EFFECT OF DATE OF SOWING ON GROWTH AND YIELD OF THREE VARIETIES OF RADISH (*Raphanus sativus* L.)

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DECEMBER 2005

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A Thesis

by

Submitted to the Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka
in partial fulfillment of the requirements
for the degree of

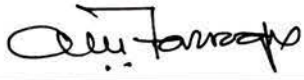
MASTER OF SCIENCE

IN

HORTICULTURE

SEMESTER: JULY-DECEMBER 2005

Approved by:



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CERTIFICATE

This is to certify that the thesis entitled "EFFECT OF DATE OF SOWING ON GROWTH AND YIELD OF THREE VARIETIES OF RADISH" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in HORTICULTURE, embodies the result of a piece of bonafide research work carried out by Md. Khairul Alam, Roll No. 18 Registration No. 23869/ 00140 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or sources of information, received during the course of this investigation have been duly acknowledged.

Dated:
Dhaka, Bangladesh

Prof. Dr. A. M. Farooque
Supervisor

Dedicated to my

Beloved Parents

ACKNOWLEDGEMENTS

Alhamdulillah, Allah the merciful, Who has created everything in this Universe and kindly enabled the author to present this thesis. The author avails the opportunity of conveying his deep sense of gratitude, heartfelt respect, immense indebtedness and profound appreciation to his honourable teacher and research Supervisor, Prof. Dr. A.M. Farooque, B.Sc. Ag (Hons.) M.Sc. Ag. Ph.D. (Nottingham) Vice-Chancellor, Sher-e-Bangla Agricultural University, Dhaka, for his Scholastic guidance, constructive criticism and helpful comments during the entire period of research work and preparation of the thesis.

The author express his sincere gratitude, heartily respect, immense indebtedness profound appreciation to his research co-supervisor, Prof. M. A. Mannan Miah, Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka, for his co-operative during this research .

The author sincerely expresses his wholehearted gratitude and indebtedness to Dr. Nazrul Islam, Associate Professor and Head, Department of Horticulture and Postharvest Technology, Dhaka, for his co-operation during this research.

The author expresses his sincere gratitude heartly respect, immense indebtedness profound appreciation to Dr. A. Faiz Md. Jamal Uddin, Assistant Professor, Department of Horticulture and Postharvest Technology, Dhaka, for his co-operation during this research.

He also expresses his deepest and sincere gratitude to his beloved parents, brother and sisters especially late Md. Saiful Alam (Liton), whose blessing opened the gate and paved the way to his higher study.

The author would like to express his sincere gratitude to all of his friends, Farm Staffs, who directly or indirectly assisted him during the course of research work. I am grateful to the many friends, who read my dissertation, criticized, corrected, and provided information.

Finally, thanks to Mr. Sukumar Chandra Singh, Data Encoder, for his careful typing and compose the dissertation.

The Author
December 2005

EFFECT OF DATE OF SOWING ON GROWTH AND YIELD OF THREE VARIETIES OF RADISH (*Raphanus sativus* L.)

By
Md. Khairul Alam

ABSTRACT

The present experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka, during the period from November 2004 to January 2005 to study the effect of date of sowing on growth and yield of three varieties of radish. Seeds of three cultivars of radish namely Tasakisan, SAU Line-1 and Red Bombay were sown on three different dates viz. November 1, November 15, December 1. Sowing date Showed significant effects on the growth and yield of radish. Maximum number of leaves and leaf length were produced by plant sown on November 1, Similarly root diameter (width), root fresh weight, yield per plot and yield per hectare were obtained from November 1 sowing.

All these parameters showed decreasing trend as sowing date was delayed. In the experiment, November 1 sowing gave the highest yields of (81.82 t/ha) compared to the lowest yield of 68.75 t/ha by December 1 sowing V2 (SAU Line-1). There was no significant variation among the varieties. Combined effect of sowing date and varieties showed that sowing on November 1, all cultivars performed well in respect of yield and yield components.

November 1 showed the best sowing date of radish and SAU Line –1 gave the highest yield but the benefit cost ratio (10.52) was the highest in Tasakisan. Late sowing produced Radish of poor quality, as they were hard in texture and poor in overall acceptability.

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ACRONYMS AND ABBREVIATIONS

Full Word	Abbreviations
Abstract	Abstr
Agro-Ecological Zone	AEZ
Bangladesh Agricultural Research Council	BARC
Bangladesh Agricultural Research Institute	BARI
Sher-e-Bangla Agricultural University	SAU
Bangladesh Bureau of Statistics	BBS
Benefit Cost Ratio	BCR
Centimeter	Cm
Cultivar	Cv.
Co-efficient of variation	CV
Days After Sowing	DAS
And other (a*t elli*)	*et. al*
Food and Agriculture Organization	FAO
Figure	Fig.
Fresh Weight	FW
Farm Yard Manure	FYM
Gram	G
Horticulture	Hort.
That is	i.e.
Journal	J.
Potassium	K
Kilogram	Kg
Least Significant Difference	LSD
Meter	M
Muriate of potash	MP
Nitrogen	N
Non-Significant	NS
Phosphorus	P
Randomized Complete Block Design	RCBD
Science	Sci.
Society	Soc.
Ton per hectare	t/ha
Ton	T
Taka	Tk.
Triple Super Phosphate	TSP
United Nations Development Program	UNDP
At the Rate of	@
Degree Celsius	^{0}C

CHAPTER I

Introduction

INTRODUCTION

Importance of vegetables in human nutrition is well known. Vegetables are rich and comparatively cheaper sources of vitamins and minerals. They also play key role in neutralizing acids produced during digestive process of porteinous and fatty foods and also provide valuable roughage, which promotes digestion and helps in preventing constipation, vegetables are good sources of carbohydrate, proteins, vitamin A, vitamin B, vitamin C, Calcium and Iron. In developing countries like Bangladesh, India, where the pressure of population on land is continuous, Vegetables are playing a significant role in supplying a balanced diet. Malnutrition is also referred to as international problem with more or less little variation from country to country. In general, for a balanced diet, the daily requirements of some of the essential nutrients like protein, minerals and vitamins can be very well met, if a man, woman or a child consumes 75 to 125 g green leafy vegetables, 85 g other vegetables and 85 g root and tubers every day along with other diets. Normally, vegetable crops give higher yield per unit area as compared to cereal crops.

Radish (*Raphanus Sativus*) a member of the family cruciferae is a popular vegetables in both tropical and temperate regions of the world. It is one of the most ancient vegetables. Inscriptions on the inner walls of pyramids show that radish was an important vegetables in Egypt about 2000 B.C. Certain remarks of Herodotus reveal that it was cultivated about 2700 B.C. (Becker, 1962) It was spread to China about 500 B.C. and to Japan A.D. 700 (Sirks, 1957).

Radish is a widely used root vegetable. Its tender leaves and shoots are also used as greens. It is roughly divided into two types one of the European origin and the other of Far Eastern Origin (Shinohara, 1984). Kumazawa (1956) divided the world diversity of radish into five groups: European type (having three groups). For Eastern or Asiatic type (having two groups), North China type and south China type. The South China type had spread into South East Asia and developed into innumerable local varieties. General characteristics of these types are (i) wide adaptability from temperate to warm temperate, and tropics to subtropics with various ecotypes, (ii) Medium to late maturity, 70-100 days from sowing (iii) leaves are deeply lobed and have less or no pubescence and (iv) large, solid, juicy and fleshy root.

Radish is a popular vegetables in Bangladesh. It is a good source of vitamin C (Ascorbic acid) Containing 34-40 mg per 100 g of edible portion and supplies a variety of minerals. Trace elements in radish include aluminium, barium, lithium, manganese, silicon titanium, fluorine and iodine (up to 18 μ g/100 g). Besides, tender leaves which are used as greens are rich in vitamin A and C. Roots are also rich in carbohydrate and protein (Gopalan and Balasubramanium, 1966). Vitamin C content of radish roots is greatly influenced by light condition for example Sid'ko *et al.*. (1975) found that root vitamin content was higher in plants grown under blue light. Lichtenthaler (1975) noted enhanced synthesis of β-carotene under red light. Radish is not indigenous to this country. It was introduced long ago. The oldest variety 'Red Bombay' was introduced from India to this country long back has deteriorated much. In the mid-sixty's, 'Miashiege' and 'Mino' early varieties were introduced from Japan.

Radish is one of the most ancient vegetables grown all over the temperate regions in the spring, summer and autumn. But in tropical and sub tropical countries radish is produced during the winter. Its root is valued as food mainly for its high Vitamin C (ascorbic acid) content (Appendix i).

Gopalan and Balasubramanium (1966) reported that radish contain 17 mg (Pink cultivar) vitamin C and 5.0 I.U. of vitamin A. The radish root contains the protein 0.7g, fat 0.3g, minerals 0.9g carbohydrate 6.8g calcium 50mg, phosphorus 22 mg thiamine 0.06 mg, riboflavin 0.02 mg, nicotinic acid 0.5 mg, fiber 0.8 g. per 100 g of edible portion.
Further, it has some medicinal value (Bose and Som 1986) Radish preparations are useful in liver and gall bladder troubles. In homoeopathy, they are used for neuralgic headaches, sleeplessness and chronic diarrhea, Roots, leaves, flowers and pods are active against gram-positive bacteria. The roots are said to be useful in urinary complaints, and piles. A salt extracted from roots, dried and burnt white ash is used in stomach troubles. Juice of fresh leaves is used as diuretic and laxative. The seeds are said to be peptic, expectorant diuretic and carminative (Kirtikar and Basu, 1935).

In Bangladesh, farmers generally cultivate radish in large-scale in the field but urban farmers generally cultivate the crop in their homesteads. Radish is grown for its young modified tender roots, which are eaten raw as salad or cooked as vegetables. It is relished for its pungent flavor and is considered as an appetizer. The young leaves are also eaten as vegetables. Radish has also been tried successfully as a fodder crop in some countries like the U.K. and South Africa. In South Africa, the giant radish of Japan has shown

much promise as a fodder crop yielding more than 60 tones /ha of roots and 12-25 t/ha of leaves (Kolbe and Voss 1952). It can also be used as a green manure.

