STUDIES ON SUITABILITY OF RADISH VARIETIES FOR RAINY SEASON (*Raphanus sativus* L.)

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FOR THE DEGREE OF
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(HORTICULTURE)

BY

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1997

THESIS ADVISOR — DR. J. M. PANDA

Dedicated to

All Mighty God

Dr. J. M. Panda,
Associate Professor,
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Bhubaneswar
The 12th... October, 1998

CERTIFICATE - I

This is to certify that the thesis entitled **"STUDIES ON SUITABILITY OF RADISH VARIETIES FOR RAINY SEASON"** submitted in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE IN AGRICULTURE (HORTICULTURE)** to the Orissa University of Agriculture and Technology, Bhubaneswar, is a faithful record of *bonafide* research work carried out by **MR. PURNA CHANDRA BISWAL** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

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

12.10.98

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CERTIFICATE - II

This is to certify that the thesis entitled **"STUDIES ON SUITABILITY OF RADISH VARIETIES FOR RAINY SEASON"** submitted by **MR. PURNA CHANDRA BISWAL** to the Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE (HORTICULTURE)** has been approved by the Student's Advisory Committee after an oral examination on the same in collaboration with an External Examiner.

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Bhubaneswar
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STUDIES ON SUITABILITY OF RADISH VARIETIES FOR RAINY SEASON

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ABSTRACT

An experiment entitled **"Studies on suitability of radish varieties for rainy season"** was carried out at the Horticultural Research Station, Orissa University of Agriculture and Technology, Bhubaneswar during rainy season, 1998.

The results revealed that out of seven varieties of radish tried, the variety Pusa Chetki proved to be the best of it, registered the highest total as well as marketable root yield of 29.6 t/ha under the existing condition. All most all the yield attributing characters were most favourable in case of this variety.

It was concluded that Pusa chetki (the variety) and Radish No 7 of (Indo-American Seeds) may be adopted by farmers of Orissa for cultivation in rainy season.

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LIST OF ABBREVIATIONS

g	.....	Gram
q	.....	Quintal
cm	.....	Centimetre
cm^2	.....	Square centimetre
mt	.....	Meter
km	.....	Kilometre
Sq.m.	.....	Square meter
ha	.....	Hectare
%	.....	Percentage
@	.....	At the rate of
*	.....	Significant at 5% level
NS	.....	Not significant
S.E.(m)	.....	Standard error of mean
C.D.	.....	Critical difference

CHAPTER - I

Introduction

INTRODUCTION

Radish (*Raphanus sativus* L.) is an important cash crop for small and marginal farmers as well as a good inter crop fitted into any vegetable cropping system and a good companion crop for intensive cropping. As a popular salad crop it is liked very much for its pungency and neverthless it has therapeutic value in curing piles, liver trouble, enlarged spleen and jaundice. A popular curry called `Kanji' is also prepared out of it. The food value of 100g of edible portion in radish is as follows (Chatfield, 1949)

Protein	:	1.1 gm
Fat	:	0.1 gm
Carbohydrate	:	4.2 gm
Phosphorus	:	31 mg
Chlorine	:	37 mg
Magnesium	:	15 mg
Calcium	:	37 mg
Potassium	:	260 mg
Sulphur	:	37 mg
Iron	:	1 mg
Calories	:	17

A look at this chart shows that it is rich in many useful minerals with less of fat and calorific value. Thus it is recommended for people getting obesity and requiring food of low calorific value.

There are 3 groups of radish cultivars namely, European, Asiatic and Indian. These 3 groups of cultivars differ from each other in various characters and require different temperature range for their growth and development (Premnath *et al.*, 1984). In general the root development of radish is best carried out at temperature of 10-15°C which is mostly available in the winter season. However,

it is also possible to grow radish in other seasons in hills and cool places of North India but the possibility of its cultivation other than winter season in the hot sub-tropical climate of Orissa needs to be widely explored and standardized with respect to variety, time of planting and temperature which affect root growth and yield.

In Orissa, rainy season starts from July and continues up to September. During this period the precipitation, relative humidity and light intensity are mostly favourable for good root development in radish. But the limiting factor is the temperature, which shows a minimum reading of 23-25°C and maximum of 33-35°C. This temperature range seems to be far above the temperature requirement for root development in radish. Under such conditions, most of the European and Asiatic types of radish seem to be less adaptable in rainy season and it may be possible to utilise the Indian types for off season growing as they are little bit heat tolerant.

Fortunately with the advancement of crop improvement programme, many new radish varieties have been developed that have tolerance to higher temperature and can develop good marketable roots under high temperature conditions. In view of this, there is necessity of assessing the performance of these newly developed varieties under high temperature and rainfall conditions to find out their relative growth rate, time required for root formation and the percentage of marketable roots developed. Over and above all, there is also necessity of assessing the quality factor that is pungency in this case without which it cannot be relished by the consumers.

Attempts to raise radish crop in the off season raise several points for consideration like the variety and its sensitiveness to climatic factors like temperature, light intensity, humidity and rainfall. Although temperature is important factor for root growth and development; heavy rainfall may cause diseases and create problems like water stagnation in the field and soil management like earthing up. Also the light intensity may affect the photosynthesis process. The other characters that are to be closely observed during offseason trial in radish are the growth parameters like days taken for germination, percentage of germination, growth of shoot, root development process and its quality factors like pungency and T.S.S. All these are likely to be more or less affected in the off-season trials and needs to be recorded to get an over all effect of off season so that the farmers can be guided accordingly.

Keeping the above said factors in view, this trial on suitability of radish varieties for Orissa during rainy season was carried out at H.R.S. O.U.A.T. during July-August 1998. In total seven varieties were choosen by selecting three pusa types (Pusa Chetki, Pusa Chetki Long, Chetki Long Barmasi), Two Indo-American hybrid types(Radish No.7 and Radish No.8), one Mahyco hybrid (Mahyco No.11) and one Asiatic type (Japanese White).

CHAPTER - II

Review of Literature

REVIEW OF LITERATURE

There is now an increased interest in the growing of vegetables beyond of the normal season as it extends their season of availability and becomes more remunerative due to higher price than the normal season. But growing of vegetables in the offseason is dependent on certain limiting factors like temperature, light, rainfall, humidity and moreover variety. Many research workers have worked on these various aspects of offseasons cultivation.

2.1 Effect of temperature on growth and development of radish cultivars

Nieuwhof (1978) conducted trials on seven radish cultivars which were sown in temperature controlled glass houses of 10, 14, 17, 20, 23 and 26°C with long days and at high light intensities. Maximum leaf and dry matter production occurred at 20 and 23°C. But at lower temperatures differences in rate of leaf and root growth were observed between cultivars. Some cultivars and environment (temperature and harvest time) interactions were assessed. But there was no cultivar and season interaction. Thus it appears possible at least with the material tested to select radish varieties for summer.

According to Nieuwhof (1983) growth and development of radish under alternating day and night temperatures. (combinations of 10, 17 and 23°C) was as good as at constant temperatures (10, 17 and 23°C). At higher day temperatures, the promotive effect of high night temperature on leaf growth decreased, while the promotive effect of high day temperature decreased at higher night temperature. Optimal root growth occurred at intermediate temperatures. At sub-optimal day temperatures, root growth was promoted by high night temperatures but at supra optimal day temperatures it was inhibited by high night temperatures.

In the opinion of Seyama *et al.* (1984) during the early stages (11th-30th day after planting), the relative growth rate (RGR) and the net assimilation rate (NAR) of Japanese radish and Chinese cabbage were most affected by air temperature., The RGR decreasing from a maximum of 25°C to zero at 5th and the NAR also falling with temperature. From 21st-50th day the RGR of Japanese radish was increased by air temperature and NAR of both crops by solar radiation. From the 51st day, RGR and NAR were unaffected by temperature and radiation. In Japanese radish, the relationship between root weight and accumulated air temperature and accumulated solar radiation varied with the planting date. Roots planted after late August did not grow to a marketable size.

Wilcox *et al.* (1991) conducted experiments to study the effect of temperature and nutrition on seed germination and plant growth of several horticultural crops. The nutritional studies on vegetables (using Hooglands solution for irrigation and varying the amounts of P and K) showed improved root growth with fertilization of nutrient deficient soils at temperatures above their critical minimum. At soil temperatures, below this, litter or no response was obtained. The crops studied were phaseolus beans, sweet corn, cucumber, egg plant, pea, sweet, pepper, radish, spinach and water melon growth of peas radish and spinach was significantly reduced by soil temperatures when maintained in the range of 12.3 to 14.5° or lower while growth of bean, cucumber, egg plant, sweet pepper and water melon was limited when soil temperatures were maintained in the 16.7-18.9° temperature range or lower

Seyama *et al.* (1992) observed, twelve Japanese radish cultivars grown in the field and under plastic tunnels under various conditions. Bolting was less

pronounced with seed sown later in the season. Little bolting had occured at harvesting (2 months after sowing) when the average temperature was above 20°C. The minimum above 10° and the number of hours above 21° was more than 120 during the first 15 days after sowing. In green house experiments, plants were grown in 6h/18h cycles 30/5°, 22.5/5°, 15/5° or 5/5° plants grown in the first 2 cycles showed the most resistance to bolting, but this was increasingly reduced when the cycles was interrupted by 1, 2, 3, 4 or 5 days continuously at 5°C.

Nieuwhof (1995) in his studies conducted with the radish cultivars Boy which tends to accumulate low levels of nitrate and Robin, which accumulates high levels of nitrate. In his trial plants were either grown at 10 or 18°C from sowing until harvest or were grown at 10° until 11, 4 or 2 days before harvest and then transferred to 14 or 18° or were sown at 10° and then placed in darkness 3 days before harvest. Leaves and roots of plants grown continuously at 18° and those transferred from 10 to 14 or 18°, 11 days before harvest had higher nitrate contents than plants grown at lower temperatures. Plants transferred to 18° had higher nitrate contents than those transferred to 14°. Nitrate content also increased with dark treatment before harvest. Boy had lower nitrate contents than Robijn except when grown at 18°.

2.2 Role of temperature in the development of hollow root in Japanese radish CV. Gensuke

Kano (1990) observed the incidence of a physiological disorder characterised by longitudinal hollow regions in the centre of roots in radishes sown in the field at 15 days intervals from July to September in 1984 and 1985. In the 1984 season, water was piped in to the rows to cool the soil. In both years, soil and air temperatures were highest from 13 July to 15 August. The cooling treatment reduced the maximum soil temperature by about 6°C during this period.

The greatest root weight 60- days after sowing was obtained in radishes sown on 17 July in 1984 and on 1 July in 1985. The occurrance of hollow root which began to increase 20-30 days after sowing was greatest in radishes sown from the beginning to the middle of July and low in those sown thereafter (Measured 60 days after sowing). The cooling treatment reduced the incidence of hollow root from 90% (for plants sown in July) to only 10%. High soil temperature appears to be an important factor in hollow root in cultivar Gensuke.

Kawashiro *et al.* (1991) studied the influence of air and soil temperature and CV on the occurrance of Akashin, a physiological disorder of radish caused by boron deficiency. Akashin did not occur until the top root reached the vigorous growth stage (when it weighs about 300 g) and then developed with the growth of the top root. Akashin occurred particularly on radishes sown from early June to mid July. Akashin did not occur at day/night temperatures of 21°/9°C but the incidence of Akashin was 25% at 24°/ 18°C and 83% of 30°/21°C. It developed at high soil temperatures at late stage of growth. Akashin was suppressed when radishes were transplanted in rows 100-130 cms apart with 24-30 cms between plants. The occurrence of Akashin varied greatly between cultivars

Kano *et al.* (1995) observed to examine the effect of high soil temperature on the development of hollowing in the root of radish, seeds were sown in the field on 27 May, 10 July and 16 August 1992 plants from the July sowing were subjected to soil temperature above 32°C during the middle of the growth period. Root weight was reduced and hollowness occurred in roots from the July sowing. Roots from the July sowing had the greatest concentration of vessels in the Central region. Legnin formed in walls surrounding the central cavity only in roots of the July sowing in a 2nd experiment. Seeds were sown on 30 April 1991 in plastic pots with heating cables to increase soil temperature. Soil heating from day 16 after

sowing (DAS) to 30 DAS and from 31 to 45 DAS, slowed root growth and produced some hollow cavities, caused more vessels to form in the central area and promoted lignfication near the central cavity. In contrast, sol heating from 10 to 15 DAS or from 46 to 60 DAS produced roots with no hollow cavities and resulted in the production of a smaller no. of vessels in the central region of the root. Soil heating during these periods had no effect on lignin formation. In conclusion, a large hollow cavity develops in the central region of the root as a result of active lignin formation in the surrounding cells induced by soil heating in the middle of the growth period.

