favoured the production of higher fruit number and final yield per plant. The kharif crop planted in the second fortnight of May availed better climatic conditions upto the last week of September.

Afterwards, the crop was severely damaged by untimely and heavy rainfall during peak period of fruiting. As a result, there were just nine harvestings during the kharif season as against seventeen during the summer season. Seshadri (1986) recommended growing of gourds mostly in summer and rainy season depending upon the rainfall pattern. He also stated that cucurbits are grown almost year-round in central and south India. The author also cautioned for avoiding fruits of cucurbits maturing during spell of rainy weather or heavy downpour. The rabi crop was sown during the second fortnight of September and since beginning it was affected by the heavy rainfall. Major flowering and fruiting were from December to February. The maximum temperatures during this period ranged from 25.5 to 32.8°c while minimum temperature from 6.0 to 16.8°c. The low night temperatures had adverse effects on growth and fruiting. The vine growth in general was stunted. The fruits were smaller in size and length. The low night temperatures might have affected the maturity and anther dehiscence due to which there was less number of fruits per plant during the rabi season.

Seaton and Kremer (1939) investigated influence of climatological factors on anthesis and anther dehiscence in cultivated cucurbits. They observed that 12-14°c is the optimum range for anther dehiscence. The incidence of fruit fly was almost equal during all the three season.

This may be due to the high humidity maintained in the micro climate of the vines and favourable effect of especially dry season due to temperature variation might have been masked.

II) Effect of training

The various characters including growth, flowering, fruiting, yield and fruit fly incidence were highly influenced by different training systems. The vine growth was vigorous on bower system followed by kniffin than bush and ground. Maximum vine length and number of branches per plant were recorded on bower system. The position of the first female flower was not affected by the training systems, however, the days required for emergence of the first female flower differed with the trainig system. The appearance of the female flower was slightly early in the bower and kniffin systems than in bush and ground. Magdum (1971) observed more vegetative growth in terms of vine length and branches in bottle gourd and ridge gourd when trained on bower system than on kniffin and ground. The present findings in respect of these characters are in agreement with above reports. The early harvest due to pergola system in cucumber has been reported by Stan et al. (1980). The results in respect of days to the first female flowering are in conformity with the reports of Stan et al.

The various training systems exercised significant influence on fruit weight, fruit length and the fruit diameter. The average weight of fruit, length of fruit and diameter of fruit were maximum in bower system followed by kniffin system then in the bush and ground system. There was 17 per cent increase in fruit weight and 40 per cent increase in fruit length due to bower system as compared to ground system. Since the fruits remained hanging freely on bower as well as in kniffin system, they increased in length as compared to those in the ground and bush. As a result, there was significant increase in average weight of fruit also. More production of straight and longer fruits of luffa on trellis. system as compared to that in the ground system have been reported by Wester et al. (1942). However, heavier fruits of melons were produced from the vines trained on vertical trellis. The present findings are in agreement with the above reports.

The main yield contributing character, the number of fruits per vine, was highly influenced due to different training systems during all the three seasons and when the data were pooled over seasons. The highest number of fruits per vine was recorded in bower system which was followed by kniffin and bush and ground system were next in order. The bower system produced 89 per cent and 82 per cent higher fruit number than ground and bush systems, respectively.

The yield per plant, per plot and finally converted to hectare basis was also highly influenced by the training systems. During all the three seasons the bower system recorded the high yields. However, the highest fruit yield was recorded (227.43 q/ha) in bower system during summer season. There was about 120 per cent and 107 per cent increase in fruit yield due to bower system over ground and bush systems, respectively.

An increase in yield in bower system is mainly because of vigorous vine growth with more number of branches, proper distribution of fruiting area, good exposure of vine to sunshine which enhanced assimilation of carbohydrates which bound to exercise favourable influence on increasing yield. Since the fruits remained hanging they were straight and more in length, weight as well as in diameter. This situation, therefore, ultimately led to higher production as compared to other training systems. Increase in yield due to training system have been reported in various cucurbitaceous crops by many workers and important amongst them are Persson et al. (1954), Allen (1963), Bafldie and Groenewegen (1965), Furner (1967), Wichold (1967), Konsler and Strider (1973), Stan et al. (1980) in cucumber, John Organ (1962), Magdum (1971) and Singh (1989) in bottle gourd, Anon (1970) in melons and Singh (1989) in bitter gourd.