The production statistics of radish in Bangladesh is covering an area of 22, 052 ha and producing 20, 0840 tones of edible roots. It ranks second both in acreage and among the major vegetables crops of Bangladesh (BBS, 2000).

Yield of any crop can be increased up to substantial quantity by using improved varieties and improved production technologies. Improved production technique and proper management are, therefore, important factors are considered to boost production of radish in Bangladesh. Salam *et al.,* (1999) conducted an experiment with different sowing time (October 10 to December 30) to find out the influence of sowing time on root yield of radish. They reported that the sowing time highly influenced the root and seed yield of radish.

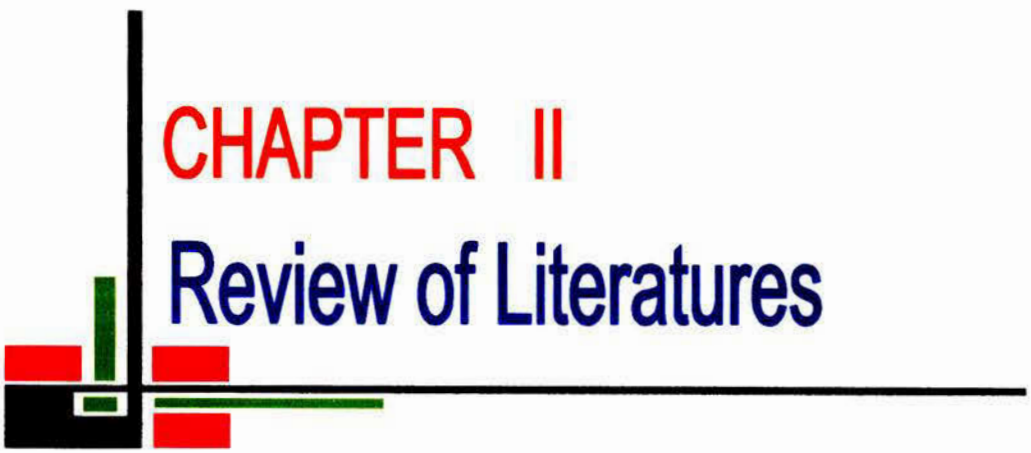
The proper sowing time again depends on the varieties and prevailing environment. Selection of right type of varieties for sowing at optimum time is the key factor for successful radish production. Growers tend to manipulate sowing time in order to obtain better growth and higher quality yield. The time of sowing is also adjusted so as to synchronize the time of harvest with market demand.

Under these circumstances, the present study was undertaken with the aim of investigating the effects of sowing date on growth and yield of three varieties of radish. It

is anticipated that the information gathered from the results of the present experiment would help the growers of Bangladesh to increase the production of radish by sowing seed in proper time.

Objectives:

1. **To investigate the effects of sowing date on growth and yield of radish**
2. **To investigate the performance of three radish varieties under Bangladesh condition**



CHAPTER II

Review of Literatures

REVIEW OF LITERATURE

Radish (*Raphanus sativus* L.) is an important vegetable crop, which received much attention to the researchers throughout the world to develop its production technique. Different time of sowing and variety has marked effects on radish production. Large numbers of researchers have studied the effects of sowing time and variety on growth and yield of radish in different countries of the world, but their findings have little relevance to the agro-ecological situations of Bangladesh. Firstly radish is a photo-and thermo-sensitive crop and its growth behavior is, to a great extent, controlled by the environmental conditions under which it is grown. Secondly, most of the introduced varieties grown at present in Bangladesh are low yield type, whereas, in most other countries, the hybrid types are grown. However, reports on the optimum sowing time and appropriate variety selection are scant. Some of the available research works in this connection have been reviewed here with the hope that this may contribute useful information to the present study.

Salam *et al.* (1999) conducted an experiment with different sowing time (October 10 to December 30) to find out the influence of sowing time on both the root and seed yield of radish. They reported that the sowing time highly influenced the root and seed yield of radish. Higher root yield (32.93 t/ ha) and seed yield (2.17 t/ha) were obtained from October 10 sowing followed by October 20 sowing. Both the root and seed yield were decreased gradually with delay of sowing time.

Malik *et at*. (1999) carried out an investigation on the effect of planting (5Nov., 20Nov., 5Dec. and 20Dec.) on seed yield and quality of radish var. pusa chetki .They reported that seed yield per plant was higher in early planting (5Nov.and 20 Nov) Higher seed Yield and better seed quality were recorded at 20November and 5 November steckling planting.

Jaiswal, (1997) conducted four seed production experiments on radish, cauliflower, onion and early sponge gourds in Nepal. According to his finding early sowing of radish (22 September) was given higher seed yield than of late sowing (October 12). Average seed yield was 1.25 t/ha and plants took 138 days to complete development.

Gill *et al.* (1995) investigated an experiment comprising an intact root system, 75 or 50% of the total were planted on 15 November, 1 or 15 December or 1 January, whole root steckling planted early (15 November or 1 December) produced plant with luxuriant vegetative growth and higher number of branches. Planting in the second half of November was optimum for seed yield. A significant interaction between planting date and steckling size suggested that a loss in seed yield as a consequence of delayed sowing could be meet up by increasing the steckling size. However planting date had no significant effect on seed quality.

Kanwar (1993) investigated to find out the influence of different sowing date (15 August to 1 November) on radish seed production and reported that the highest seed yield (1.23 t/ha) was obtained from sowing on 1 October.

Saharan (1991) studied the effect of date of steckling planting spacing on radish seed. Maximum seed yield/ha was obtained by 15 November planting with the closest spacing of 60x45 cm whereas; the maximum seed yield/plant was obtained with 15 November planting with the widest spacing.

Sharma and Lal (1991) reported that maximum seed yield per plant was obtained from 15 cm long steclking planted in mid December at 60 ×60 cm spacing.

Maurya *et al.* (1990) investigated the effect of sowing dates for quality radish seed production. They reported that seed yield per hectare gradually decreased as the planting delayed from September to January.

Ghormade *et al.* (1989) investigated on seed production in same varieties of radish as influenced by dates of steckling planting found that steckling of 45 days old planted on 24 Oct. (earliest planting) gave the highest seed yield (13.9 q/ha) on average for all cultivars.

Chatterjee (1989) investigated an experiment on year round root and seed production of radish during two years. He reported that no seed were produced from crops sown between March and July. The seed yield was highest (12.83 q/ha) when it was sown in the 2nd week of October and a significance reduction in seed yield was recorded for other sowing dates in both years. Seed quality (% of germination) was also highest in the same sowing date in October.

Brar and Kaul (1971) found that Japanese while radish stickling gave the highest seed yield when planted on November 25 at the closest spacing of 60x45 cm. In a study on the ecological response of phenotype, Shinohara (1959) observed that sowing time was influencing bolting.

Singh *et al.* (1998) studied an experiment with different sowing date (8, 15, 22 and 29 December) on radish (cv. Japanese white) during 1992-93 and 1993-94. Seed yield and other yield contributing characters were found to be higher in plants transplanted on 8 December.

In a study on the ecological response of phenotype, Shinohara (1959) observed that bolting was being influenced by sowing time.

Bose and Som (1986) started that seed production of radish is very specific in its climatic requirement. Flowering of radish, especially of biennial type, is greatly influenced by temperature.

Singh and Singh (1985) studied the effect of time of sowing and seed yield of radish. In trials with cv. Japanese white, the seeds were sown in late September, the stecling were transplanted in mid December and the seeds were harvested in the late May. In some cases the plants were left in situ without transplanting.

Watanabe (1954) in his experiment on effect of low temperature exposure to different age groups of cabbage seedlings in flower induction in relation to sowing time, found that bolting and seed setting percentage varied with varieties and stem diameter.

In a trail for evaluating the effect of temperature and day length on flowering, Hegiya (1952) reported that low temperature is a critical factor for flowering, which is accelerated by long photoperiod.

Rahman (1989) reported the effect of time of sowing and yield contributing characters, and quality of radish seeds. Time of sowing showed significant effect on seed yield per plant and quality of seeds crop planted on first and 15 November produced comparatively higher yield. He obtained drustic reduction in seed yield from plants of December sowing.

Gill and Singh (1979) obtained highest field germination of Punjab sufaid variety of radish. Highest root yield was produced from mid October sowing compared to other sowing made from first September to first December.

Rao and Manohar (1990) conducted the experiment the sowing time on yield and quality of radish (*Raphanus sativus L.*) cultivars and found that the seeds of the cultivars Pusa Chetki, Pusa Reshmi and Nerima long were sown on the 15th and 30th or 31st day of June, July. August, September. October and November. The highest mean yields of good

quality roots (313 100 marketable roots/la) were obtained with the 31 October sowing. Nerima long out yielded the other 2 cultivars.

Kazantsev (2004) reported the sowing time of Brassica crops and found out the importance is discussed of wide-scale introduction of spring swede rape (*Brassica napus var. oleifera*) spring turnip rape (*B. campestris var. obiferal*) and oil seed radish in Russian agriculture for production of vegetable oil and fodders. Investigations were conducted in the non-chernozem Zone in the Omsk region West Siberia, during 1982-87. Data are tabulated on effect of sowing date on field emergence and vegetation period of spring swede rape, spring turnip rape and oilseed radish, Data are also included on the effects of sowing date on production, yield structure and fodder quality.

Nguyen *et al.* (1999) conducted an experiment to study the effect of planting time on the growth and quality of Japanese white radish (daikon; *Raphanus sativus L.*) grown on the central coast of New South sales, Australia. The growth and root quality of (7) seven Japanese white radish cultivars were studied paying particular attention to shoot and root development, pithiness, pungency and bolting of the processing cultivars in four (4) growing Seasons (Spring, summer Late-Summer and autumn) to determine optimum maturity for harvest targets for the dried and pickling industries. Results showed that the processing cultivars always achieved a standard root size of 1000 g about 5-10 days later than fresh market cultivars. The occurrence of pithiness varied among cultivars but was not significantly different between processing and fresh market types. Daikons tended to develop pithiness early in summer and late in autumn development of pungency varied

among cultivars. Generally, processing cultivars showed a significantly higher level of pungency than fresh market cultivars. Flower bud formation (bolting) varied among cultivars but spring and summer plantings showed the highest risk of bolting white the autumn planting showed the least.