Kano *et al.* (1983) conducted two experiments to study the effect of plant density and time of thinning on the hollowness in radish. They concluded that root hollowness occurred when rapid root growth took place during the late sowing period as a result of early thinning.

Reijers *et al.* (1990) reported some possible factors affecting the incidence of worts, a physiological disorder in glass house grown radishes. The disorder (in which the white inner root tissue protrudes through splits in the skin) occurs mainly between june and September in new soil and on dry patches. The incidence is also affected by population intensity, soil pH. The nutrient content donot appear to have any influence nor (so far) has any pathogen been found in the worts.

2.3 Effect of season/month of sowing on growth of radish

Thiem (1978) reported that radish cultivars korund, certina or certus were sown at weekly intervals from 7th March until the end of August. The time from sowing to harvest varied from 5-9 weeks. Staggered sowing date made it possible to supply the market with radishes over a period of 24 weeks.

The effects of sowing date on earliness and total yield of 4 winter radish cultivars have been reported by Reppen horst *et al.* (1981). According to him Pax proved the earliest cultivar when sown in April or May. No marketable crops were obtained from June sowing and many roots rotted from July sowing. Minowase April cross produced the highest total yields in the first half of the year while minowase summer cross no. 3 gave the highest autumn yields. April sown minowase spring cross bolted badly.

Milde (1984) conducted trials on three radish cultivars which were sown in 5th and 25th February 1982 in a green house with a soil temperature of 12°C lowered to 6°C after germination and ventilation at air temperature of 20°C. Yields of early sown radishes harvested after 52 days were higher than yields of later sown radishes harvested after 47 days. The cultivar Kutara produced the highest total yield, but Karissima gave the lowest total yield and minitas produced the highest yield of first class roots.

Reppenhorst (1984) conducted trials on thirteen radish cultivars which were sown on 6 dates from February until August. Cultivar, Karisshima was the earliest, produced the heaviest yield of highest quality and was recommended for February sowing. The cultivars Minitos and Rador were recommended for April and Tamira and SG 481 for May sowings. For July and August sowings SG 481 and primo were best.

Gray *et al.* (1986) reported the relationship for a number of successional sowings of the cultivars on harvest date over the period 1971-77. Harvest date was curvilinearly related to sowing date a fitted curve accounting for 99.3% of the variation in harvest date. No improvement in the fit was obtained by replacing chronological time by a temperature time scale.

Rao *et al.* (1991) reported that seeds of the cultivars Pusa Chetki, Pusa Reshmi and Nerima long were sown in the 15th and 30th or 31st day of June, July, August, September, October and November. The highest mean yields of good quality roots (213100 marketable roots/hect) were obtained with the 31st October sowing. Nerima long out yielded the other 2 cultivars.

Kobryn (1993) reported that in long term trials with cultivar Rowa, the seeds were sown on different dates in September, October, November, December, January, February and March. The growing cycle in the green house where the day/night temperature was maintained at 10-12/ 5-8°C extended from 30 to 98 days. The yield of marketable roots decreased with delay in sowing date with the lowest yield occurring with sowing on 11 December. This was attributed to low PAR during the winter months. During the first 18 days, root diameter at 5 MJ/m^2 was only 0.5 mm where as at 30 MJ/m^2 it was 5 mm. The length of the growing cycle depended on the sowing date, the later the date, the longer the cycle. A model is presented for predicting the length of the growing cycle which enables the optimum sowing date to be selected.

Capecka (1995) observed Japanese radish cultivars Tokinoshi and Minowase summer cross F_1 which were sown in April-June or July in field trials near Krakow in 1990-92. The average growing period was 60-75 days. Tokinashi formed shorter and Thinner storage roots than Minowase summer cross. Marketable yield were 513 and 719 Q/ha respectively, Both cultivars could be sown after 15 June and Tokinashi could possibly be sown earlier. Japanese radishes were resistant to sponginess but susceptible to root deformation and cabbage fly (*Delia radium*) infestation.

Stolk *et al.* (1983) have presented data on the production/m^2 and other characteristics of 7 radish cultivars assessed from glass house trials in several places. Among crops sown between 10 June and 10 August and harvested between 6 July and 7 September, Primo and Marabelle performed the best followed by Helro and Sexa-Nova.

Hogendonk *et al.* (1990) an assessed the characteristics and keeping quality of 6 radish cultivars compared with the standards Sexanova and Mirabelle in glass house trials conducted from mid-May to early August. The new cultivar Hilo was considered the best followed by Madeira and Sexa Rafine. Hilo produced the largest roots of very good colour and shape and yielded well.

Wijk *et al.* (1992) reported that the Japanese summer radish cultivars Easter, wonder Icicle. Toma winter, E-1085, Silver star were sown at the end of July and harvested during the last 10 days of October after which they were stored at 0°-1°C and 90% RH. The first and cultivars name were considered suitable for autumn culture. But Easter was the only one recommended for storage.

Capecka *et al.* (1994) in a 2 year trial, seeds of 2 cultivars (i.e. Rex Summer Radish and Tokinoshi Japanese Radish) were sown on 12 and 13 April, 20 and 26 June, 22 and 27 July. The crop was harvested when the roots were 3 cm in diameter or longer. Both cultivars were suitable for growing in any of the 3 cultivation cycles. However the earliest cycle gave lower yields, higher percent of mishappen roots and a greater no. of bolting plants of the 2 cultivars. Tokinashi gave higher yields than Rex. However, Tokinoshi was also noted for greater D. W. and higher vitamin-C and isothiocyanate contents than Rex, where as Rex had a higher sugar content.

2.4Performance of radish cultivars

Deotalea *et al.* (1994) observed that the radish cultivars pusa. Reshmi, Pusa Himani, Japanese white, Barmasi vijay and Pusa chetki were trialled at Nagpur in India during the rabi season. Pusa Reshmi was the best cultivar with respect to the following root length 45 days after sowing which was 23 cm, compared with 19.2-21cm root diameter of 3.86 cm compared with 3.01 -3.50 cm, wt/plant of 299.12g compared with 216.10-278.12 g and yield of 27.76 t/ha compared with 24.11-27.14 t/ha. Barmasi produced the greatest root wt/ plant of 219.4g compared with 108.11-142.33g for the other cultivar pusa chetki produced the greatest leaf wt/plant of 136.56 g compared with 106.34-135.20g for the other cultivars.

Dixit *et al.* (1981) reported that out of the seven radish cultivars studied, Japanese white gave the highest yield (56.11 Q/ha) followed by Kalyanpur T-1 (44.017 Q/ha) and scarlet long (37.21 Q/ha)

Bianchi (1987) reported the performance of four varieties recently released in Italy. According to him , Vadka is a radish which can be sown in late summer for an autumn harvest in December-January, under tunnels for a March harvest or in early spring for harvesting in late spring. It has long white roots.

Jargensen (1991) in trials between 1984 and 1986 assessed six cultivars which were compared at 2 sites (Arslev and Lammefjarden) with sowing dates between early May and early September. The cultivars were Tokinoshi minowase, April cross minowase spring cross. All season cross Minowase summer cross and Minowase spring cross tables show the percent salable crop and percent bolting. Root weights and dimensions for each cultivar trial and site. The NO_3 - N content (DM) percent, DM and fibre content (ing/100 gfw) are also shown for each

cultivar. The percent of salable roots was acceptably high for all cultivars and the tendency to bolt was insignificant. Tokinoshi produced very few bolted roots. It also had the thinnest and shortest roots. It appeared that the best quality roots were produced from a late sowing with harvesting between 1 October and 1 November. In all 3 years the poorest results were obtained from sowing around 1 July and harvesting in mid-September.

2.5 Growth and yield of radish (Rphanus sativus L.) in relation to nitrogen and potash fertilization

Srinivas *et al.* (1991) conducted field trial on cultivar Akra Nishant plants which received N at 0, 50, 100 or 150 kg/ha and K_2O at 0, 40 or 80 kg/ha, P_2O_5 at 80 kg/ha applied as a basal dressing. One half of the N and all of the P and K were applied before sowing and the remaining N was applied as a top dressing 20 days later. The crop was harvested 50 days after sowing. Data are tabulated and graphically presented on DM accumulation and distribution in the plant LAI, Leaf area duration (dm^2/d), N uptake and root yield. The highest yield of 395.9 Q/ha was obtained with the highest N and K rates. The non-fertilized control yield was 121.8 Q/ha.

Chatterjee *et al.* (1992) reported that the highest root yield of cultivar Improved Chinese pink were found with 30 kg N/ha and 80 kg K_2O/ha at a spacing of 40 x 20 cm. The highest seed yield were found at the same N and K rates and at a spacing of 40 x 10 cms.

Joshi *et al.* (1995) conducted an experiment on radish cultivar Japanese white during the rabi (winter) season of 1987-88 using different plant spacings (5 or 10cm) and raw spacing (10, 20 or 30 cms) together with N at 30, 60 or 90 kg/ha

and P at 0, 15 or 30 kg/ha. The observed that optimum yield was obtained with the plants spaced 5 cm apart (60.55 t/ha) in rows, 10 cms apart (66.57 t/ha) combined with 2 applications of N at 45 kg/ha, each given as a basal dressing and a top dressing 4 weeks after sowing (63.82 t/ha). There was no significant improvement in yield from the use of phosphorus.

2.6 Effects of cultivars and cultural conditions on the pungent contents in radish roots

The substances responsible for the pungent taste and flavour of 11 radish cultivars were extracted and analysed by GC (Lee *et al.*, 1996). The major pungent principle was identified as 4-methyl thio-3-butanyl iso thiocynate (MTB-ITC) but small amounts of other substances were observed. MTB-ITC contents varied with cultivar and growth site. Long and Slender Japanese cultivars had higher MTB-ITC contents than short and solid Korean cultivars. Portions adjacent to the root tip had higher MTB-ITC contents than portions near to the root top or shoulder. Peel contained high concentration (10-50%) of MTB-ITC than the inner root flesh. Fertilizers, including sulphur-containing fertilisers failed to influence over all MTB-ITC contents. Even though plants grown in non-fertilized plots showed significant reductions in shoot and root growth they had higher MTB-ITC contents in root. MTB-ITC contents were not significantly reduced in roots stored in a cool and moist cellar for up to 2 months.

2.7 Quality studies in radish

As per Fuhrmann *et al.* (1987) studies on sugar content, using a hand held refractometer were carried out on 11 cultivars of radish grown under different conditions (in the open field or under plastic) with sampling dates between March and September. In radish cultivars, overall mean values ranged from 1.1 to 4.1%. Values were generally highest with summer sampling. Differences existed within varieties between sampling dates, but it is concluded that sugar content in radish is a varietal characteristics.

CHAPTER - III

Materials and Methods

MATERIALS AND METHODS

The present experiment entitled **"Studies on suitability of radish varieties for rainy season"** was carried out at Horticultural Research Station, Orissa University of Agriculture and Technology, Bhubaneswar during Rainy season (July to August), 1998.

3.1 Site and location of the experiment :

The experimental trial was conducted under field conditions during kharif season of 1998 in Horticultural Research Station of Orissa University of Agriculture and Technology located about 4kms west of college of Agriculture near the National Highway no. 5.

3.2 Climate :

Bhubaneswar experiences a sub tropical climate as it is between 20° (N) latitude 80° 52′ (E) longitude with an altitude of 25.5m above the mean sea level. It is 65 kilometers away from the Bay of Bengal towards the west.

3.3 Weather condition during the period of Experiment :

The average maximum temperature experienced during the period of experiment (July-August) varies from 34.5° to 35.7°C and the average minimum temperature varies from 23.6° to 24°C. The humidity during the period varied from 62% to 98%. The amount of precipitation during the year under report was 1048.9 m.m out of which 505 mm of rain was received between July to August. The meteorological data were obtained from the meteorological observatory of the State Research Station, Bhubaneswar. which is presented below in Table-1.

Table 1

Month and Year	Temperature (°C)		R. H. (%)		Rainfall (mm)	No. of rainy days	Sunshine hrs/day
	Max.	Min.	Max.	Min.			
July' 98	35.7	23.6	98	62	341.5	20 days	4.6
August' 98	34.5	24	98	64	163.5	17 days	4.1

3.4 Soil of the experimental field :

The physico-chemical composition of the soil collected to a depth of 15cm of the experimental field is presented in Table - 2.

The soil of the experimental field was sandy loam in texture, poor in nitrogen as well as phosphorus and rich in potash content having an acidic reaction. The soil is considered to be well suited for radish crop.