The performance of kniffin system was also encouraging as compared to ground and bush system. There is possibility of further increase in yield per unit area by reducing the spacing between two rows as against 2.5 m adopted during the present investigation. This needs further experimentation. The bush system did not show prominent results mainly because the cotton stakes collapsed and decomposed even before the vine life. The bushes stronger than cotton stakes may probably give some different results.

The training system exercised significant influence on the incidence of fruit fly (weight basis). The fruit fly incidence was the lowest on bower system followed by kniffin, ground and bush system in order. About 48 per cent higher fruits (weight basis) affected by fruit fly were harvested on ground system as compared to bower system. The fruits in bower system were placed sufficiently high above the ground, there was free air circulation as well as proper illumination. These aspects probably might have helped in minimising the incidence of fruit fly. Further, the efficient spraying in bower as well as kniffin system as compared to ground also might have added to lower the fruit fly incidence. Konsler and Strider (1973) observed less incidence of scab and soil rot in cucumber when trained on vertical trellis.

III) Economic feasibility of training system

The importance of providing supports to the vines have been emphasized by a number of workers in the past and the advantages of these supports are attributed to efficient disease management, easy harvesting and improving the quality of fruits besides high yield.

It is not only the added productivity which decides the adoptability of the practice but its feasibility and economic viability are more deciding factors for successful adaptability. The main object of the present investigation was to compare the performance of different training systems in terms of their effect on yield improvement of the crop, financial implication involved for systems and return per rupee invested in installation of the system, because it is now well established that the vegetable production technology adoption is only dependent on surity of productivity. The vegetable production, in general, is confined to a limited and interested farmers who are more choicy and very critical in adoption of new innovations and fiscal involvement is secondary to them provided they are fully convinced about the efficiency of the practice and high productivity. These characters of the vegetable growers have already been isolated long before and can be illustrated by adoptation like training of grapes, use of auxins in vegetable crops and resorting to costly irrigation systems.

Scrutiny of the data in Table 4.15 had clearly brought out the efficacy of the systems of training on improvement in the productivity of the crop and the productivity is found to increased with strength and durability of the system and the yields are doubled or even increased by $2\frac{1}{2}$ times in sufficiently stronger systems (kniffin and bower system respectively) when compared to untrained vines.

Further scrutiny of the data indicated that the return per rupee invested in installation of training system goes on increasing when the system becomes more stronger and durable and resultantly becomes more paying. Bower system fetched Rs.2.44 per rupee invested in its installation and was the most efficient in its economic viability. These results are in conformity with the earlier workers who have reported the efficiency of bower system in grapes for improving the productivity and returns. Important amongst them are Randhawa (1967), Bakhshi and Kanwar (1969), Sathiamoorthy and Bhakthratsalu (1977), Bindra and Brar (1978).

Thus, the results discussed earlier have brought out that for improving the productivity of bitter gourd, summer planting is highly efficient when compared to planting in either kharif or rabi seasons. It is important to pinpoint here that the summer crop was more productive

as it enjoyed most of the favourable weather conditions during its major growth period, especially fruiting and rabi planting was the next in order as it had enjoyed clear post-monsoon climate during fruiting span, while the kharif planting, productivity ranked the lowest despite of favourable season. The main reason for such a low productivity of kharif planted crop, can be erratic distribution of precipitation in drought prone area like Ahmednagar, concentrating over 80 per cent in the month of September and early October which are most critical growth stages of this crop. Heavy rains in a very short spell with high intensity adversely affect the fruitset which results in low fruitset, high intensity of diseases and consequently considerable reduction in yield.