Kang and Kim (1995) conducted an experiment on the growing character and selection of the rational seeding period of radish for after crop of maize and found that when radish is grown after a crop of zea may it grows slowly, particularly during the first 50 days after seed germination. The best growth and yield were obtained from seeds planted early in August when the accumulated temperature of 5°C was > 1400-1500°.

Vergote *et al.* (1997) investigated that several crop characteristics in a greenhouse study with radish in Belgium. Five radish cultivars (Bellar, claudies, Niz 34-14, Radish Sprit) were sown on 18 November and harvested on 17 February. cv. spirit performed best having a high production and short shoot length. In another trial in a green house with CO_2 producing heating system., cultivars Bellar, Altox, Radius and Boy were sown on 30 October and 2 December and harvested on 29 January and 3 March, respectively. Cv. Boy had the best production and greatest resistance against leaf burn caused by CO_2.

Kano and fukuoka (1995) reported the effects of soil temperature on hollowness in Japanese radish (*Raphanus sativus L.*) Cv. 'Gensuke' and found out to examine the effect of high soil temperature on the development of hollowing in th 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^{0}C during the middle of the growth period. Root weight was reduced and hollowness occurred in roots from July sowing. Roots from July sowing had the greatest concentration of vessels in the central region. Lignin formed in walls surrounding the central cavity only in roots of July sowing. In a second 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 31 to 45 DAS showed root growth, and produced some hollow cavities, caused more vessels to from in the central area, and promoted lignifications near the central cavity. In contrast, 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.

Deotale *et al.* (1994) studied the performance of some radish (*Raphanus sativus L.*) cultivars under Nagpur condition during rabi season. The radish cultivars trials were Pusa Rashmi, Pusa Himani, Japanese White, Baramasi, Vijay and Pusa Chetki. Pusa Rashmi was the best cultivars with respect to the following root length 45 days after sowing, which was 23.0 cm compared with 19.2-21.0 cm, root diameter of 3.86 cm compared with 3.01-3.50 cm, weight/plant of 299.12 g compared with 216.10-278.12 g; and yield of 27.26 t/ha compared with 24.11-27.14 t/ha. Baramasi produced the greatest leaf weight/plant of 136.56 g compared with 106.34-135.20 g for the other cultivars.

Capecka (1995) reported the Japanese radish in field cultivation and found that Japanese radish cultivars Tokinashi and Minowase Summer cross F_1 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 yields were 513 and 719 dt/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 infestation.

Sarveshwar *et al.* (1991) conducted the experiment Response of radish cultivars to different sowing dates and seed of radish cultivars Pusa Himani, selection-9, Japanese White, Local Red and white Icicle were sown on 8 different dates between March and September 1987. Roots were harvested at marketable size and quality. Data on root weight, root length and diameter, size of plant canopy and bolted plants were recorded. Highest percentage of marketable roots (35.31%) was recorded for Pusa Himani, followed by white Icicle (34.86%). Lowest percentage of marketable roots was recorded for Japanese white (22.70%). Pusa Himani gave significantly higher yield and longer roots (mean of 16.05 cm) in 7 of the 8 sowings had the maximum number of days to bolting and the least pithiness in roots. This cultivar was recommended for summer sowing in hilly regions.

Coogan *et al.* (1999) conducted the experiment. Effect of planting time on the pungency conantration of while radish (*Raphanus salivus L.*) grown on the central coast of New south wales, Australia and found this trial investigated the effects of different planting

times on 4-methy 1 thio-e-trans-bulenyl Isothiocyanate (MTBITC; the cause of pungency in white redish) concentration in the roots of Cv. Hoshiriso white radish. Additionally, it was determined whether there was any change in MTBITC concentration due to poor maturity and distribution throughout the root. Four different planting times corresponding to growth in the spring, summer, late summer and autumn were used and roots were harvested at 5 stages throughout the crop development period between 47 and 110 days after sowing. It was found that the MTBITC concentration differed significantly between the 4 growing seasons with root maturity. The average MTBITC concentration was the highest in the distal end of the root, decreased along the root, and was the lowest in the top section of the root. MTBITC concentration was the highest in the spring trial and was the lowest in the autumn trial.

CHAPTER III

Materials and Methods

MATERIALS AND METHODS

Materials and methods that were used for conducting the experiments have been presented in this chapter.

3.1. Experimental Site

Field experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, during the period from November 2004 to January 2005. The experimental Site was located at 8.45 m elevation above sea level with latitude of 23^0 46′ and longitude of 90^0 23′.

3.2. Soil

The experiment was carried out in a typical vegetable growing soil. The medium high land belonging to the Madhupur Tract of Agro-ecological Zone-28 Fig: 1 Map (UNDP, 1988). Soil of the experiment plot was sandy loam in texture. The land was well drained with good irrigation facilities. The nutrient status of soil of farm area determined at the Soil Resources Development Institute (SRDI) Khamar Bari, Farmgate, Dhaka the Morphological, Physical and Chemical Characteristics or analysis is presented in Appendix ii.

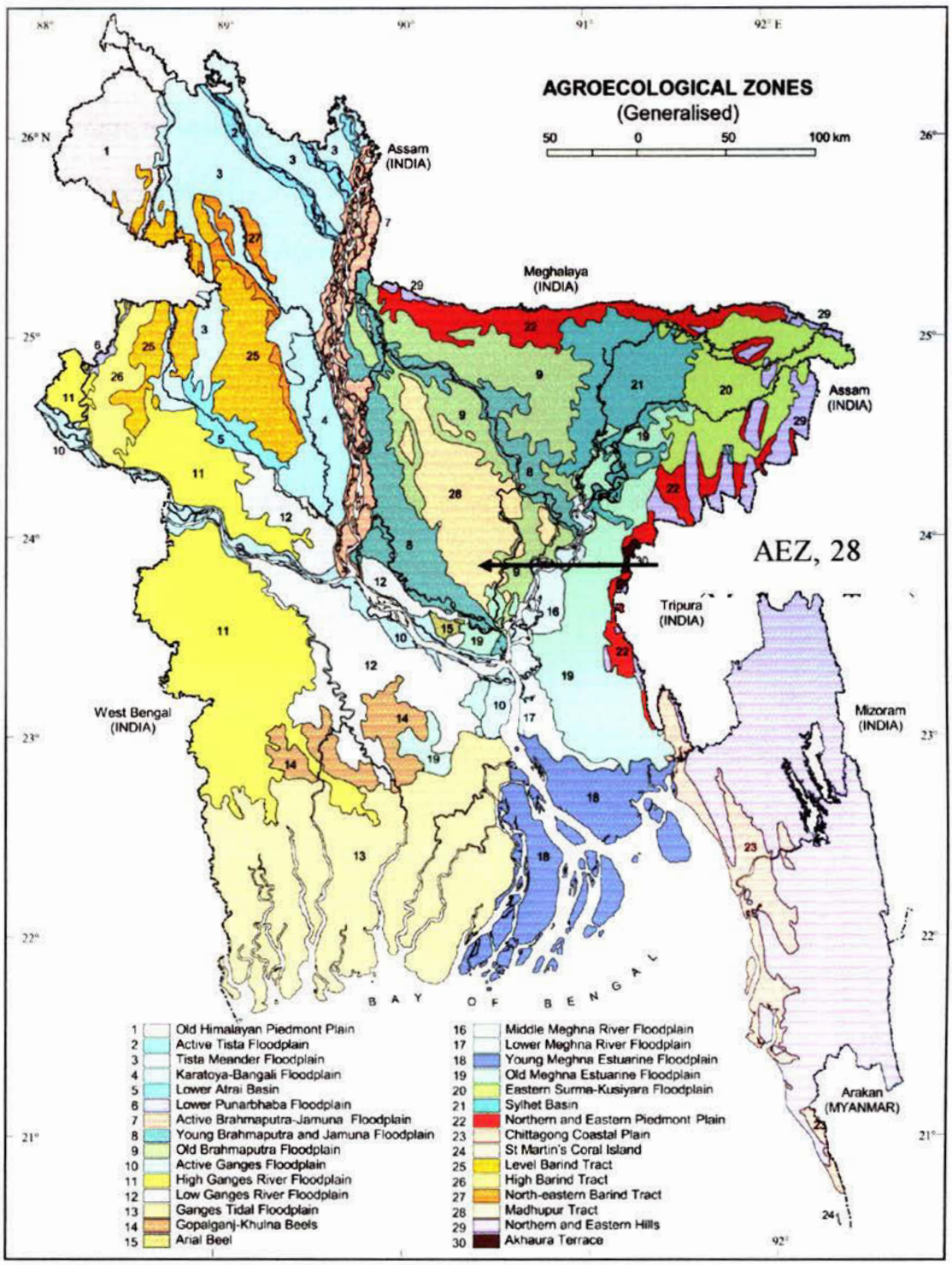


Fig. 1. Map showing the experimental sites under the study

3.3. Climate

The experimental area is under the sub tropical climate characterized by the three (3) distinct seasons the monsoon or rainy season extending from May to October. Winter or dry season from November to February and the pre-monsoon period or hot season from March to April Information regarding monthly maximum and minimum temperature, rainfall, relative humidity, soil temperature and sunshine as recorded by Bangladesh Meteorological Department, Agargaon Dhaka, during the period of study have presented in Appendix iii.

3.4. Treatments

The experiment was designed to study the effect of date of sowing time on growth and yield of three varieties of radish. Thus the experiment consisted of two factors.

They were –

A. Variety

Three different radishes variety, their origins and designations are given below:

Variety	Origin	Designated treatments
Tasakisan	Japan	V1
SAU Line-1	Japan	V2
Red Bombay	Indian	V3

First and 3rd Varieties were obtained from Siddique Seed 11-A, 3/7 (Main Road) Dhaka-1221, while the 2nd cultivar collected from Japan.