Table 2 Physico-chemical composition of soil of the experimental plot.

	Mechanical composition	Percentage (Air dry basis)	Methods followed
1.	Course sand	51. 97%	Bauyoucos hydrometer
	Fine sand	29. 51%	
2.	Silt	7.12%	
3.	Clay	11. 58%	
4.	Textural class	Sandy loam	

	Chemical Composition	Amount present (oven dry basis)	Methods followed
1.	Available Nitrogen (N)	0.042%	Kjeldahl's method (Jackson, 1962)
2.	Available Phosphorus (P_2O_5)	0.5 kg/ha	Bray's strong reagent (Bray, 1948)
3.	Available potassium (K_2O)	130.0 kg/ha	Margan's Reagent (Jackson, 1962)
4.	Organic carbon	0.41%	Walkley and Black Rapid titration method (Black and Walkey 1934)
5.	pH	5.5	Buckman's pH meter (Piper, 1966)
6.	C : N ratio	9.76:1	

3.5 Crop history of the experimental field :

Year	Crop		
	Kharif	Rabi	Summer
1996-97	Fallow	Tamato	Fallow
1997-98	Fallow	Tamato	Fallow
1998-99	Radish		

3.6 Details of the experiment :

3.6.1 Design of the experiment and plan of layout. The detail plan of layout is presented in the fig. 1

I) Design followed :- Randomised Block design

ii) a) Number of varieties :- Seven as mentioned below

- V_1 – Pusa Chetki
- V_2 – Pusa Chetki Long
- V_3 – Chetki Long Barmasi
- V_4 – Japanese White
- V_5 – Mahyco Hybrid Radish No.11
- V_6 – Radish No.7
- V_7 – Radish No.8

b) Spacing adopted :- 30 cm × 10 cm

iii) Number of replications - 3

iv) Number of plots - 21

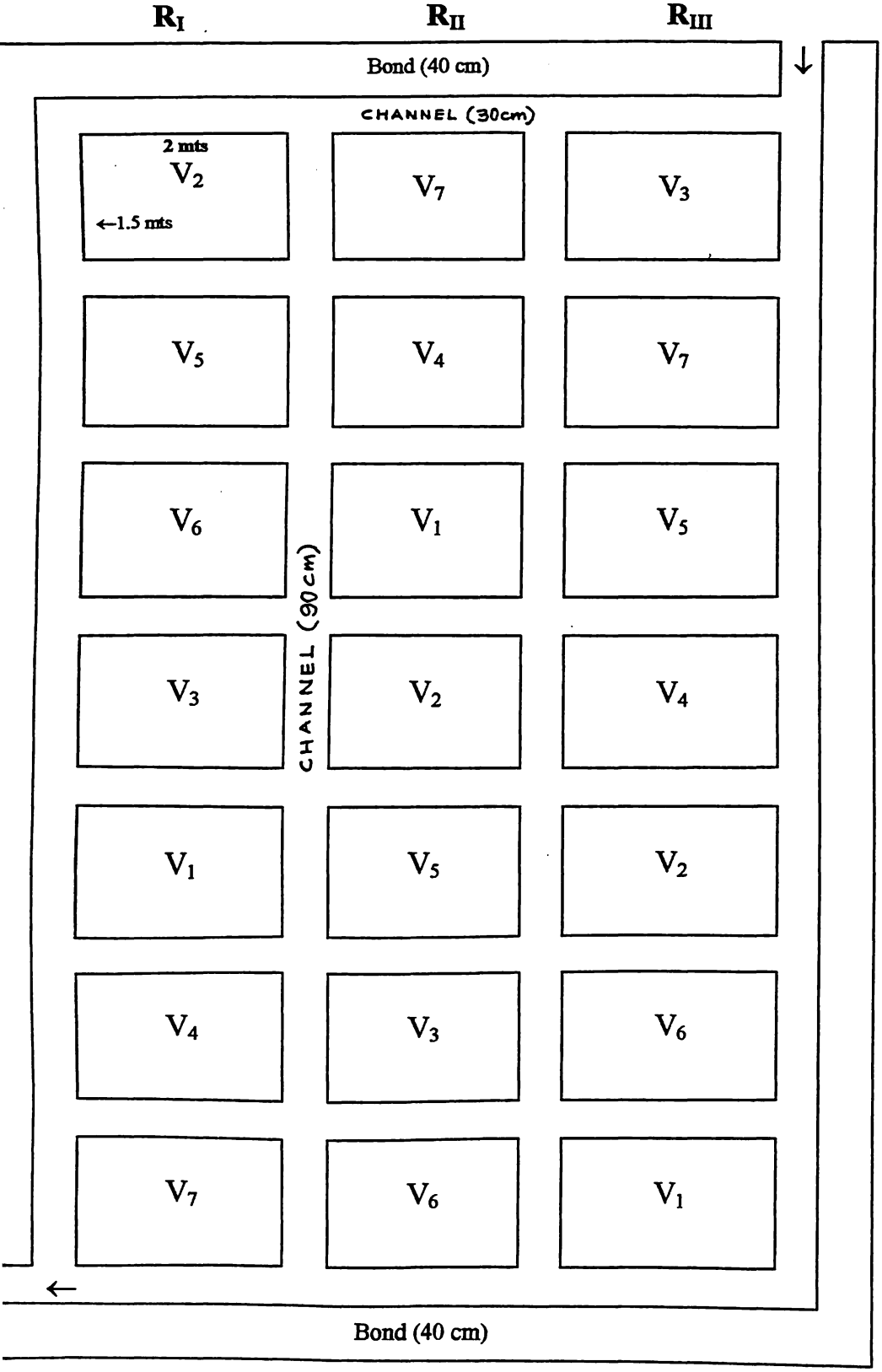
v) Net plot size - (2×1.5m)

vi) No. of plants per plot- 100

vii) Bond size- 0.4 m

viii) Drainage channel - (90cm ×30 cm) all around the plot

Fig. 1 Experimental Design and Plan of Layout



N

SPACING

30 cm × 10 cm

VARIETIES

V_1 – Pusa Chetki

V_2 – Pusa Chetki Long

V_3 –Chetki Long Barmasi

V_4 – Japanese White

V_5 – Mahyco hybrid Radish No. 11

V_6 – Radish No. 7

V_7 – Radish No. 8

sign – R.B.D.

plications – 3 (R_I, R_{II}, R_{III})

: Plot size – 2 mts.×1.5 mts.

. of Plants/Plot – 100

Total No. of Plots – 21

Bond size – 0.4 mts.

Drainage Channel – (90 cm × 30 cm) all round the plot

3.7 Preparation of the experimental site

The general pre planting operations were carried out in the field as follows :

Date	Operations	Remarks
18.6.98	Ploughing (Discharrow)	By tractor
19.6.98	Ploughing and cross ploughing (cultivator)	By tractor
19.6.98	Levelling (Leveller)	By tractor
20.6.98	Weeding	By manual labour
25.6.98	Layout	By manual labour
30.6.98	Preparation of plots (drainage channels bund etc.) and appl. of F. Y. M. @ 1 basket/plot.	By manual labour
3.8	**Sowing of crop** 4.7.98	By manual labour

3.8.1 Source of planting material

Seeds of different varieties were collected from Indo-American seeds-BBSR, Mahyco seeds-BBSR, Kamal traders BBSR and Shree MAA seeds, Cuttack.

3.8.2 Application of basal dose of manures and fertilizers

The fertilizers like urea, ssp and mop @ 50g: 25g : 50g per plot i.e. (@ 166 kg, 83 kg and 166 kg N: P: K./ha) were applied to each plot (2×1.5m). Before sowing, half dose of urea i.e. 25 g, full dose of ssp i.e. 25 g and full dose of potash i.e. 50 g were applied as the basal fertiliser to each plot on 3.7.98 and mixed thoroughly with the soil.

3.8.3 Sowing of seeds

Sowing of radish seeds was done on 4.7.98 in lines of the plots as per the plan of layout. Seeds of most of the varieties germinated by 7.7.98 and the initial crop stand was above 95%.

3.8.4 Thinning, weeding and hoeing

On 11th July 1998, the first operation like thinning, weeding and a light hoeing was carried out to maintain recommended spacing and the plant population/plot.

3.8.5 Top dressing and earthing

The first top dressing was under taken on 18.7.98 with application of remaining dose of 25g of urea per each plot followed by earthing after weeding. Due to dry spell prevailing at that period, a light irrigation was given after top dressing.

3.8.6 Plant protection measures

After 3 weeks of sowing the crop was found to be affected by leaf eating caterpillars. A spraying with Cypermethrin @ 1.5ml/litre of water was undertaken on 26.7.98.

3.8.7 Second inter cultural operation

The 2nd weeding operation was carried out on 1.8.98 with much care to avoid the competition of weeds along with 2nd earthing to facilitate better development of roots.

3.8.8 Harvesting

By judging the tenderness of the roots from time to time, the crop was harvested at the marketable stage of maturity. The first harvest of radish crop was taken up on 18.8.98 and the harvesting continued for 2-7 days depending on the variety.

3.9 Observations

Ten number of plants selected randomly from each plot were tagged and maintained as observational plants for recording their growth and yield attributing characters.

3.9.1 Pre-harvest studies

i. **Percentage and days taken for germination of radish seeds:-** The germination of seeds were counted variety wise daily till the completion of germination process and the percentage and days taken for germination was calculated .

ii. **Height of the plant :-** By means of a meter scale the height of the plant was measured at 15, 30 and 45 days of sowing.

iii. **No. of leaves/plant :-** Number of leaves per plant were counted at fortnightly intervals till harvesting i.e. at 15, 30 and 45 DAS.

iv. **Average leave area :-** From the ten observation plants of a plot five small and five big leaves were collected from each plant before harvest and the leaf area was ascertained in each case through the leaf area meter which was recorded in square centimeters.

3.9.2 Post harvest studies :

The plants under observation were harvested variety wise at marketable stage of maturity and washed thoroughly in water. The shoot and root portion were separated by stainless steel knife and kept with care to take necessary post harvest studies as follows :

i. **Days taken for harvesting :-** The days taken from the date of sowing to the harvest was recorded in each case for the purpose.

ii. **Weight of the shoot/plant(g) :-** After harvest, the shoot along with the leaves were cut from the root of individual plant and weighed in the balance. The data so obtained were recorded in grammes.

iii. **Average length of the root/plant :-** The length of the radish root was measured from shoulder to the tip by means of a meter scale and was recorded in centimeter.

iv. **Thickness of the root/plant :** The thickness of the individual root at two sites i.e. one at the top and the other at the middle was recorded by the help of a side callipers. The average of the two data gave the thickness of the root which was recorded in centimeter.

v. **Weight of the root/plant :-** The root was weighed in a balance and the weight was recorded in grammes.

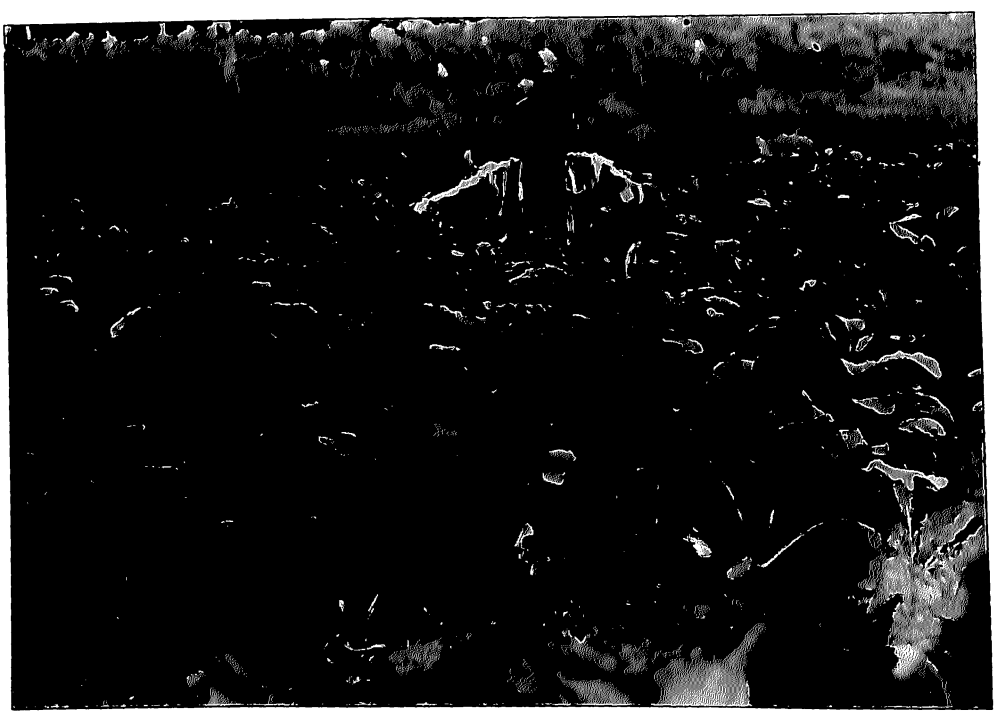
vi. **Skin thickness :-** The thickness of the skin (rind) of the individual root was ascertained by the help of an engineering scale by cutting the root transversely and was recorded in centimeter.

vii. **Core thickness :-** By subtracting the skin thickness from the root thickness, the core thickness of the individual root was found out and recorded in centimeter.

viii. **Percentage of dry matter of roots :-** From the root samples, 100g of root was taken out and kept separately variety wise. These 100 g samples were cut into pieces and kept in a paper packet in the oven for 48 hrs at temperature of 40°C after which its ovendry weight was recorded. The dry weight of the samples were expressed as percentage of dry matter of roots.

ix. **Total yield of marketable roots (t/ha) :-** In this case, the weight of all the marketable roots including the samples from each plot was ascertained by actually taking their weight after harvest and the yield was recorded in tonnes/hectare.