Irrespective of the seasons, bower system of training was found to be superior not only from the point of view of increasing the productivity per se coupled with reasonably low incidence of the fruit fly (Dacus cucurbitae Coq.) but it had also proved its economic viability beyond doubts, and could safely be adopted by the enterprised but risk ventured vegetable growers who considered the fiscal involvement as the secondary.

Summary and Conclusion

6. SUMMARY AND CONCLUSIONS

The investigation leading to the "Studies on the effects of different training systems and seasons on yield of bitter gourd cv. CO White Long" was undertaken at the Department of Horticulture, Mahatma Phule Agricultural University, Rahuri, with a view to identifying approptriate planting season and system of training.

The observations are recorded on the length of vine, number of branches, first female flowering node number, days required to first female flowering, weight of fruit, length and diameter of fruit, number of marketable fruits, yield per hectare and percentage of fruits affected by fruit fly.

The seasons of planting and various training systems exercised significant influence on the yield and yield contributing characters in bitter gourd during the present investigation. The summer planting recorded the highest fruit yield than kharif and rabi seasons. The major fruiting period of summer planting was from June to September which availed congenial climatic conditions; as a result there was vigorous vine growth in terms of vine length and number of branches and higher number of fruits per vine. Irrespective of the training system, the summer season recorded 141.33 quintals of marketable fruits per hectare which was 42 and 59 per cent higher than the rabi

and kharif seasons, respectively. The rabi planting was next in order as it has enjoyed mild and clear climate during the fruiting period, while the kharif planting recorded the lowest yield despite of favourable season. The main reason of low productivity in the kharif season was mainly due to erratic distribution of rainfall during the period of present investigation. Heavy downpouring during peak fruiting period not only reduced the yield but created very congenial conditions for foliar diseases.

The response of training systems was highly encouraging. The bower system of training was observed to be superior to all the other training systems, as it has recorded the highest yield of marketable fruits. There was 120, 107 and 25 per cent increase in yield due to bower system over ground, bush and kniffin systems, respectively. This increase in yield was mainly due to vigorous vine growth, higher number of branches, proper distribution and exposure of fruiting area to sunshine which resulted into higher number of fruits with more length and diameter. The higher position of fruiting area from ground level not only helped to increase the length of fruit but also helped to reduce the incidence of fruit fly. The marketable produce was clean and attractive.

When the effect of training systems and of planting seasons were compared together, it was clearly observed that the summer planting with training of vines on bower system was the most ideal having recorded 227.43 quintals of fruit yield per hectare which was much higher than in other combinations.

The bower system of training was observed to be more stronger, durable and economically viable as it had given the highest return per rupee invested in its installation (Rs.2.44).

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7. LITERATURE CITED

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Appendix

8. APPENDIX

Appendix-I

Schedule of cultural operations done in bitter gourd plot during the investigation period (1990-91).

A) Preparatory tillage	Total
Ploughing	2
Harrowing	2
Clod crushing	2
Collecting weeds and stubbles	1

B) After care	Total
Hand weeding	5
Mending of rings and basins	1
Sprayings (Dithane M-45, Blitox, Nuvacron, Endosulphan)	5
Dusting (Sulphur)	1
Fertilizer application	2
(Recommended dose 100:50:50 NPK per ha.)	

Appendix-II

Duration and number of harvestings of bitter gourd during summer, kharif and rabi season 1990-91.

Season	Duration of crop	No.of harvestings
Summer	5.2.1990 to 10.9.1990	17
Kharif	15.5.1990 to 16.11.1990	9
Rabi	15.9.1990 to 17.2.1991	10