B. Sowing Time

Radish Seeds were sown at 3 sowing times; Viz. Designated treatments

i)	1st sowing: November1	S1
ii)	2nd sowing: November15	S2
iii)	3rd sowing: December 1	S3

Sowing time before November 1, was not considered, because in most of the years the soil of this region remains wet due to late rainfall.

SAU Line-1 Tasakisan Red Bombay

Two factors in combination gave 9 (nine) treatment combinations, which were as follows:

SL No	Treatment Combination	Description	
		Varieties	Sowing time
1	$V1S_1$	Tasakisan	Nov. 1
2	$V2S_1$	SAU Line-1	Nov. 1
3	V3S1	Red Bombay	Nov. 1
4	$V1S_2$	Tasakisan	Nov. 16
5	$V2S_2$	SAU Line-1	Nov. 16
6	V3S2	Red Bombay	Nov. 16
7	$V1S_3$	Tasakisan	Dec. 1
8	$V2S_3$	SAU Line-1	Dec. 1
9	V3S3	Red Bombay	Dec. 1

3.5. Experimental Design and Layout

(i) Experimental Design

Design	: RCBD
Treatment	: 3x3 = 9
Replication	: 3
Total No. of Plots	: 27
Plot size	: 2.4 m x 2.1 m
Block to Block	: 50 cm
Row to row	: 30 cm

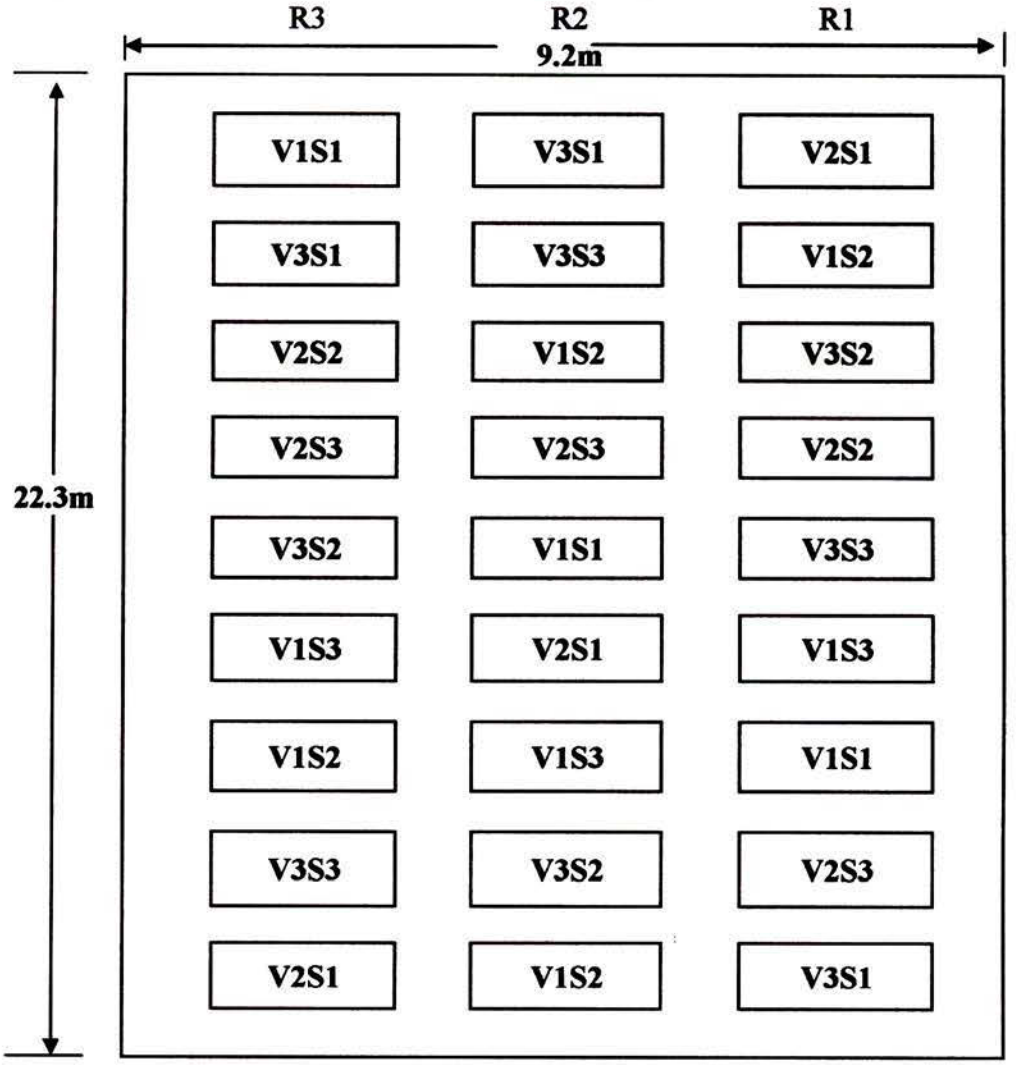
(ii) Experimental Design and Layout

The two-factor experiment was laid out following a Randomized Complete Block Design with three Replications. The whole experimental area was 205.16 m^2, each block was divided into nine plots where nine treatments were allotted at random. Thus there were altogether 27 unit plots in the experiment. Size of each plot was 2.4m x 2.1m Block to Block distance was 50 cm and plot to plot distance was 30 cm spacing for Tasakisan (T) and Red Bombay (R) plant to plant 15 cm row to row 30 cm. Spacing for SAU Line-1 was Plant to plant 70cm and row to row 80 cm.

3.6. Land Preparation

The land of experimental field was first opened on October 24, 2004 with a power tiller. Then it was exposed to the sunlight for 7 days prior to the next ploughing. The land was ploughed 6 times by a tractor to obtain good tilth. After that the land was properly prepared by several ploughing and cross ploughing to obtain a good tilth by a power tiller. Deep ploughing and good tilth was necessary for getting better yield of this crop (Ahmed, 1969). Laddering to break the clod in pieces followed each ploughing. All weeds and stubbles were removed from the plot especially care was taken to the

rhizomes, durba grass and mutha. Well-decomposed cow dung and basal dose of fertilizer were applied during final land preparation. Irrigation and drainage channel were prepared around the plot were before sowing of the seeds. Finally the land was uniformly pulverized and the soil.



Design: RCBD with 3 replication
Factor: Two factorial experiment (Date of sowing and cultivars)
Date of sowing (S): 3 times
Cultivar: 3 cultivars
Treatments: (3 x 3)= 9
Total no. of plot= 9 x 3= 27
Unit plot: 2.4m x 2.1m
Block to block distance= 50 cm
Plot to plot distance: 30cm
Spacing [for Tasakisan (V1) and red Bombey (V3)]:
plant to plant=15 cm
row to row= 30 cm
Spacing [for SAU Line-1(V2)]:
plant to plant=70cm
row to row= 80 cm

Fig 2 Experimental layout of the study

3.7. Manuring and Fertilizers

Crop was fertilized with the following doses of manure and fertilizers as recommended in a report of (Krishi Projukti Hat Boi) Bangladesh Agricultural Research Institute (BARI).

Manures and fertilizers	Dose/ha	Dose/plot
Cow dung	8-10 (ton)	7.50 kg
Urea	300-350 (kg)	260 g
TSP	250-300 (kg)	230 g
MP	215-235 (kg)	190 g

Urea, Triple super phosphate and Muriate of potash were used as sources of Nitrogen, phosphorus and potassium, respectively. Moreover, well-decomposed cowdung was applied to the plots

Total amount of cowdung and TSP, and 50% of urea and muriate of potash were applied as basal dose during land preparation. They were mixed with the soil by spading. The rest quantity of urea top-dressed after 25 and 30 days of sowing the seeds.

3.8. Collection of Seed

The experiment was conducted with seeds of radish cv. Tasakisan, BARI registered variety and the Red Bombay variety was Indian. Both the varieties were obtained from Siddique Seed 11-4 3/7, Dhaka-1221. Cultivar SAU Line-1 was procured from Dai-ichi Seed, Japan.

3.9. Soaking

Seeds were soaked in water for 24 hours and then wrapped with a piece of thin cloth prior to planting. Then they were separated over polythene sheet for 2 hours to dry out surface water. This treatment was given to help quick germination of seeds.

3.10. Seed rate and sowing

Seeds were sown at the rate of 2.5-3.0 kg/ha (Kirshi Projukti Hatboai, BARI). The seeds were sown on three different sowing time with 15 days interval. in about 1.5 cm depth. Seeds were sown in lines continuously and covered by loose soil.

3.11. Intercultural Operations

3.11.1. Thinning and Weeding: Seedling emergence was completed within ten days after sowing seed. Seedlings were thinned out two times. First thinning was done after 20 days of sowing, keeping two Seedlings in each location. The second thinning was done ten days after first thinning, keeping only one seedling in each hill. Weeding was done as and when required to keep the plots free from weeds and to pulverize soil. Tasakisan and Red Bombay variety (V1 and v3) are same spacing. The plant to plant spacing 15cm and row to row spacing 30cm. But the SAU Line-1 cuntivar (V2) are different spacing than Tasakisan and Red Bombay. The plant to plant spacing of this cultivar was 70cm and 80cm for row to row.

3.11.2. Disease and Pest Management

The crop was not infected with any disease but the infestation by cutworm (*Agrotis ypsilon*) during the early stage of seedling was serious. This insect was controlled by spraying Dursban 20EC (@ concentration of 0.2%).

3.11.3. Irrigation:

The young plants were irrigated by water cane and at the later stage irrigation was done by flooding. Generally irrigation was done by 2 to 3 times per week

3.12. Harvesting

The crop was harvested periodically. It was started after 60 days of each sowing date Final harvesting was done when most of each the roots of radish showed the sign of maturity i.e. after 100 days of sowing.

3.13. Collection of Data

To evaluate the effect of sowing time on three selected varieties, the following observations were made to get information related to plant growth as well as yield. Ten representative individuals were evaluated on each parameter for the collection of per plant data. Whole plot was harvested to record per plot yield calculation.

Data were collected on different growth and yield components and yield. Plants in the outer rows and at the extreme end of the middle rows were excluded from the random selection to avoid border effect. Following observations were made regarding plant growth yield and yield attributes as affected by different sowing time.