GENERAL VIEW OF THE EXPERIMENTAL FIELD



x. **Root : Shoot ratio (Variety wise) :-** After recording the weight of individual root and shoot of the observational plants, the root : shoot ratio was calculated.

xi. **Total root yield (t/ha) :-** This included the yield of both marketable and unmarketable roots, which was obtained from each plot variety wise at the time of harvest and was expressed as yield per plot and converted to yield /hectare.

xii. **Percentage of marketable root yield :-** It was determined by discarding all the unmarketable roots from the total yield and expressing it in percentage.

xiii. **Total soluble solids (%) :-** The juice extracted from roots of different varieties was examined by means of refractometer and the percentage of T.S.S. was recorded.

3.10 Statistical analysis

The data recorded on various growth and yield parameters of radish in this study were subjected to statistical analysis following the method randomised Block Design with seven varieties replicated thrice.The interpretation of the results was carried out using 'F' test for significance in findings. Appropriate standard error for each character was calculated inorder to compare the two treatment means and the critical difference (C.D) was worked out at 5% level of significance using the following formulae.

1. S. E. (m) ± for treatment = $\sqrt{\frac{\text{Error M.S.}}{r}}$

where, Error M. S. = Error mean sum of square
r = Number of replications (3)

2. C. D. (0.05) for treatment means =

$$\text{S. E.(m)} \times \sqrt{2} \times \text{'t' value at error degree of freedom (2.179)}$$

The results have been presented in tables.

CHAPTER - IV

Experimental Findings

EXPERIMENTAL FINDINGS

4.1 Percentage and days taken for germination of radish seeds:-

The data recorded on percentage of germination of seeds were transformed to corresponding angular values for statistical analysis and the analysed data have been presented in table no.1.

Table No.1 Percentage and days taken for germination of radish seeds

Sl. No.	Name of the Variety	Germination of Seeds (%)	Days taken for germination
1	Pusa Chetki	90.00 (71.56)	3.00
2	Pusa Chetki Long	90.00 (71.56)	3.00
3	Chetki long Barmasi	95.00 (77.08)	4.00
4	Japanese White	90.00 (71.56)	3.00
5	Mahyco No.11	90.00 (71.56)	3.00
6	Radish No.7	90.00 (71.56)	3.00
7	Radish No.8	85.00 (67.21)	3.00
	$S.E._{(m)} \pm$	2.92	0.20
	C.D. (at 5%)	NS	NS

The perusal of the data revealed that the maximum germination percentage (95.00 %) of seeds was recorded in the variety Chetki Long Barmasi. Among the rest of the varieties, 90.00% germination was recorded in the varieties like Pusa Chetki, Pusa Chetki Long , Japanese White, Mahyco No.11 and Radish No.7. The minimum germination percentage(85.00%) of seeds was recorded in the variety Radish No.8. However, the differences observed between the varieties were found to be non-significant statistically. So far as days taken for germination of radish seeds are concerned, early germination was observed in all most alll varieties except Chetki Long Barmasi. Chetki Long Barmasi took 4 days for full germination. But others took only 3 days to complete the seed germination.

4. 2 Height of the plant at 15, 30 & 45 DAS

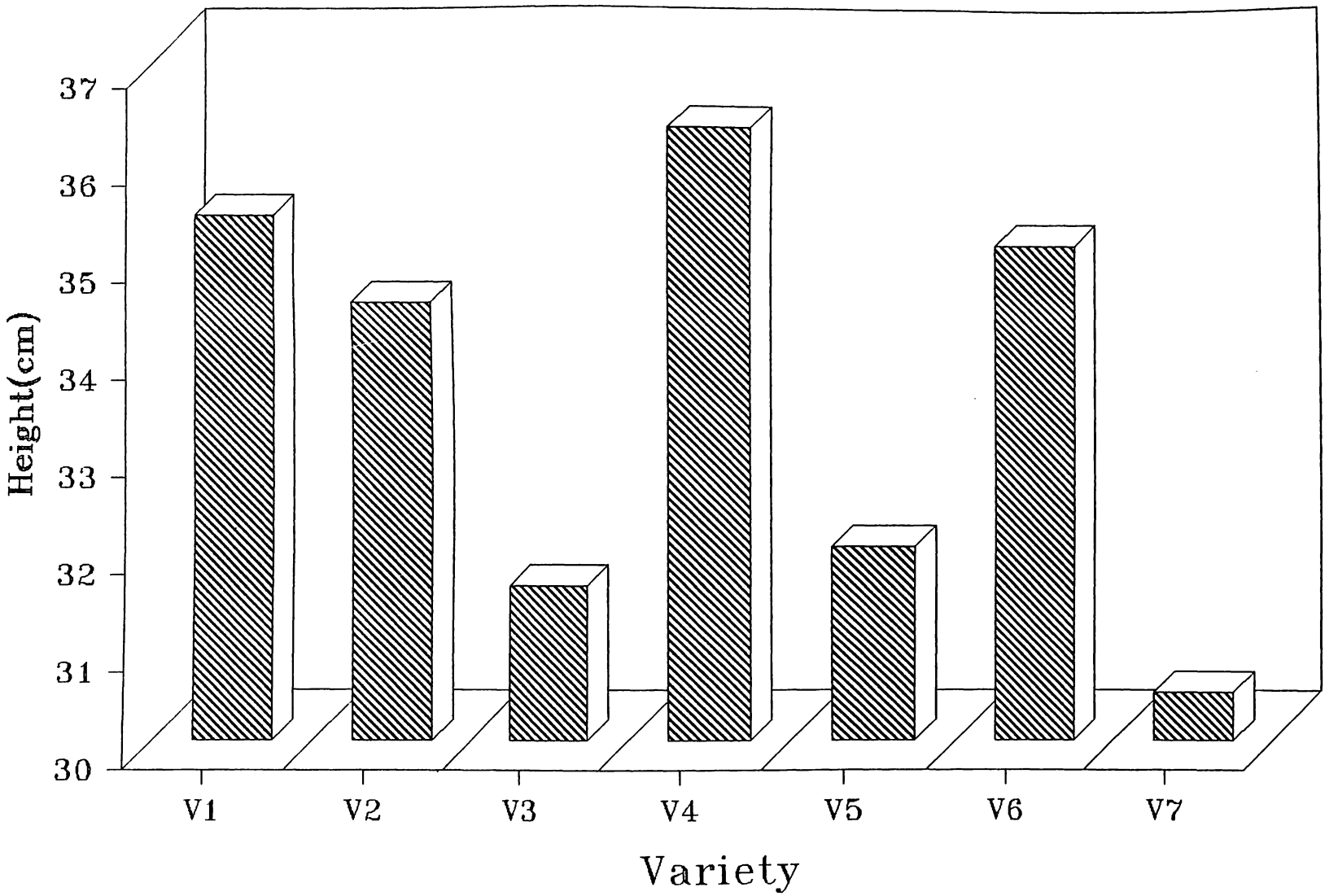
The data recorded on height of the radish plant at 15, 30 and 45 DAS were statistically analysed and the analysed data have been presented in table no. 2 and illustrated graphically in figure-1.

Table No. 2 Height of the plant at 15, 30 & 45 DAS

Sl.No.	Name of the Variety	Plant height (cm)		
		15 DAS	30 DAS	45 DAS
1	Pusa Chetki	12.10	21.10	35.40
2	Pusa Chetki Long	10.40	19.30	34.50
3	Chetki Long Barmasi	10.00	17.40	31.60
4	Japanese White	12.40	21.50	36.30
5	Mahyco No.11	10.40	18.20	32.00
6	Radish No.7	11.40	20.60	35.10
7	Radish No.8	8.50	17.30	30.50
	$S.E._{(m)} \pm$	0.17	0.93	0.81
	C.D. (at 5%)	0.54	2.87	2.50

The data presented in table no.2 revealed that there was significant variation in the height of the plants in different varieties when recorded at 15, 30 and 45 DAS. At 15 DAS, the maximum height of plant (12.40 cm) was recorded in Japanese White and the minimum (8.50 cm) in Radish No.8. Similar trend on height of plants was recorded at 30 DAS. At 45 DAS maximum height of plant (36.30 cm) was recorded in Japanese White closely followed by Pusa Chetiki (35.40 cm), Radish No.7 (35.10 cm) and Pusa Chetki Long (34.50 cm). These varieties were found to be at par with each other. The minimum height of radish plant (30.50 cm) was recorded in Radish No.8 and it was found to be at par with Chetki Long Barmasi (31.60 cm) and Mahyco No.11 (32.00 cm).

Fig.1 Height of the Plant (cm)



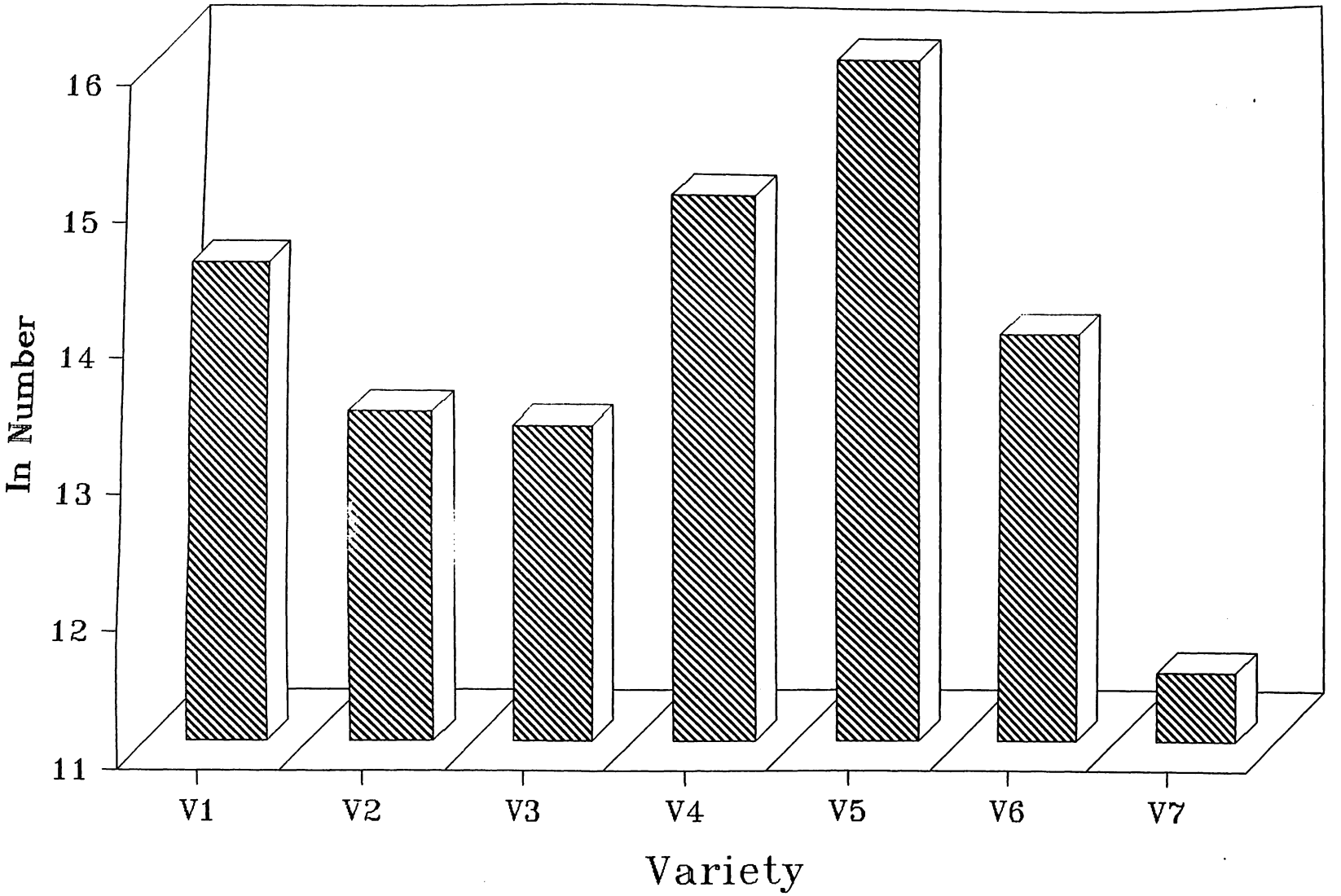
4. 3 Number of leaves per plant at 15, 30 & 45 DAS

The data recorded on number of leaves per plant at 15, 30 and 45 DAS were statistically analysed and presented in the table no. 3 and illustrated graphically in figure-2.