Appendix- III

Weather Record

Month	Week	Temperature ^{O}c.		Relative humidity %		Rain-fall mm.
		Max.	Min.	Max.	Min.	
1	2	3	4	5	6	7
Feb.90	6	32.5	14.5	59	22	0.0
	7	31.1	13.9	71	30	0.0
	8	28.5	8.7	68	29	0.0
	9	31.1	12.4	63	27	0.0
March 90	10	31.8	12.8	60	23	0.0
	11	34.1	15.4	64	28	0.0
	12	35.2	15.6	55	18	0.0
	13	34.7	15.4	54	20	0.0
April 90	14	35.7	15.5	56	21	0.0
	15	37.8	16.6	53	29	0.0
	16	38.5	17.9	61	36	0.0
	17	39.8	19.2	43	16	0.0
May 90	18	38.5	21.0	63	30	0.0
	19	38.1	24.1	69	35	9.0
	20	36.1	23.2	74	37	0.0
	21	36.3	22.9	76	41	5.1
	22	31.7	22.5	86	59	62.1
June 90	23	34.0	23.1	83	55	101.2
	24	31.8	22.5	85	57	56.0
	25	30.7	23.0	81	55	0.0
	26	30.1	23.1	79	65	4.2

Appendix-III contd..

1	2	3	4	5	6	7
July 90	27	29.6	22.0	84	64	11.7
	28	29.6	22.3	82	61	5.2
	29	29.6	22.7	82	62	1.0
	30	28.9	21.8	86	66	0.0
Aug.90	31	30.5	22.0	81	61	1.0
	32	30.3	22.0	91	68	88.3
	33	27.3	21.8	90	83	31.9
	34	28.2	22.0	87	74	9.2
	35	28.8	21.2	85	71	5.1
Sept.90	36	30.9	21.4	85	62	4.1
	37	31.2	19.9	81	54	2.8
	38	32.3	19.0	84	60	1.4
	39	30.5	21.7	88	66	78.8
Oct. 90	40	31.0	20.2	84	51	38.2
	41	27.7	20.5	95	79	224.8
	42	29.6	16.0	66	43	0.0
	43	28.0	18.7	92	63	40.4
	44	28.3	16.6	86	47	0.0

Appendix-III contd..

1	2	3	4	5	6	7
Nov. 90	45	29.1	14.3	78	36	0.0
	46	29.1	16.1	77	46	0.0
	47	28.3	16.6	86	49	0.0
	48	30.7	17.7	82	44	0.0
Dec. 90	49	29.8	16.8	82	44	0.0
	50	27.7	12.1	84	40	0.0
	51	26.8	10.1	79	35	0.0
	52	28.0	10.8	78	34	0.0
Jan. 91	1	25.5	6.0	72	25	0.0
	2	28.0	9.5	77	32	0.0
	3	28.6	11.7	75	41	0.0
	4	31.2	12.7	78	38	0.0
	5	30.0	8.9	67	19	0.0
Feb. 91	6	32.4	13.2	68	23	0.0
	7	31.3	9.6	67	18	0.0
	8	32.6	14.1	64	22	0.0
	9	32.8	13.2	70	23	0.0

Vita

9. V I T A

VINAYAK RAMCHANDRA JOSHI

A candidate for the degree
of
MASTER OF SCIENCE
(Agriculture)

Title of thesis : Studies on the effects of different training systems and seasons on yield of bitter gourd (Momordica charantia L.) cv. CO White Long.

Major field : **Horticulture**

Biographical information

- **Personal data** : Born at Rahuri, Tal. Rahuri, District, Ahmednagar on 20th September, 1961.
  Son of Shri. Ramchandra Trimbak Joshi of Rahuri, District, Ahmednagar.
  Married with Ujwala Ratnaparkhi on 13th May 1989 and having a daughter **Ku. Shraddha.**

- **Educational data** : Completed primary and secondary education at Rahuri, Dist : Ahmednagar. Higher Secondary Education at Ahmednagar and received the degree of BACHELOR OF SCIENCE (Agriculture) with FIRST CLASS from College of Agriculture, Pune in 1982.

- **Professional experience** : Started service career as Junior Research Assistant under Sugarcane Specialist, C.S.R.S., Padegaon from 1983 to 1985, and from 1986-1987 under Director of Farms, MPAU, Rahuri.
  Senior Research assistant under the Senior Vegetable Breeder, MPAU, Rahuri since, 1988.