3.14. Observed Parameters

a. Plant height (cm)

b. Length of the leaf (cm)

c. Number of leaves per plant

d. Diameter (width) of root per plant (cm)

e. Length of root per plant (cm)

f. Fresh weight of root per plant (g)

g. Root yield (kg)/plot

h. Root yield (t/ha).

3.15. Before Harvesting

During different stages of crop growth data on the following parameters were recorded at interval of 10 days.

3.15.1. Plant Height

Plant height was measured in centimeter by a meter scale at 20, 30, 40, 50, 60, 70, 80, and 90 days after sowing (DAS) from the point of attachment of the leaves to the root (ground level) to the tip of the longest leaf.

3.15.2. Number of Leaves per Plant

Number of leaves per plant on selected hills was counted at 30, 45, 60, 75 and 90 DAS. The leaves of each plant were counted separately. Only the smallest young leaves at the growing point of the plant were excluded from the counting and the average number was recorded.

3.16. After Harvesting

3.16.1. Length of Root per Plant

Average length of the fusiform and napiform roots was measured in cm with the help of a meter scale from the proximal end of the root to the last point of the tapered end of the root (distal end) in each treatment.

3.16.2. Diameter (Width) of Root per Plant

To measure the diameter of the root a slide caliper was used. Average diameter of the root was measured in cm at every harvest at the thickened portion of the root.

3.16.3. Fresh Weight of Root Per plant

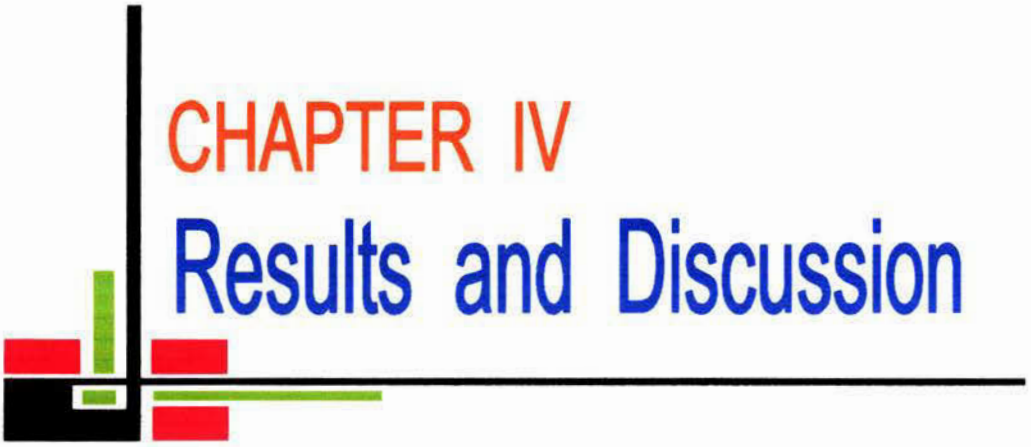
Underground modified radish roots of the ten selected plants were detached by a knife and after cleaning soil and fibrous root fresh weight was taken by a balance in gm and then the average value was calculated.

3.17. Statistical Analysis

Data were collected from the experimental plots were statistically analyzed. The mean value for all the treatments was calculated and the analyses of variance for most of the characters were accomplished by F variance test. The significance of difference between a pair of means was tested by the Duncan's Multiple Range Test (DMRT) at 5% and 1% level of probability (Gomez and Gomez 1984).

3.18. Cost and Return Analysis

Cost and return analysis in details was done according to the procedure of Alam *et al.* (1989). The cost production was analyzed in order to finds out most economic value of radish. All input cost and interest on fixed (land) and running capital were considered for computing the cost of production.



CHAPTER IV

Results and Discussion

RESULTS AND DISCUSSION

The present research work was conducted to find out the effect of date of sowing on growth and yield of three varieties of radish. The results obtained from the study have been presented and discussed in this chapter. The data recorded in respect of harvesting have been presented in tables and figures.

4.1. Effects of Cultivars on Growth and Yield of Radish

4.1.1. Leaf Length

A significant variation was observed on leaf of length per plant (cm) (Table 1) among the varieties of radish. The highest leaf length per plant was obtained from the SAU Line-1 (V2) (68.9 cm). The shortest leaf (43.8 cm) was obtained from Tasakisan (V1), which was followed by V3 that is Red Bombay (52.2 cm).

4.1.2. Number of Leaves per Plant

There was significant difference in the number of leaves per plant among the varieties (Table 1). The genotypes varied in number of leaves per plant from 19.2 (V2) to 10.1 (V3). Number of leaves per plant of Red Bombay and Tasakisan did not differ statistically.

4.1.3. Root Width/Diameter per Plant

Cultivars showed a significant variation in root diameter (Table 1). Maximum root diameter (33.7cm) was recorded from V2 variety which was followed by the variety Tasakisan (V1) and Red Bombay (V3). Root width/diameter of Tasakisan (4.0cm) and red Bombay (4.1cm) was statistically similar. It was concluded that greater root width per plant showed greater width.

Table 1. Effects of cultivars on growth and yield of radish

Cultivars[x]	Leaf		Root			Root Yield (Kg) / plot	Yield (t/ha)
	Length (cm)	Number	Width (cm)	Length (cm)	Fresh Weight (gm)		
Tasakisan	43.8 c	12.4 b	4.0 b	25.8 a	335.9 b	37.6 b	74.6 b
SAU Line-1	68.9 a	19.2 a	33.7 a	24.0 b	4688.9 a	42.2 a	83.73 a
Red bomby	52.2 b	10.1 b	4.1 b	23.1 b	324.9 b	36.38 b	72.18 b

[x] Tasakisan, V1(BARI registard variety) ; SAU Line-1, V2 (imported from Japan);Red bombey ,V3 (Indian)

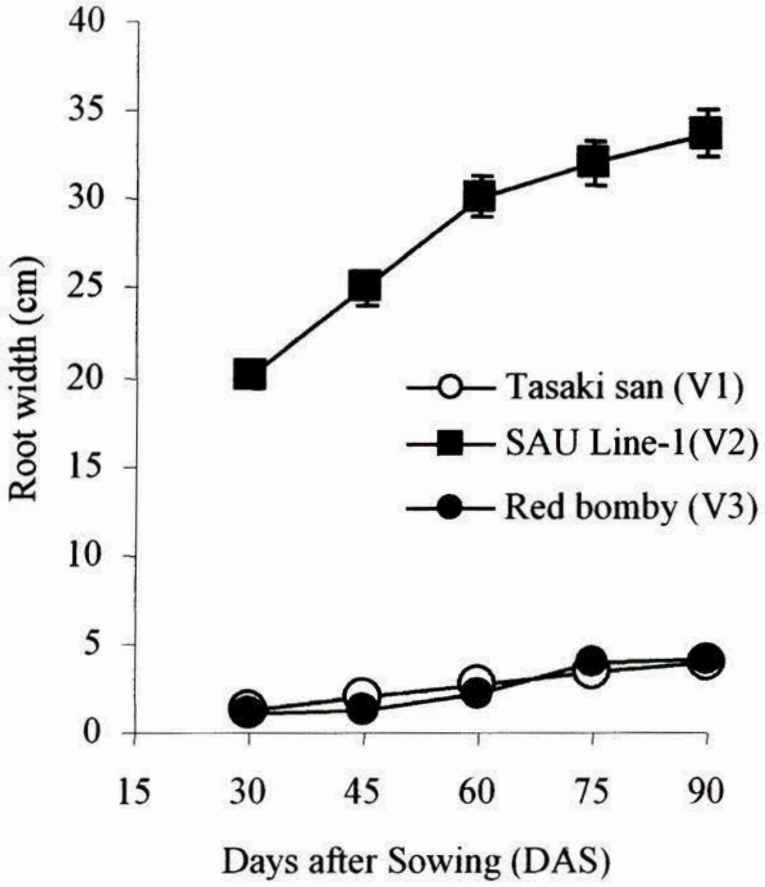


Fig. 3. Variation of root width (cm) with days after sowing with different cultivar of radish. Vertical lines are SD (n=9)

Plate 1: Morphological view of the "SAU Line-1"

Plate 2: Morphological view of the variety of 'Red Bombay"

Plate 3: Morphological view of the variety of 'Tasakisan"

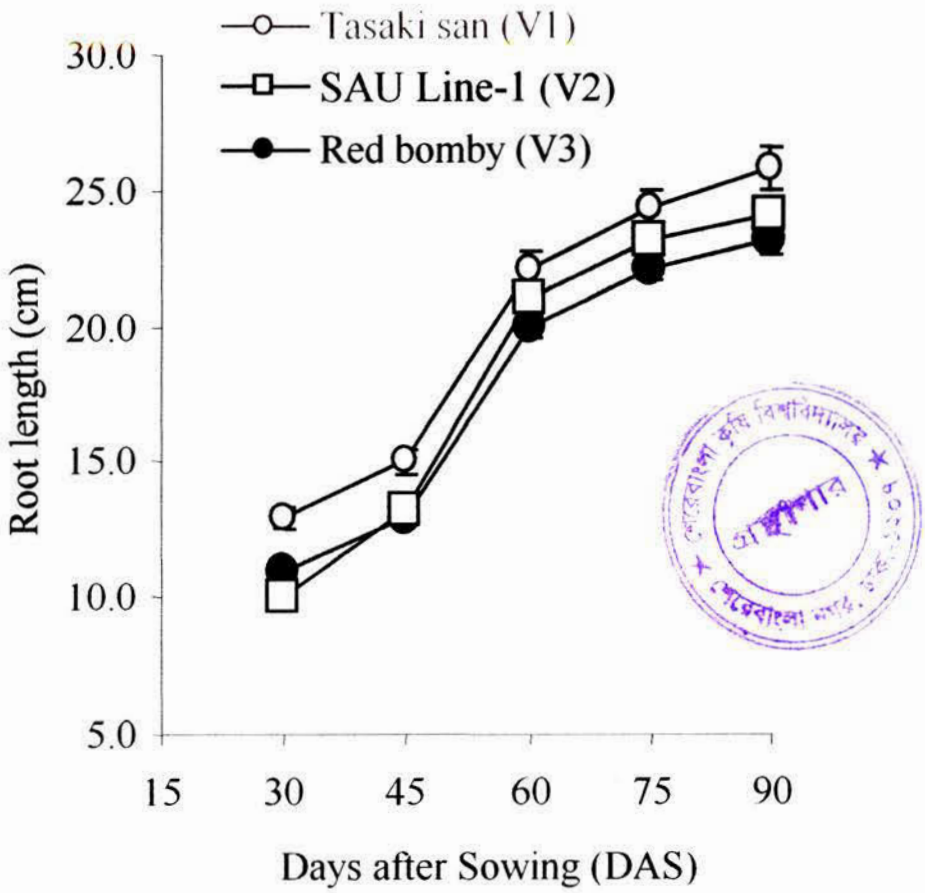


Fig. 4. Variation of root length (cm) with days after sowing of different cultivar of radish. Vertical lines are SD (n=9)

Root width of three varieties may be observed in Figure 3. In general, there was an increasing tendency in the spreading of root width up to the last sowing (December 1) from the first sowing in all the varieties. A linear increase of root width was found up to 60 days incase of V2 variety then its increase was slow (Fig 3). It was identified that the root width of SAU Line-1 was very high than the other two varieties.