Table No.3 Number of leaves per plant at 15, 30 & 45 DAS

Sl.No.	Name of the Variety	Number of leaves per plant		
		15 DAS	30 DAS	45 DAS
1	Pusa Chetki	6.00	10.50	14.50
2	Pusa Chetki Long	6.00	10.30	13.40
3	Chetki Long Barmasi	6.00	9.80	13.30
4	Japanese White	6.00	10.30	15.00
5	Mahyco No.11	6.60	11.30	16.00
6	Radish No.7	6.00	10.40	14.00
7	Radish No.8	5.30	9.10	11.50
	$S.E._{(m)} \pm$	0.07	0.14	0.47
	C.D. (at 5%)	0.20	0.45	1.45

The data presented in table no.3 revealed that the number of leaves per plant varied significantly when recorded at 15, 30 and 45 DAS. At 15 DAS, maximum number of leaves per plant (6.60) was recorded in Mahyco No.11 and was found stastistically superior to rest of varieties. The minimum numbers of leaves per plant (5.30) was recorded in Radish No.8. Similar trend in maximum and minimum number of leaves per plant was also observed at 30 DAS. At 45 DAS, the maximum number of leaves per plant (16.00) was recorded in Mahyco No.11, followed by Japanese White (15.00) and Pusa Chetki (14.50) which were found to be at Par with each other. The minimum number of leaves per plant (11.50) was recorded in variety Radish No.8.


16
15
14
13
12
11
In Number
V1
V2
V3
V4
V5
V6
V7
Variety

. 4 Average Leaf area of the standard leaf

The data recorded on average leaf area of the standard leaf at harvest were atistically analysed and presented in table no.4 and illustrated graphically in gure-3.

able No. 4 Leaf area of the standard leaf (cm^2)

Sl.No.	Name of the Variety	Average leaf area of standard leaf (sq. cm)
1	Pusa Chetki	86.00
2	Pusa Chetki Long	75.00
3	Chetki Long Barmasi	63.30
4	Japanese White	78.60
5	Mahyco No.11	90.50
6	Radish No.7	83.50
7	Radish No.8	50.30
	$S.E._{(m)} \pm$	1.25
	C.D. (at 5%)	3.86

The data presented in table no.4 showed that there was significant variation mong different varieties so far as average leaf area of standard radish leaf is oncerned. The maximum leaf area (90.50 sq. cm) was computed in Mahyco No. 1 and minimum leaf area (50.30 sq.cm) was computed in variety Radish. No. 8). he average leaf area of standard leaf computed in cultivar Pusa Chetki (86.00sq. n), and Radish No. 7 (83.50 sq. cm) was at par.

5 Days taken for harvest

The data recorded on days taken for harvesting were statistically analysed d the analysed data presented in table no.5.

Fig.3 Average Leaf Area(cm)

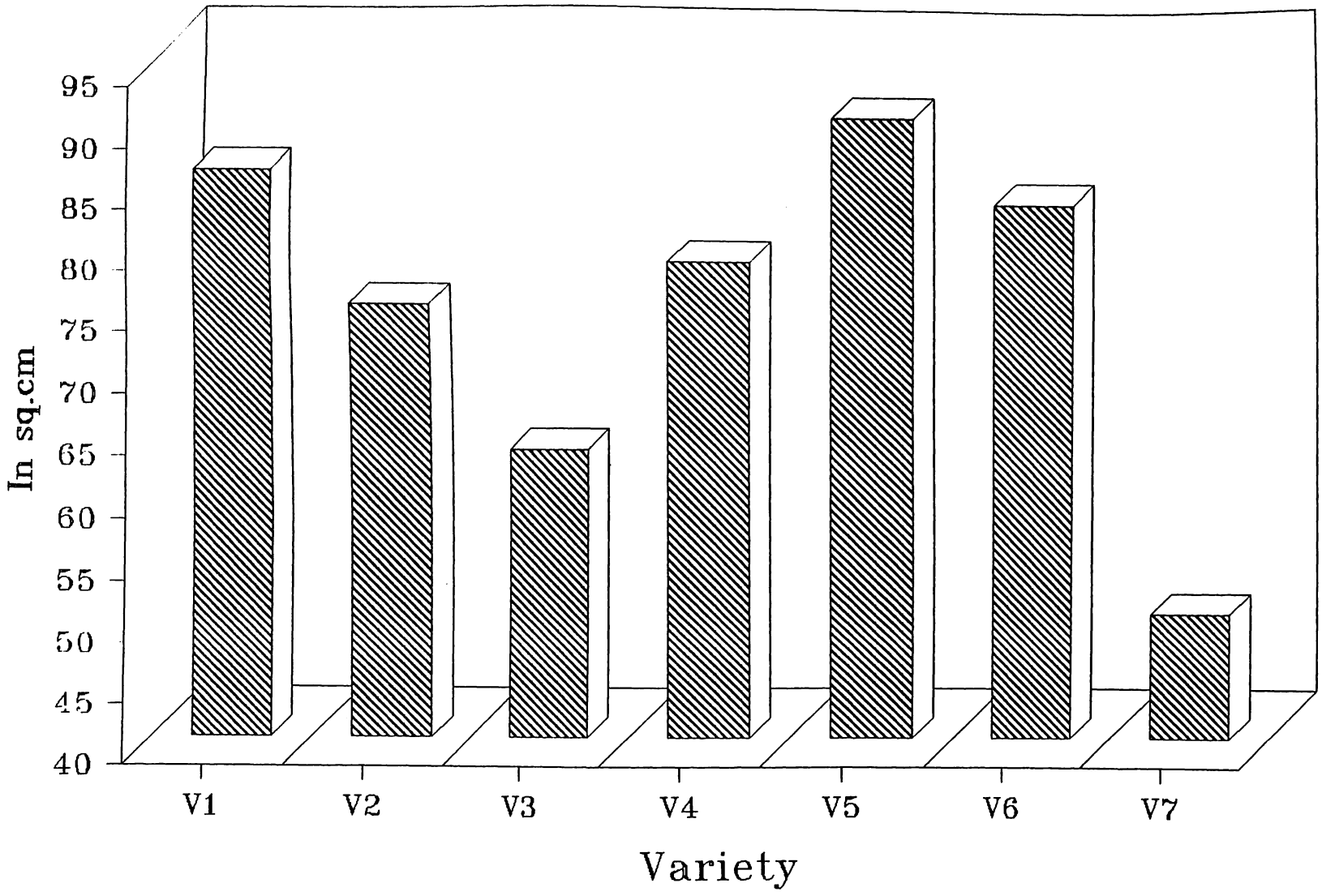


Table No. 5 Days taken for harvesting

Sl.No	Name of the Variety	Days taken for harvesting
1	Pusa Chetki	46.00
2	Pusa Chetki Long	47.00
3	Chetki Long Barmasi	46.00
4	Japanese White	53.00
5	Mahyco No. 11	54.00
6	Radish No.7	47.00
7	Radish No.8	47.33
	$S.E._{(m)} \pm$	0.61
	C.D. (at 5%)	1.90

The perusal of data presented in table no.5 revealed that the maximum days taken for root formation (54 days) was recorded in Mahyco No. 11 closely followed by the variety Japanese White (53 days). These varieties were also found to be at par with each other. The days taken for root formation was found to be (47 days) in Pusa Chetki Long, Radish No.7 and Radish No.8. These varieties remained at par with each other. However, the minimum (46 days) days taken for root formation was in both Pusa Chetki and Chetki Long Barmasi. These varieties remained at par when this character is concerned.

4. 6 Weight of shoot per plant (g)

The data recorded on weight of shoot per plant after harvest were statistically analysed and presented in table no.6.

Table No. 6 Weight of shoot per plant (g)

Sl.No.	Name of the Variety	Shoot weight (g)
1	Pusa Chetki	81.90
2	Pusa Chetki Long	63.20
3	Chetki Long Barmasi	62.10
4	Japanese White	100.70
5	Mahyco No. 11	108.80
6	Radish No. 7	67.10
7	Radish No. 8	57.60
	$S.E._{(m)} \pm$	1.11
	C.D. (at 5%)	3.42

The perusal of the data table no.6 revealed that there was significant variation among the varieties so far as weight of the shoot per plant is concerned. The highest shoot weight (108.80 g) per plant was observed in the variety Mahyco No. 11 which was significantly superior to rest of the varieties. This was followed by Japanese White and Pusa Chetiki which recorded (100.70 g) and (81.90 g) of shoot weight per plant respectively. In the varieties Pusa Chetki Long and Chetki Long, Barmasi the shoot weight per plant was (63.20 g) and (62.10 g) respectively and they are found to be at par with each other. However, the minimum shoot weight per plant (57.60 g) was recorded in the variety Radish No.8

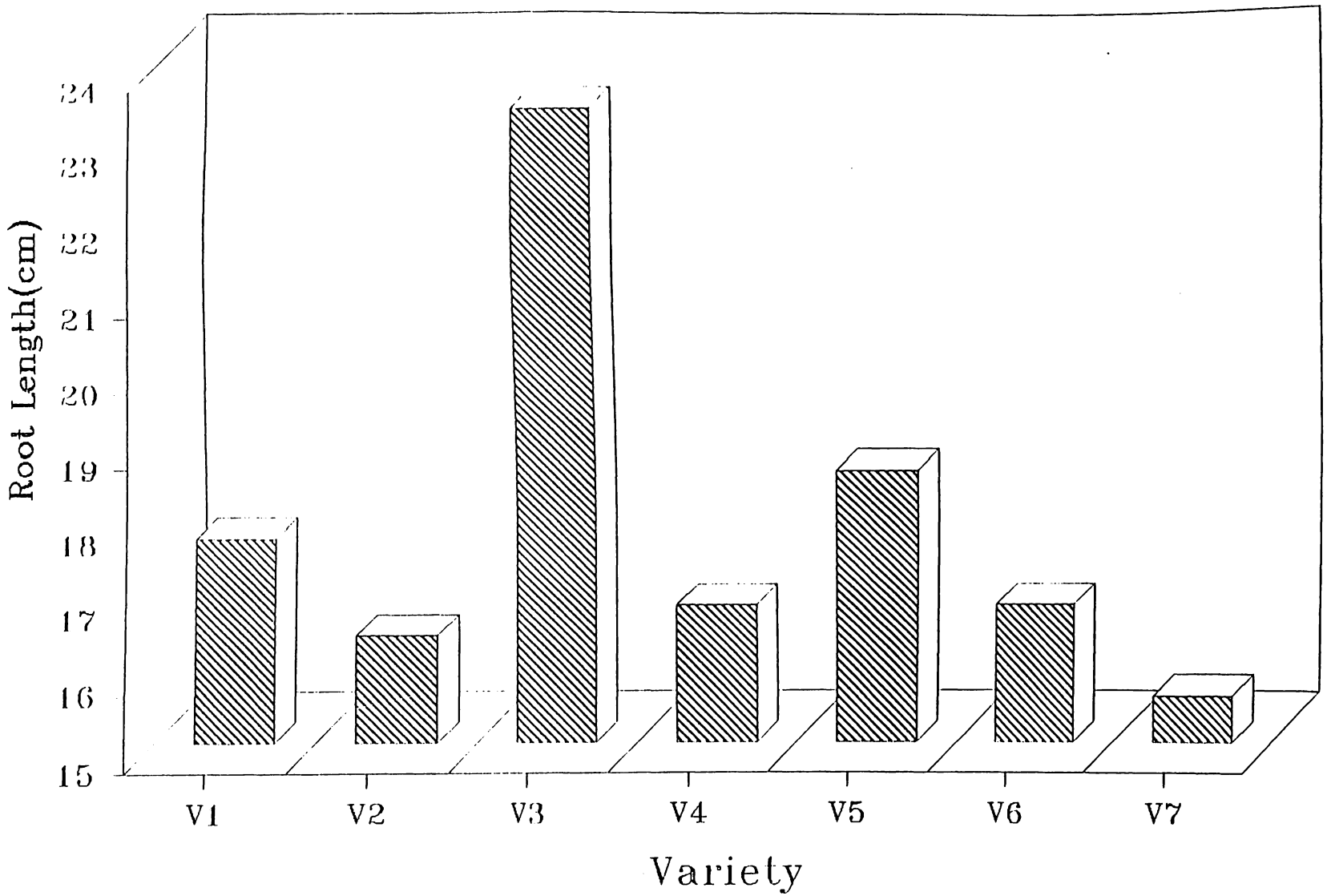
4. 7 Average length of root (cm)

The data recorded on average length of root per plant after harvest were statistically analysed and presented in table no. 7 and illustrated graphically in figure-4.

Table No. 7. Average length of root per plant(cm)

Sl.No.	Name of the Variety	Length of root (cm)
1	Pusa Chetki	17.70
2	Pusa Chetki Long	16.40
3	Chetki Long Barmasi	23.40
4	Japanese White	16.80
5	Mahyco No. 11	18.60
6	Radish No.7	16.80
7	Radish No.8	15.60
	$S.E._{(m)} \pm$	0.57
	C.D. (at 5%)	1.76

Fig.1 Average Length of Root (cm)



The perusal of the data in table no.7 revealed that the varieties of radish understudy varied significantly so far as average length of root per plant is concerned. The highest root length per plant (23.40 cm) was recorded in Chetki Long. Barmasi and it was significantly superior to rest of the varieties under study. The other varieties with higher root length were Mahyco No. 11 and Pusa Chetki with (18.60 cm) and (17.70 cm) long roots respectively and were also foud to be at par to each other. The variety Radish No.8 recorded the lowest root length (15.60 cm) per plant.

4.8 Thickness of the root (cm)

The data recorded on thickness of the root after harvest were statistically analysed and presented in table no. 8.

Table No. 8. Thickness of the root (cm)

Sl.No.	Name of the Variety	Thickness of the root (cm)
1	Pusa Chetki	3.90
2	Pusa Chetki Long	3.70
3	Chetki Long Barmasi	2.80
4	Japanese White	2.40
5	Mahyco No. 11	1.70
6	Radish No.7	3.70
7	Radish No.8	3.50
	$S.E._{(m)} \pm$	0.06
	C.D. (at 5%)	0.21

The data presented in table no.8 revealed that there was significant variation among different varieties so far as thickness of the root is concerned. The maximum root thickness (3.90 cm) was recorded in Pusa Chetki and was found significantly superior to rest of the varieties except Pusa Chetki Long and Radish No.7 which recorded a root thickness of 3.70 cm each. However, the minimum thickness of the root (1.70 cm) was recorded in Mahyco No. 11.

4. 9 Weight of root per plant (g)

The data recorded on weight of modified fleshy root per plant after harvest were statistically analysed and presented in the table no. 9 and illustrated graphically in figure-5.

Table No. 9 Weight of root per plant (g)

Sl.No.	Name of the Variety	Weight of root per plant (g)
1	Pusa Chetki	111.90
2	Pusa Chetki Long	106.90
3	Chetki Long Barmasi	104.70
4	Japanese White	64.90
5	Mahyco No. 11	35.40
6	Radish No. 7	111.00
7	Radish No. 8	103.20
	$S.E._{(m)} \pm$	1.78
	C.D. (at 5%)	5.49

The data presented in table no. 9 showed significant variations among different varieties with respect to weight of root per plant. The highest root weight (111.90 g) was recorded in Pusa Chetki followed by Radish No. 7 (111.00g) and Pusa Chetki Long (106.90 g). These varieties were found to be at par with each other statistically. However, the minimum weight of root per plant (35.40 g) was recorded in variety Mahyco No. 11.

4. 10 Skin thickness of the root (mm.)

The data recorded on skin thickness of the root after harvest were statistically analysed and presented in table no. 10

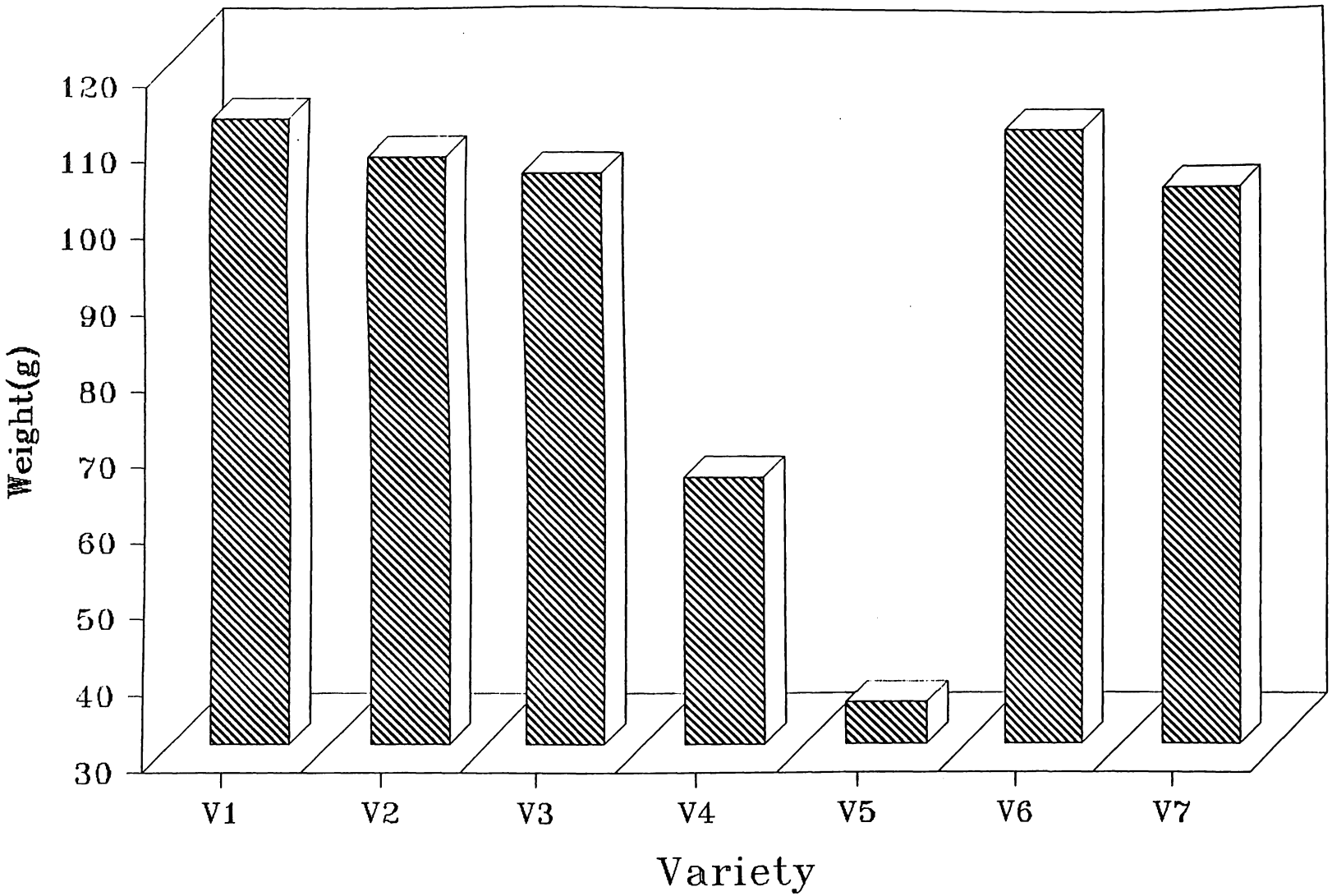

120
110
100
90
80
70
60
50
40
30
Weight(g)
V1
V2
V3
V4
V5
V6
V7
Variety

Table No.10 Skin thickness of the root (mm.)

Sl.No.	Name of the Variety	Skin thickness of the root (mm.)
1	Pusa Chetki	3.50
2	Pusa Chetki Long	3.20
3	Chetki Long Barmasi	2.70
4	Japanese White	2.50
5	Mahyco No. 11	1.50
6	Radish No.7	3.50
7	Radish No.8	1.70
	$S.E._{(m)} \pm$	0.08
	C.D. (at 5%)	0.26

The data presented in table no. 10 indicated that the varieties Pusa Chetki and Radish No.7 both produced roots with exactly same skin thickness (3.50 mm.) and were statistically superior to rest of varieties taken for evaluation. The skin thickness of roots of Chetki Long Barmasi (2.70 mm.) and Japanese White (2.50 m.m.) was found at par. However, minimum skin thickness of the root (1.50 m.m.) was observed in variety Mahyco No. 11.

4. 11 Core thickness of the root (cm)

The data recorded on core thickness of the root after harvest were statistically analysed and presented in table no. 11.

Table No. 11. Core thickness of the root (cm)

Sl.No.	Name of the Variety	Core thickness of the root (cm)
1	Pusa Chetki	3.50
2	Pusa Chetki Long	3.30
3	Chetki Long Barmasi	2.50
4	Japanese White	2.20
5	Mahyco No. 11	1.50
6	Radish No.7	3.40
7	Radish No.8	3.30
	$S.E._{(m)} \pm$	0.06
	C.D. (at 5%)	0.20

The results presented in table No.11 revealed that there was significant variation among different varieties with respect to core thickness of root. The highest core thickness of root (3.50 cm) was observed in Pusa Chetki which was closely followed by Radish No.7 (3.40 cm), Pusa Chetki Long and Radish No. 8 (3.30 cm). However, minimum core thickness of the root (1.50 cm) was observed in variety Mahyco No. 11.

4. 12 Percentage of dry matter of roots

The data recorded on dry matter content of radish (variety wise) were statistically analysed and presented in table no.12.

Table No.12 Percentage of dry matter content of Radish (variety wise)

Sl.No	Name of the Variety	Percentage of dry matter content
1	Pusa Chetki	5.85
2	Pusa Chetki Long	5.30
3	Chetki Long Barmasi	5.52
4	Japanese White	7.50
5	Mahyco No. 11	11.40
6	Radish No.7	6.50
7	Radish No.8	6.50
	$S.E._{(m)} \pm$	0.18
	C.D. (at 5%)	0.56

The perusal of data table no.12 revealed that the varieties studied varied significantly so far as percentage of dry matter content of radish root is concerned. The highest percentage of dry matter content of root (11.40%) was observed in Mahyco No. 11 and was statistically superior to rest of varieties. This was followed by Japanese White (7.50%), Radish No.7 (6.50%) and Radish No.8 (6.50%). However, the minimum percentage of dry matter content of root was recorded in the variety Pusa Chetki Long (5.30%).

4. 13 Total yield of marketable roots per plot($3m^2$) and per hectare

The data recorded on total yield of marketable roots after harvest were statistically analysed and presented in table no.13.

Table No.13 Total yield of marketable roots per plot($3m^2$) and per hectare

Sl.No.	Name of the Variety	Total yield of marketable roots ($kg/3m^2$)	Tons/hect
1	Pusa Chetki	8.10	27.00
2	Pusa Chetki Long	5.60	18.60
3	Chetki Long Barmasi	5.40	18.00
4	Japanese White	2.40	8.00
5	Mahyco No. 11	0.40	1.40
6	Radish No.7	7.30	24.50
7	Radish No.8	3.60	12.00
	$S.E._{(m)} \pm$	0.20	0.38
	C.D. (at 5%)	0.64	1.18

It was observed from the data presented in table no.13 that the highest yield of marketable roots (8.10 kg) was recorded in Pusa Chetki which was significantly superior to rest of the varieties. The next variety with higher yield was radish No. 7 which recorded (7.30 kg) per plot (3 m^2). However, minimum yield of marketable roots (0.40 kg) per plot were recorded in variety Mahyco No. 11.

So far as yield per hectare is concerned the variety Pusa Chetki recorded maximum root yield (27.00 ton/ha) followed by Radish No.7 (24.50 tons/ha). Similarly the minimum root yield (1.40 tons/ha) was recorded in Mahyco No. 11.