4.1.4. Root Length

Root length was significantly affected by the varieties (Table.1). Maximum root length (25.8 cm) was found from Tasakisan (V1) variety. Minimum root length per plant (23.1cm) was found in red Bombay (V3). This was statistically similar with V2 (24.0 cm). The length of the root was found to increase till 90 days of planting (Fig 4) in all the varieties. The rapid increased of root length was found up to 60 days and then it was slow. The variety V_1 produced longer roots in all planting. It was suggested that increasing days after planting increased length of root.

4.1.5. Fresh Weight of Root per Plant

A Highly significant difference was observed among the varieties in respect of fresh weight of root per plant (g) (Table1). Highest fresh weight of root per plant was obtained from the SAU Line-1 (4688.9 g). Fresh weight of root per plant (g) of Red Bombay and Tasakisan were statistically similar which were 324.9 g and 335.9 g, respectively.

4.1.6. Root Yield (kg)/Plot

Root yield per plot was found statistically significant with the respect of varieties (Table1). SAU Line-1 (V_2) produced the highest yield (42.2 kg) per plot. Other two

Table 2. Effect of sowing date on the growth and yield of radish

	Leaf		Root			Root Yield	Yield
Sowing Time[x]	Length (cm)	Number	Width (cm)	Length (cm)	Fresh Weight (gm)	(Kg) / plot	(t/ha)
S1	59.6 a	16.3 a	15.9 a	25.6 a	535.6 a	41.24 a	81.82 a
S2	51.5 b	14.2 a	12.5 b	23.8 b	485.5 b	35.84 b	74.12 b
S3	53.7 b	11.1b	13.3 b	23.5 b	450.0 c	34.65 c	68.75 c

[x] S1 November 1; S2 November 15; S3 December 1

varieties Tasakisan (V_1) and Red Bombay (V_3) comparatively produced lower root yield, which were 37.6 kg, and 36.38 kg per plot respectively. They were not statistically different.

4.1.7. Root Yield (t/ha)

Root yield per ha was significantly influenced due to varieties (Table1). SAU Line-1 (V_2) produced the maximum root yield per ha 83.73 ton which was highly significant than other varieties. Plants of Red Bombay (V_3) produced the lowest root yield per hectare (72.18 ton) which was statistically similar to Tasakisan (V_1) 74.6 ton.

4.2. Sowing Date on the Growth and yield of radish

4.2.1. Leaf Length

Length of leaf per plant (cm) was significantly influenced by the date of sowing (Table 2).The longest leaf was obtained from November 1 sowing (59.6 cm) and the lowest on November 15 sowing (51.5 cm). Sowing on November 15 and December 1 produced statistically similar length of roots. It was observed that the sowing on Nov. 1 showed the best performance.

4.2.2. Number of Leaves per Plant

A Significant variation was found incase of number of leaves per plant due to the effect of date of sowing (Table 2). Maximum number of leaves per plant (66.3) was obtained from Nov. 1 sowing, which was identical with date of sowing on Nov. 15 (14.2). Date of sowing on December 1 showed the minimum/lowest number of leaves per plant (11.1). Highest number of leaves per plant achieved on account of early sowing possibly attributed to maximize photosynthesis. Plant produced higher number of leaves on Nov. 15 sowing have been reported by Gill *et al.,* 1995.

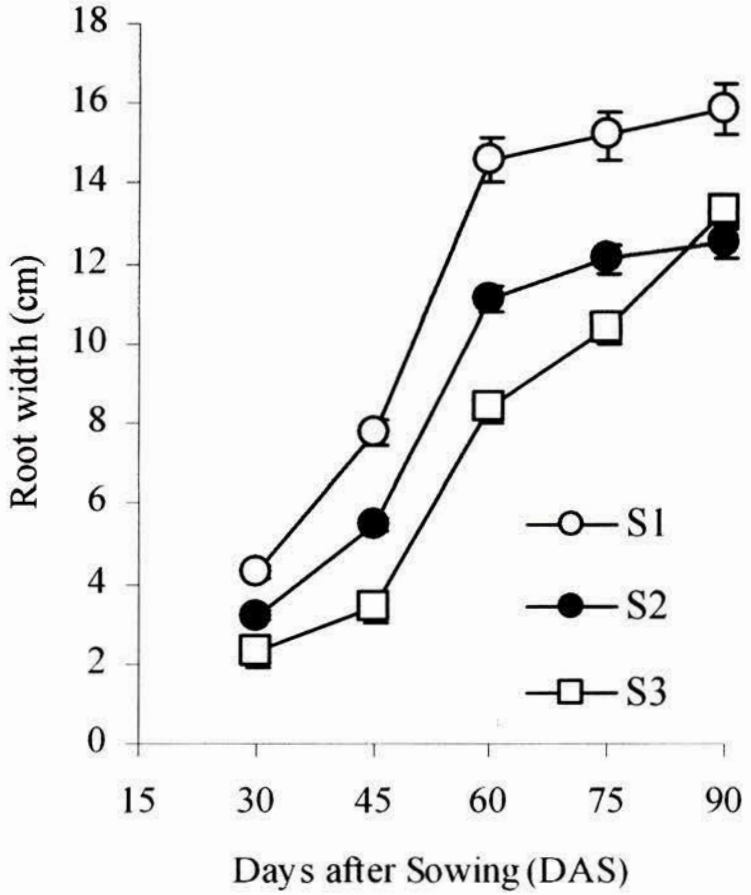


Fig 5 Variation of root width (cm) with days after sowing with different sowing time of radish. Vertical lines are SD (n=9)

4.2.3. Root Diameter per Plant

Diameter of root per plant exhibited a significant variation with date of sowing (Table 2). Root width per plant was found to decrease gradually and then increase with the date of sowing. Root diameter per plant showed a decreasing trend with late sowing. Nov, 15 (12.5 cm) and December, 1 (13.3 cm) sowing was identical effect in respect of this character. Highest root width (15.9 cm) per plant of observed from date of sowing on Nov. 1. The width of root was found to increase rapidly as the growth progressed from first harvest to third harvest then it declined against November 1 and November 15 sowing (Fig. 5). But the width of root was increased gradually up to 5th harvest in the plants grown from December 1 sowing.

4.2.4. Root Length per Plant

Root length per plant (cm) was significantly influenced by different date of sowing (Table 2). The longest root per plant (25.6 cm) was obtained from Nov. 1 sowing. While the shortest root length per plant (23.5 cm) was obtained from December 1. Sowing which was statistically identical with Nov. 15 sowing. It was observed that the root length per plant reduced considerably in the later sowings. This might be due to gradually increased in the later part of the reason temperature during December, which influenced early transition of the plants from vegetative to reproductive phase. Different sowing date of radish variety was shown in Fig 6 in respect of root length. In all the cases root length was increased with the advancement days after planting and it continued up to December 1 planting. November 1 sowing showed the maximum root length in every 30, 45, 60, 75 and 90 DAS than the other two sowings. December 1 sowing gave the minimum length of root in every investigation. It was suggested that early sowing of radish variety gave more length of root. As a result yield is increased.

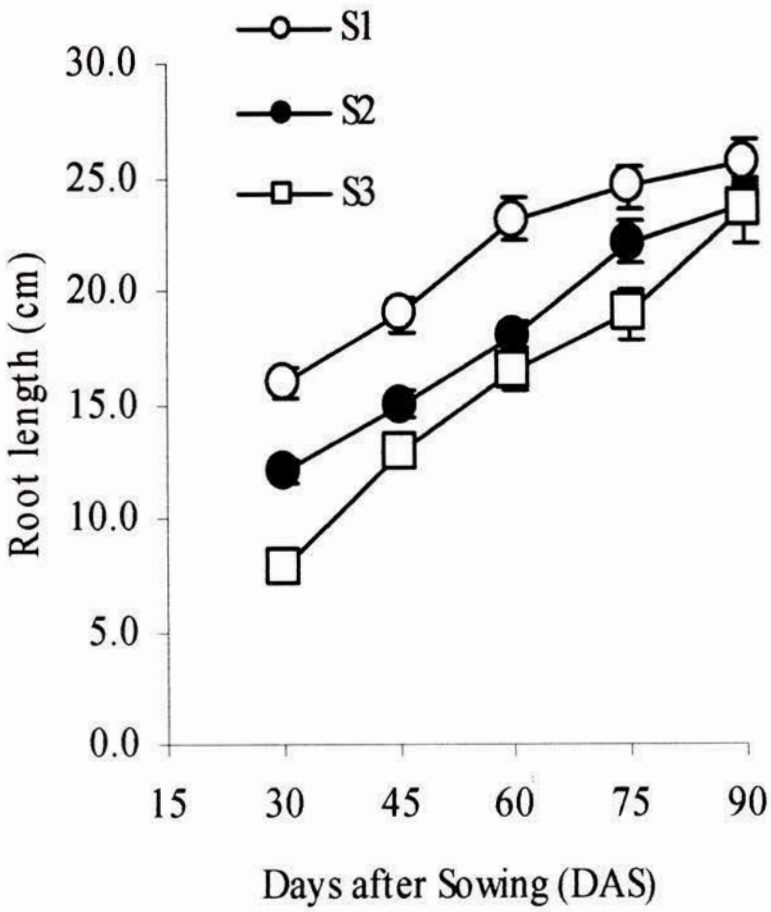


Fig 6 Variation of root length (cm) with days after sowing of different sowing time of radish. Vertical lines are SD (n=9)

4.2.5. Fresh Weight of Root per Plant

Nov. 1 sowing produced the heavier weight of fresh roots per plant (Table 2), which was statistically different from other two sowings. The late sowings produced lighter weight of fresh root. Lowest fresh weight of root was obtained from December 1 sowing.

4.2.6. Root Yield per Plot

Significant variation was obtained from root yield (kg) per plant respect of different date of sowing (Table 2). Maximum root yield (41.24 kg) per plot was obtained from Nov. 1, and minimum was obtained from (34.65 kg) per plot December 1 sowing. It was found that root yield (kg) per plot was gradually decrease in the later sowing. This might be due to low temperature during later sowings, which turn energy from vegetative phase to reproductive phase.

4.2.7. Root Yield per Hectare

Root yield t/per hectare was significantly affected by different date of sowing. Considering the date of sowing Nov, 1, sowing gave the highest root yield (81.82 ton) per hectare and that the lowest was obtained from December, 1 sowing (68.75 ton). It was observed that the root yield per ha reduced considerably in the later sowings. Malik *et al.* (1999) reported that root yield per plant was higher in early sowing (November 5). Rao and Manhar (1990) reported that the highest root yields were obtained with 31 October sowing. Gill *et al.* (1995) also found higher root yield from sowing on second half of November.

Table 3. Interaction effects on the growth and yield of radish[x]

Cultivar X	Leaf		Root			Root Yield (Kg) / plot	Yield (t/ha)
Sowing Time	Length (cm)	Number	Width (cm)	Length (cm)	Fresh Weight (gm)		
V1 S1	46.7 d	12.9 c	4.7 c	24.6 bc	435.75 d	48.8 d	96.82 d
V1 S2	42.7 d	13.3 c	2.3 c	27.0 ab	410.75 de	46.0 de	91.26 de
V1 S3	42.2 d	10.9 c	5.0 c	25.8 bc	392.95 de	44.01 de	87.32 e
V2 S1	73.5 a	24.8 a	38.3 a	28.4 a	6212.0 a	55.90 a	110.91 a
V2 S2	63.6 bc	19.3 b	33.0 b	23.6 c	5850.50 b	52.65 b	104.46.b
V2 S3	69.7 ab	13.5 c	29.7 b	20.0 d	5660.9 c	50.94 c	101.07 c
V3 S1	58.7 c	11.3 c	4.7 c	23.8 c	430.25de	48.18 de	95.59 d
V3 S2	48.6 d	10.0 c	2.2 c	20.7 d	405.20 e	45.38 de	90.03 e
V3 S3	49.4 d	8.9 c	5.3 c	24.7 bc	387.45 de	43.39 e	87.09 e

[x] Tasakisan, V1; SAU Line-1,V2 ;Red bombey ,V3

[x] S1 November 1; S2 November 15; S3 December 1

4.3. Interaction Effects on the Growth and Yield of Radish

4.3.1. Leaf Length per Plant

Insignificant interaction was observed between the variety and date of sowing in respect of leaf length (Table3). However, Maximum leaf length was found in V_2 (73.5 cm) on Nov. 1 sowing and the minimum leaf length in V_1 (42.2 cm) on December 1 Sowing.

4.3.2. Number of Leaves per Plant

Interaction between variety and sowing date was not significant, However SAU Line-1(V_2) variety produced maximum (29.8) number of leaves per plant on Nov. 1 sowing and Red Bombay (V_3) on December 1 sowing exhibited the lowest number of leaves (8.9) per plant. The varieties Tasakisan and Red Bombay did not different statistically in all the sowing dates in respect of number of leaves per plant.

4.3.2. Root Diameter per Plant

SAU Line-1 (V_2) sown on Nov. 1 gave the highest root diameter (38.3 cm) compared to other treatments (Table 3). Variety Red Bombay (V_3) when sown on Nov. 15 resulted in the lowest root width per plant (2.2 cm). There were no variations statistically between Tasakisan and Red Bombay in respect of all the sowing dates. Similar trend was found in the SAU Line-1 (V_2) when sown on Nov. 15 and December 1. Incase of two varieties Tasakisan and Red Bombay showed less root width sown on Nov. 15, but incase of SAU Line-1 December 1 sowing produced lower root width. It was summarized that later sowing exhibited maximum root width unexpective of varieties Tasakisan (V_1) and Red Bombay (V_3) and early sowing in case of SAU Line-1.

4.3.3. Root Length

A significant effect of variety and date of sowing was observed on root length per plant (Table3). SAU Line-1 sown on Nov. 1 gave the longest root per plant (28.40 (g)

but when the same variety was sown on December 1 gave the shortest root (20 cm) per plant. Root length decreased with every delay in sowing incase of the varieties SAU Line-1 (V_2). On the other hand root length increased in the plant sown on Nov. 15 and then decreased incase of Tasakisan (V_1). Red Bombay (V_3) was showed highest root length on December 1 sowing plants.

4.3.4. Fresh Weight of Root

Interaction between the variety and date sowing on fresh weight of root per plant (g) was found highly significant (Table3). Highest fresh weight of root per plant was observed in SAU Line-1 (6212.0 g) at Nov.1 sowing, which was followed by 2nd Nov.15 sowing (5850.0 g). In Tasakisan variety highest fresh weight per plant was observed on Nov.1 sowing, which was statistically identical with December 1 sowing. On the other hand December, 1 sowing gave highest fresh weight of root per plant which was statistically identical with the variety Red Bombay (V_3) sown on Nov. 1.

4.3.5. Root Yield per Plot

Variety and date of sowing interacted significantly in respect of root yield per plot (Table3). Highest root yield per plot was found in the SAU Line-1 (55.9 kg) sown on November, which was followed by the same variety sown on November 15 and December 1. Lowest root yield per plot was found in the variety Red Bombay (43.39 kg) sown on December 1. There were significant variations between the SAU Line-1 sown on November 1 and the variety Red Bombay sown on November 15. It was observed that root yield per plot of SAU Line-1 variety exhibited highest than the root yields other two varieties.

4.3.5. Root Yield per Hectare

Interaction between the variety and date of sowing differed significantly (Table 3). SAU Line-1 (V_2) gave the highest root yield (110.9 t) sown on Nov. 1 and the lowest root yield per hectare was observed in the variety Red Bombay (86.09 t) sown on

December1. The experiment demonstrated that the root continued to grow in size until harvest. The yield of radish was increased with the increase in length of the growing period. For getting higher yield, it is better to plant the crop as early as possible.

4.4. Cost and Return Analysis

Materials, non-material and overhead costs were recorded for all the treatments for Unit plot and were calculated per hectare basis (marketable yield). The price of radish roots at the local market was also noted. The cost and return analysis were done and have been presented in table 4 and appendix V.

Cost of production varied due to price of seed of different variety. The lowest and highest production cost (45998.8 Tk/ha) was same the different treatment combination.

Lowest gross return of (404280.00 Tk/ha) was obtained from the treatment combination of SAU Line-1(V_2S_3) and sown on December 1. Highest gross return of (484100.00 Tk/ha) was obtained from the treatment combination of cultivar SAU Line-1 (V_2S_1) and sown on Nov 1. On the other hand, highest net return of (438101.2 Tk/ha) was obtained from the treatment combination of cultivar Tasakisan (V_1S_1) and sown on Nov 1, and the lowest net return of (358281.2 Tk/ha) was obtained from the treatment combination of SAU Line-1 (V_2S_3) and sown December 1.

Benefit cost ratio (BCR) was found to be the highest (10.52) in the treatment Combination (V1S1) Tasakisan and sown on Nov 1. Lowest BCR (8.79) was recorded from V_2S_3 treatment Combination. Thus, the Nov 1 sowing of (V1S1) variety Tasakisan was economically beneficial than that of the treatment combination of the variety Red Bombay (V3) and SAU Line-1.

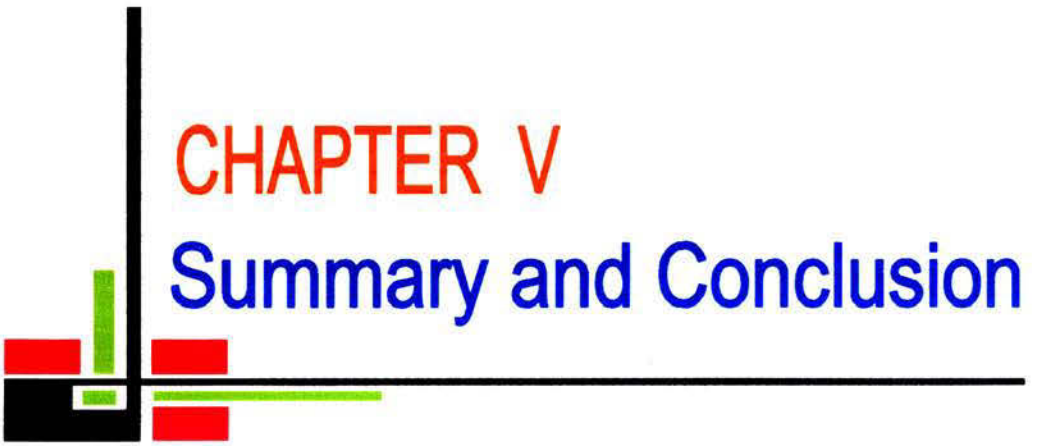
Table 4. Cost and Return of Radish due to Sowing time and Varital Treatment