4. 14 Root : Shoot Ratio

The data recorded on root : shoot ratio after harvest were statistically analysed and presented in table no. 14.

Table No. 14Root : Shoot Ratio

Sl.No.	Name of the Variety	Root : Shoot Ratio (per plant)
1	Pusa Chetki	1.36
2	Pusa Chetki Long	1.68
3	Chetki Long Barmasi	1.68
4	Japanese White	0.64
5	Mahyco No. 11	0.32
6	Radish No. 7	1.65
7	Radish No. 8	1.78
	$S.E._{(m)}\pm$	0.027
	C.D. (at 5%)	0.084

The data presented in table no. 14showed that there was significant variation among different varieties so far as root : shoot ratio is concerned. The highest ratio of root : shoot (1.78) was observed in Radish No.-8 followed by Pusa Chetki Long (1.68), Chetki Long Barmasi (1.68) and Radish No. 7 (1.65). These varieties were found to be at par with each other. The root : shoot ratio in Pusa Chetki was 1.36. However, the minimum root : shoot ratio (0.32) was observed in the variety Mahyco No. 11.

4. 15 Total root yield per plot (3 m^2) and per hectare

The data recorded on total root yield per plot after harvest were statistically analysed and presented in table no.15 and illustrated graphically in figure-6.

Table No. 15 Total root yield per plot (3 m^2) and per hectare

Sl.No.	Name of the Variety	Total root yield (kg) 3m^2	Tons/hect
1	Pusa Chetki	8.90	29.60
2	Pusa Chetki Long	6.80	22.60
3	Chetki Long Barmasi	7.20	24.00
4	Japanese White	4.30	14.30
5	Mahyco No. 11	2.40	8.00
6	Radish No.7	8.30	27.60
7	Radish No.8	5.30	17.60
	$S.E._{(m)}$ ±	0.31	0.39
	C.D. (at 5%)	0.96	1.22

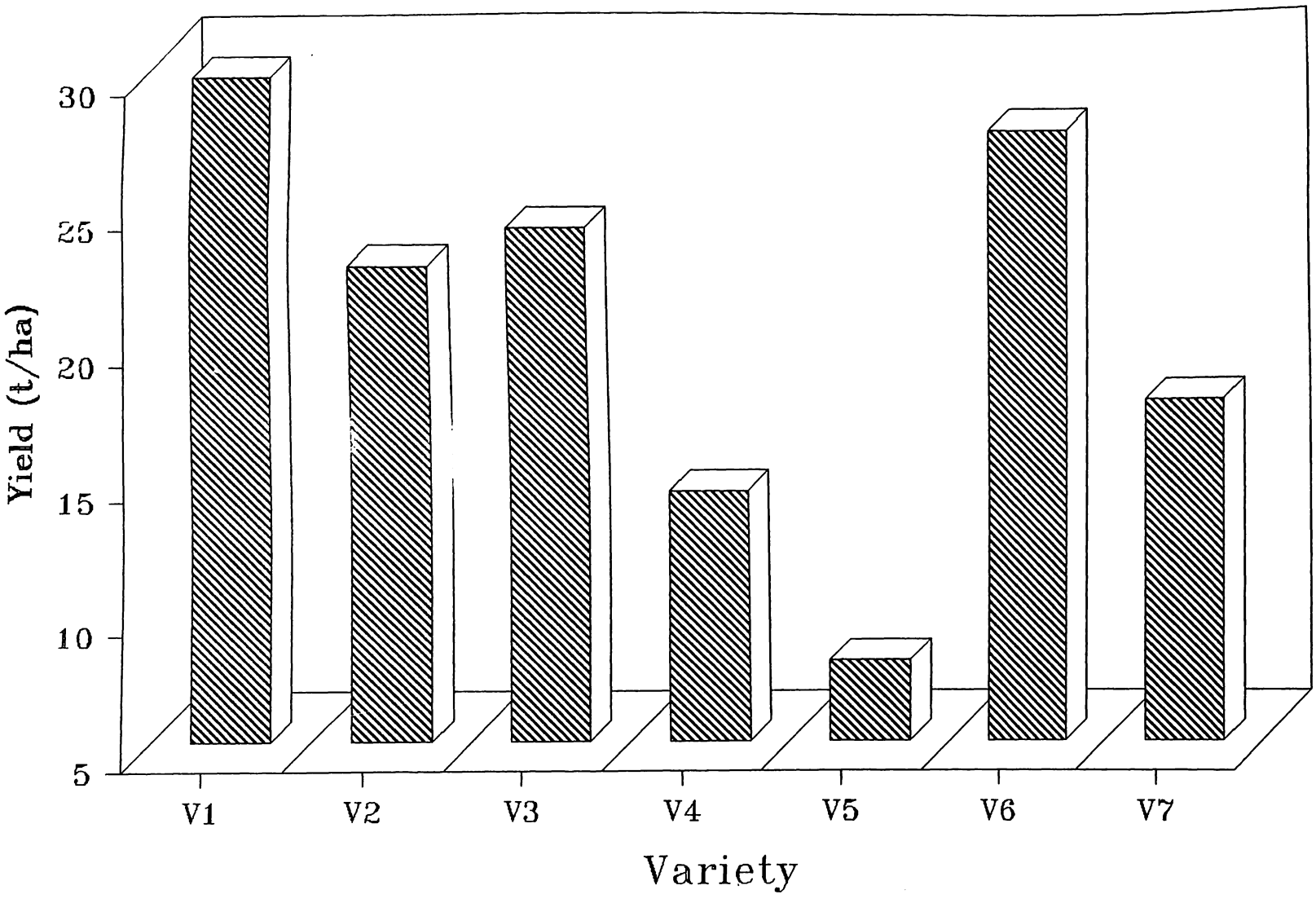
The data presented in table no.15 revealed that among different varieties, the highest total root yield (8.90 kg) was observed in Pusa Chetki which was closely followed by Radish No.7 (8.30 kg). Also the varieties Chetki Long Barmasi and Pusa Chetki Long were at par with each other so far as total root yield per plot is concerned. They recorded total yield of (7.20 kg) and (6.80 kg) respectively. however, minimum total root yield (2.40 kg) per plot was recorded in variety Mahyco No. 11.

So far as yield per hectare is concerned, Pusa Chetki recorded maximum root yield (29.60 tons/ha) followed by Radish No.7 (27.60 tons/ha). Similarly the minimum root yield (8 tons/ha) was recorded in Mahyco No.11.

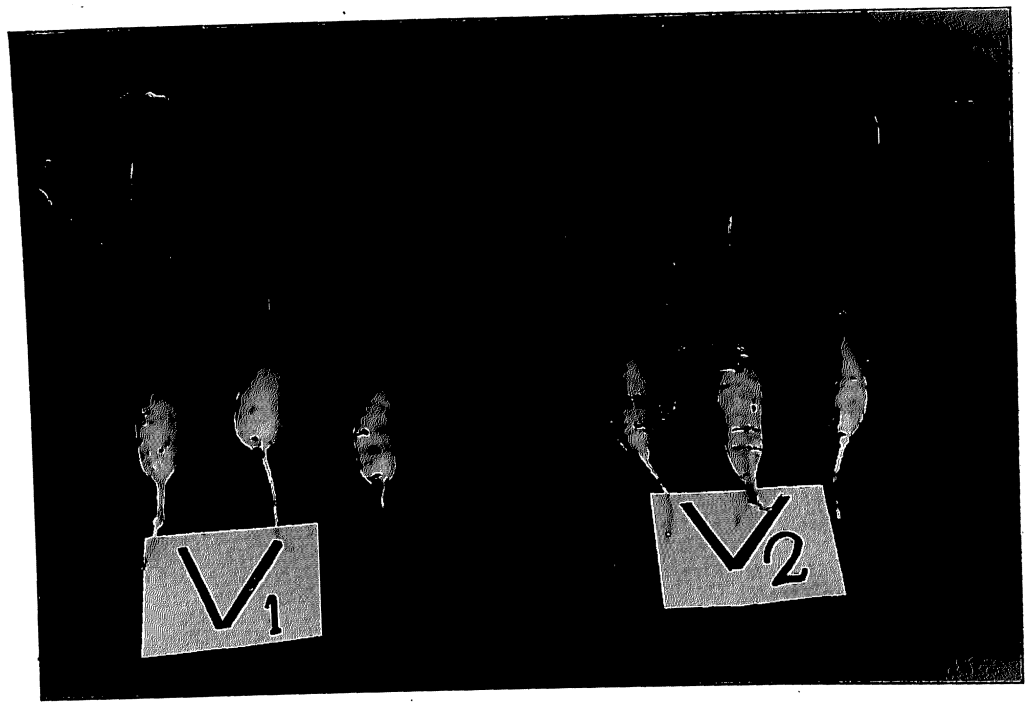
4. 16 Percentage of marketable root yield per plot

The data recorded on percentage of marketable root yield were transformed to corresponding angular values for statistical analysis and the analysed data presented in table no.16.

Fig.6 Total Yield of Roots (t/ha)

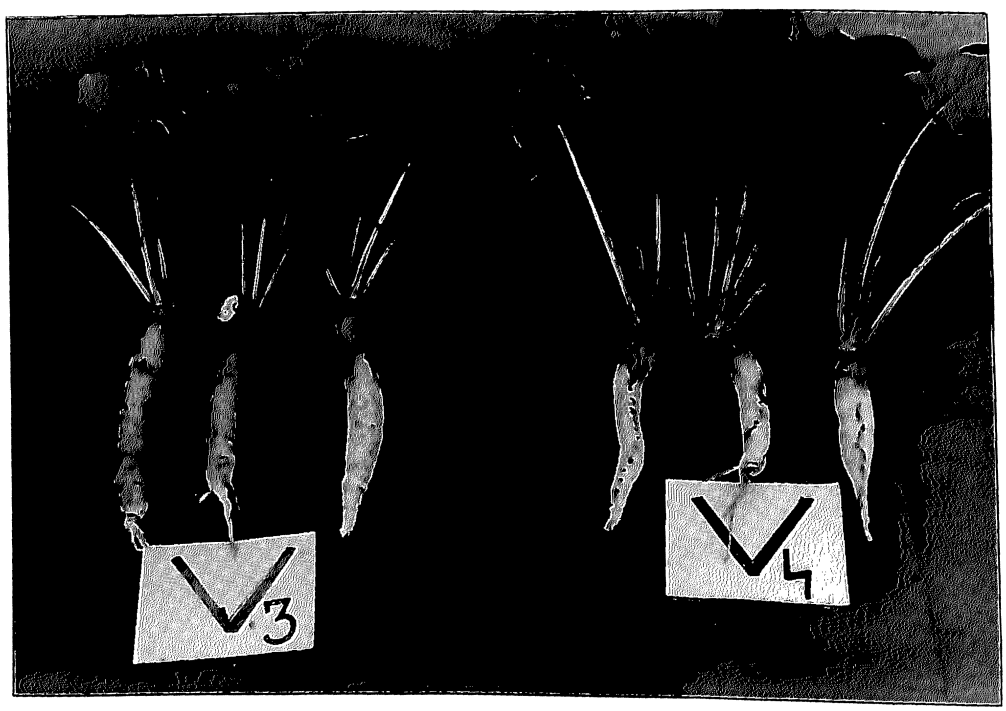


RELATIVE GROWTH OF THE RADISH VARIETIES AT HARVESTING STAGE (SPACING 30 × 10 CMS)



V_1 – Pusa Chetki

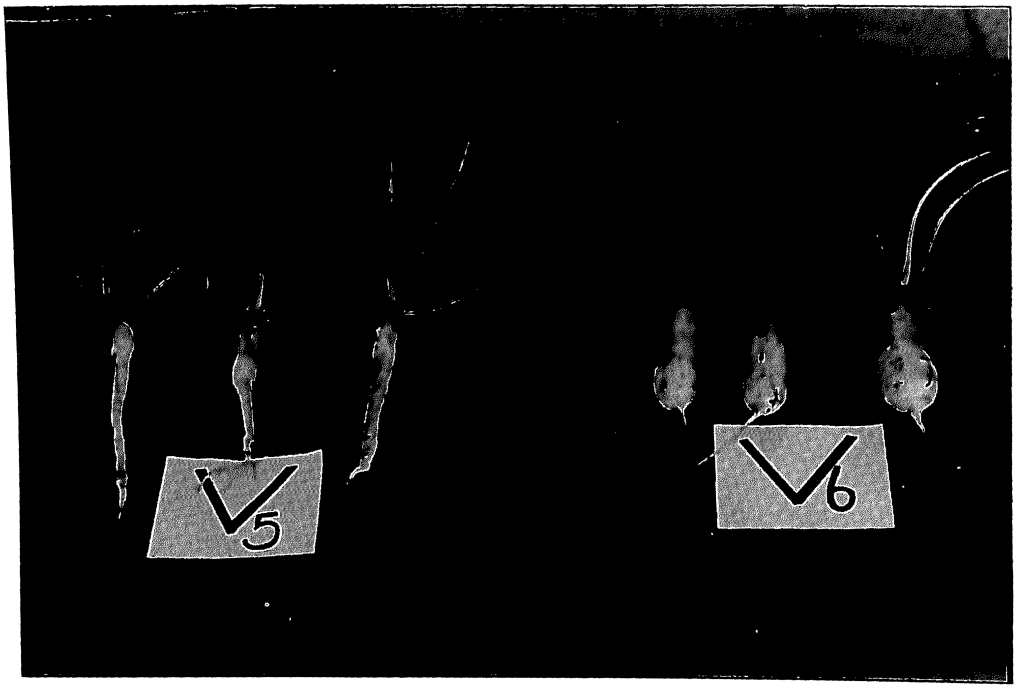
V_2 – Pusa Chetki Long



V_3 –Chetki Long Barmasi

V_4 – Japanese White

RELATIVE GROWTH OF THE RADISH VARIETIES AT HARVESTING STAGE (SPACING 30 × 10 CMS)



V_5 – Mahyco hybrid Radish No. 11 **V_6 – Radish No. 7**

V_7 – Radish No. 8

CHAPTER - V

Discussion

DISCUSSION

Generally radish crop is cultivated in winter season, but in hills and cooler places of North India, it can also be cultivated in seasons other than winter since the temperature of these places remain low so as not to affect root development. But in warm climate of sub-tropics as in Orissa, its cultivation in rainy season is beset with many problems like improper development of radish roots, very poor yield due to high temperature and development of physiological disorders in roots making them unmarketable. It appears that all the above mentioned problems can be solved if suitable radish varieties are developed for rainy season in hot subtropics. With the advancement in crop improvement programme many new radish varieties suitable for summer culture have been evolved which are required to be tried in Orissa. So that a suitable variety can be selected for adoption by farmers. The results of the trial conducted in this regard at Orissa University of Agriculture and Technology have been presented in the preceding chapter and the interpretation of relevant findings have been made in this chapter.

In the present experiment, seven varieties were included in this trial out of which three were Pusa varieties, two were Indo-American type and one each from Mahyco and Asiatic type. The germination percentage of seeds of different varieties was found to vary (85-95%). The highest percentage of germination (95%) was observed in Chetki long Barmasi and the lowest percentage of germination (85%) was found in Radish No.8. In general, the percentage of germination of radish seeds is very poor (Sadhu , 1986) in winter season. Even treatment of seeds with 5-10 ppm GA resulted in 80-89 percent germination in the field (Power *et al.*, 1977). Hence it appears that the higher percentage of germination obtained in the varieties tried might be due to the effect of higher temperature of the rainy season.

The number of days taken for germination of radish seeds was found to vary from 3-4 days in the varieties of the present trial. Usually the radish seeds take a longer time to germinate that is 7-14 days in winter season as reported by Sadhu (1986). The early germination observed in the present experiment might be due to the effect of season specifically higher temperature.

The height of the plant among different varieties was found to range between 30.50 cm to 36.30 cm. The maximum plant height was observed in the variety Japanese white. Likewise number of leaves at 45 DAS varied from 11.50 to 16.00 and maximum number of leaves was observed in the variety Mahyco No.11. Perhaps the variety Mahyco No. 11 was most sensitive to temperature than rest of varieties which encouraged more vegetative growth which is manifested in form of plant height, number of leaves per plant and leaf area. This corroborates with the findings of Nieuwhof (1978) that higher number of leaves and dry matter production occurs at 20-23°C. In the present experiment also the minimum temperature during the period of field trial varied between 23.6°-24°C.

The shoot weight among different varieties were found to vary from 57.60 g to 108.80g and percentage of dry matter content varied from 5.30 to 11.40%. The maximum shoot weight and percentage of dry matter content was found in Mahyco No. 11. This might be due to exposeur of this variety to long day condition in the rainy season. This supports the views expressed by Sadhu (1986) and Nieuwhof (1978) as mentioned earlier. The most economical character is the root weight per plant which in this rainy season trial varied from 35.40 g to 111.90g. The maximum root weight was recorded in Pusa Chetki and minimum in Mahyco No. 11. This might be due to varietal characteristics as this

variety responded better to long day photo period than other varieties. This is in line with the findings of Angell and Hillyer (1962).

The most of important character of interest in the present study is the total yield performance of the varieties. The variety Pusa Chetki outyielded other varieties with a yield record of 29.60 tons/ha in the rainy season which agrees with the reports of Premnath *et al.* (1984) that this variety has the yield potential of 30 tons/ha. The high yield obtained in this variety may be attributed to highest root weight per plant as well as the highest root girth. So far as other factors are concerned, Pusa Chetki is adaptable to higher temperature conditions as pointed out by Premnath *et al.* (1984) and Shanmugavel (1989). This is also perhaps due to its better performance under long day photo period condition as pointed out earlier by Angell and Hillyer (1962). The growth studies of the varieties also support this finding that under this photoperiodic condition and high temperature, the variety Mahyco No.11 has interacted in a reverse manner by putting up better vegetative growth in stead of developing storage root. Physiologically it is understood that when a variety puts up excessive vegetative growth, its phytosynthates are utilised for respiration of recurrent vegetative growth instead of its diversion to storage organs. This supports the view of Seyamma *et al.* (1984).

So far as the percentage of marketable root is concerned, it was more in Pusa Chetki (90.3%) as compared to other varieties. This is specially important in rainy season crop when the radish roots are affected by several physiological disorders like hollow root and akashin occurrance as reported by Kano (1990) and Kawshiro *et al.* (1991).

The low yield record in Mahyco No.11 (8tons/ha) is possibly due to its sensitiveness to higher temperature (23-24°C) which prevailed in rainy season and this temperature was far above the temperature required for root development (10-15°C) in winter in this variety.

The highest total soluble solids content observed in Pusa Chetki variety is due to its varietal character and the effect of temperature pointed out by Fuhrmann *et al.* (1987).

Effect of season

Temperature

This trial was carried out in the rainy season (July to August 1998) in Bhubaneswar when the average maximum/minimum temperature varied from 34.5-35.7°C/23.6-24.0°C. Since this temperature was higher than the minimum temperature required for root development of radish in winter season i.e. 10-15°C, the varieties recommended for winter season like Mahyco No.11 and Japanese white were affected adversely with a higher vegetative growth and low yield. But Pusa Chetki performed better since it can withstand higher temperature and carry on root development. In this regard, it is worth citing the findings of Nieuwhof (1978) who observed 20-23°C as the optimum temperature required for root development during summer/rainy season. The temperature data of the place shows that the minimum temperature varied from 23-24°C which was favourable for the good performance of Pusa Chetki variety.

The other characters which are influenced by the season are 1) The increase in germination percentage 2) Days taken for germination. Almost all the varieties included in this trial showed higher percentage of germination and took less time to germinate than the winter season which has been pointed out earlier in this chapter.

In the present experiment, the physiological disorders of radish roots caused lue to high temperature like occurrence of hollow root and akashin was observed to a lesser extent since the increase in soil temperature due to high air temperature was not possible because of intermittent rains which possibly had a cooling effect on the soil.

Photo period

The effect of photo period was quite pronounced in variety like Pusa Chetki which interacted suitably to long day condition by giving higher yield. On the other hand, varieties suitable for winter season like Mahyco No.11 and Japanese white reacted adversely to long day condition by putting up more of vegetative growth at the expense of yield as pointed out earlier in this chapter.

CHAPTER - VI

Summary and Conclusion

SUMMARY AND CONCLUSION

This trial on "suitability of radish varieties for rainy season" was carried out at Horticultural research station, Orissa university of Agriculture and Technology during July-August 1998 with an objective to select radish varieties suitable for cultivation in rainy season. The trial consisted of seven varieties such as Pusa Chetki, Pusa Chetki Long, Chetki Long Baramasi, Japanese white, Mahyco Hybrid Raidsh No. 11, Radish No. 7 and Radish No. 8 which were replicated thrice following a Randomised Block Design.

The results of this experiment are summarised as follows :

In rainy season, the germination percentage of radish seeds varied from 85-95%. The highest germination percentage (95%) was observed in Chetki Long Barmasi and the lowest (85%) was observed in Radish No. 8. Germination of seeds was completed with in 3-4 days of sowing in all the varieties taken in the trial.

The height of the plant at 45 DAS was maximum (36.30cm) in Japanese white followed by Pusa Chetki (35.40cm) and minimum (30.50cm) was in Radish No.8.

The number of leaves per plant at 45 DAS was maximum (16.00) in Mahyco Hybrid Radish No. 11 followed by Japanese white (15.00) and Pusa Chetki (14.50). The minimum number of leaves per plant (11.50) was recorded in Radish No. 8.

The average leaf area was maximum (90.50cm²) in Mahyco Hybrid Radish No. 11 followed by Pusa Chetki (86.00cm²) and minimum (50.30cm²) was in Radish No. 8.

The maximum shoot weight per plant (108.80 g) was recorded in Mahyco Hybrid Radish No.11 followed by Japanese White (100.70g) and Pusa Chetki (81.90 g). The minimum shoot weight (57.60 g) was recorded in Radish no.8.

The maximum root weight per plant (111.00 g) was recorded in Pusa Chetki followed by Radish No. 7 (111.00 g) and Pusa Chetki Long (106.90 g). The minimum root weight per plant (g) was recorded in

The average length of individual root was maximum (23.40cm) in Chetki Long Barmasi followed by Mahyco Hybrid Radis No. 11 (18.60 cm) and minimum (15.60 cm) was in Radish no. 8. However the maximum girth of the root (3.90 cm) was recorded in Pusa Chetki and minimum (cm) was recorded in

The highest yield per hectare (29.60t) was obtained in Pusa Chetki followed by Radish No. 7 (27.60t) per hectare. The lowest yield (8.0 t) per hectare was obtained in Mahyco No. 11.

The total soluble solids content of root was found maximum 3.5% in Pusa Chetki Long and Chetki Long Barmasi followed by Pusa Chetki (3.00%). the minimum T.S.S. of root (2.00%) was found in Myhyco Hybrid Radish No. 11.

4. The average leaf area was maximum (90.50cm²) in Mahyco Hybrid Radish No. 11 followed by Pusa Chetki (86.00cm²) and minimum (50.30cm²) was in Radish No. 8.

5. The maximum shoot weight per plant (108.80 g) was recorded in Mahyco Hybrid Radish No.11 followed by Japanese White (100.70g) and Pusa Chetki (81.90 g). The minimum shoot weight (57.60 g) was recorded in Radish no.8.

6. The maximum root weight per plant (111.90 g) was recorded in Pusa Chetki followed by Radish No. 7 (111.00 g) and Pusa Chetki Long (106.90 g). The minimum root weight per plant (35.40 g) was recorded in Mahyco No. 11

7. The average length of individual root was maximum (23.40cm) in Chetki Long Barmasi followed by Mahyco Hybrid Radis No. 11 (18.60 cm) and minimum (15.60 cm) was in Radish no. 8. However the maximum girth of the root (3.90 cm) was recorded in Pusa Chetki and minimum (1.70 cm) was recorded in Mahyco No. 11

8. The highest yield per hectare (29.60t) was obtained in Pusa Chetki followed by Radish No. 7 (27.60t) per hectare. The lowest yield (8.0 t) per hectare was obtained in Mahyco No. 11.

9. The total soluble solids content of root was found maximum 3.5% in Pusa Chetki Long and Chetki Long Barmasi followed by Pusa Chetki (3.00%). the minimum T.S.S. of root (2.00%) was found in Myhyco Hybrid Radish No. 11.

10. The varieties like Pusa Chetki and Chetki Long Barmasi took minimum time (46 days) for harvest where as Pusa Chetki Long, Radish No. 7 as well as Radish No. 8 took 47 days for harvest. But Japanese white and Mahyco No. 11 took maximum days for harvest i.e. 53 days and 54 days respectively.

Conclusion

The results of the experiment indicated that out of seven varieties tried, the variety Pusa Chetki performed best as it produced maximum root weight, root thickness and yield (29.60 tons) per hectare. As radish is normally cultivated in winter season, the variety Pusa chetki may be recommended to farmers for cultivation in rainy season to obtain higher return.

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