Treatment Combination [x]	Marketable yield t/ha	Gross return (GR) Tk/ha	Total Cost (TC) Tk/ha	Net Return (NR) Tk/ha	BCR [y]
$V1S_1$	96.82	484100.00	45998.80	438101.2	10.52
$V1S_2$	91.26	456300.00	45998.80	390601.2	9.91
$V1S_3$	87.32	436600.00	45998.80	410301.2	9.49
$V2S_1$	110.91	443640.00	45998.80	397641.2	9.64
$V2S_2$	104.46	417840.00	45998.80	371841.2	9.08
$V2JS_3$	101.07	404280.00	45998.80	358281.2	8.79
$V3S_1$	95.59	477950.00	45998.80	431951.2	10.39
V3S2	90.03	450150.00	45998.80	404151.2	9.78
$V3S_3$	86.09	430450.00	45998.80	384451.2	9.35

[x] V1,Tasakisan; V2, SAU Line-1; V3, Red bombay

S_1, 1 Nov Sowing; S2,16 Nov Sowing; S3, 1December Sowing

[y] BCR=GR/Cost of Production NR. GR-TC Price Tasakisan and Red bombay 5000 Tk/t SAU Line-1 4000Tk/t



CHAPTER V

Summary and Conclusion

SUMMARY AND CONCLUSION

An experiment was carried out at the Horticulture farm of the Sher-e-Bangla Agricultural University Dhaka-1207 during the period from November, 2004 to January, 2005 to study the effect of date of sowing date three varieties of radish. Three (3) different sowing dates namely, Nov. 1, Nov. 15 and Dec. 1, and three (3) different varieties were viz., (i) Tasakisan (ii) SAU Line-1 and (iii) Red Bombay.

A Factorial experiment was set up in Randomized Complete Block design with three replications. In total there were nine (9) treatment combinations in the study. In each block the treatments were assigned randomly to the unit plot measuring 2.4 x 2.1 sq. meters each, which accommodated 112 plants. The data were collected periodically on different parameters from 10 randomly selected plants from each unit plot. Final harvest was done at 60 days after each sowing.

Results of the experiment revealed that the sowing date and variety significantly influenced the length leaf per plant. The highest leaf length was recorded in November 1 and that the lowest was recorded in December 1 sowing (42.2 cm) irrespective of varieties under study. SAU Line-1 produced the longest leaf (73.5 cm) irrespective of time of sowing. Variety SAU Line-1, sown on November. 1 gave maximum length (73.5 cm).

Significantly different results were found in case of root length. The highest root length was recorded in November 1 sowing (25.6 cm) while the lowest in December 1 (23.5 cm) sowing. SAU Line-1 sown on November 1 produced the longest root length (28.4 cm) per plant. SAU Line-1 produced the shortest root length (20.0 cm) sown on December 1.

Root diameter also differed significantly by sowing time. Maximum root diameter of plant (15.9 cm) was obtained from Nov 1 sowing. SAU Line-1 gave the highest root diameter.

Fresh weight of root was also significantly influenced the time of sowing. November 1 sowing produced the highest fresh root weight. December 1 sowing produced the lowest fresh radish root. The SAU Line-1 sown on Nov. 1 produced the highest fresh (6200.0 g) weight of root.

Result of the present study indicated that the highest yield (41.24 Kg) per plot and per hectare (81.82 t) was obtained in the SAU Line-1 and sown on Nov 1.

The economic analysis showed that the highest net return (438101.2 Tk/ha) was found from the treatment combination of V1S1 (variety Tasakisan and sowing date November 1) while, the lowest was (358281.2 Tk/ha) from the treatment combination of V2S3 (SAU Line-1 and sowing date December 1). The highest benefit cost ratio (10.52) was obtained from the treatment combination of V1S1.

From the above results it is revealed that Nov. 1 is the best date of sowing of radish in respect to cultivar. It can be concluded that the highest yield was found SAU Line-1 but the cost benefit ratio is the highest in Tasakisan.

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APPENDICES

Appendix i Nutritional value of radish

Nutritional Elements	Leaf	Root
Water	89.5	95 g
Calory (Energy)	15	23 Kcal
Carbohydrate	25	4.0 g
Protein	2.5	0.30 g
Vitamin-A	3.1	0.05 mg
Vitamin-B	0.3	0.03 mg
Niacin	0.4	0.50 mg
Vitamin-C	0.9	0.20 mg
Calcium	190	35 mg
Iron	1.4	0.4 mg
Carotene	9000	0

Source: Bangladesh Agricultural Research Institute

Appendix II : Characteristics of Horticultural farm soil Composite Sample

pH	5.30	Strongly acidic
Total N (%)	0.09	%
P (ppm)	41.89	kg/g
K (ppm)	0.18	cmol/kg (me/100 gm soil)
Organic Carbon (%)	0.45	%
Sulphur (ppm)	45.00	ppm

Source: Analysis by Soil Resource Development Institute (SRDI) Khamarbari, Farmgate, Dhaka,(AEZ No. 28. Modhupur Tract).

Appendix iii: Monthly records of Temperature, Rainfall, Relative humidity, Soil temperature and Sunshine of the experimental Site during the period from October 2004 to March 2005.

Year	Month	Air temperature (^{0}c)			Relative humidity (%)	Rainfall (mm)	Soil temperation			Sunshine (ha)
		Maximum	Minimum	Mean			5 cm depth	10 cm depth	20 cm depth	
2004	October	31.0	23.3	27.1	75.3	208.0	16.9	17.2	17.3	208.9
	November	29.5	18.6	24.0	69.5	0.0	13.8	14.4	14.8	233.2
	December	26.9	16.2	21.5	70.6	0.0	12.6	13.6	14.0	210.5
2005	January	24.5	13.9	19.2	68.5	4.0	11.3	12.4	13.0	194.1
	February	28.9	18.0	23.4	61.0	3.0	12.9	13.7	13.8	221.5
	March	32.2	21.8	27.0	66.7	155.0	16.2	17.1	17.2	210.2

Source: Bangladesh Meteorological Department (Climate division) Agargaon, Dhaka-1212.

Appendix iv : Analysis of Variance of the data on the different characteristics influenced by different times of sowing and verities

Source of Variation (SV)	Degree of freedom (df)	Mean sum of squares						
		Leaf length /plant (cm)	No. of leaves plant	Root diameter plant (cm)	Root length plant (cm)	Fresh weight of root plant	Root yield (kg/plant)	Root yie (t/ha)
Replication	2	6.757	2.96	7.732	2.218	340915.815	58879.628	2297.5
Variety	2	1961.735**	202.61**	2636.917**	17.281**	52788440.704**	72425507.868**	2850505.3
Sowing time	2	285.361**	61.127**	27.98**	12.188**	2456244.037*	6395100.101**	251832.9
Sowing time x Variety	4	82.241NS	21.139NS	22.09**	29.592**	8129042.648**	7346869.45**	289315.7
Error	16	41.080	9.27	4.833	1.954	537279.981	19946.4	781.69

* = Significant at 5% level of Probability; ** =Significant at 1% level of Probability; NS= Not Significant

Appendix iv : Analysis of Variance of the data on the different characteristics influenced by different times of sowing and verities

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* = Significant at 5% level of Probability; ** =Significant at 1% level of Probability; NS= Not Significant

Appendix V. Production cost of Radish per hectare (a) Material Cost (Tk)

Treatment[x]	Seed 3 kg/ha	Manures and Fertilizer[y]				Pesticide	Irrigation	Sub To (A)
		Cowdung 10 t/ha	Urea 300 kg/ha	TSP 250 kg/ha	MP 215 kg/ha			
$V1S_1$	1500	4000	2100	3250	2150	2000	1000	1600
$V1S_2$	1500	4000	2100	3250	2150	2000	1000	1600
$V1S_3$	1500	4000	2100	3250	2150	2000	1000	1600
$V2S_1$	1500	4000	2100	3250	2150	2000	1000	1600
$V2S_2$	1500	4000	2100	3250	2150	2000	1000	1600
$V2S_3$	1500	4000	2100	3250	2150	2000	1000	1600
$V3S_1$	1500	4000	2100	3250	2150	2000	1000	1600
$V3S_2$	1500	4000	2100	3250	2150	2000	1000	1600
$V3S_3$	1500	4000	2100	3250	2150	2000	1000	1600

[x] V1,Tasakisan;V2, SAU Line-1; V3, Red bombay

S_1, 1 Nov Sowing; S2,16 Nov Sowing; S3, 1December Sowing

[y] Radish seed @ Tk 500/kg; Cowdung @ Tk 0.40/kg Urea @ Tk 7.00/kg TSP @ Tk 13.00/kg MP @ Tk10.00/kg

Table V(b). Non Material Cost [y]

Treatment Combination [x]	Land Preparation	Manures Fertilizer Application	Irrigation Practice	Seed Sowing Cost	Intercultural Operation	Harvesting	Sub Total1 (B)	Total Input Cost 1(A) + 1(B)
$V1S_1$	7000	420	700	2800	1400	7000	19320	35320
$V1S_2$	7000	420	700	2800	1400	7000	19320	35120
$V1S_3$	7000	420	700	2800	1400	7000	19320	35320
$V2S_1$	7000	420	700	2800	1400	7000	19320	35320
$V2S_2$	7000	420	700	2800	1400	7000	19320	35320
$V2S_3$	7000	420	700	2800	1400	7000	19320	35320
$V3S_1$	7000	420	700	2800	1400	7000	19320	35320
$V3S_2$	7000	420	700	2800	1400	7000	19320	35320
$V3S_3$	7000	420	700	2800	1400	7000	19320	35320

[x] V1, Tasakisan; V2, SAU Line-1; V3, Red bombay

S_1, 1 Nov Sowing; S2,16 Nov Sowing; S3, 1December Sowing

[y] Labour Cost @ Tk 70/day

Table V(b). Non Material Cost [y]

Treatment Combination [x]	Land Preparation	Manures Fertilizer Application	Irrigation Practice	Seed Sowing Cost	Intercultural Operation	Harvesting	Sub Total1 (B)	Total Input Cost 1(A) + 1(B)
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$V1S_2$	7000	420	700	2800	1400	7000	19320	35120
$V1S_3$	7000	420	700	2800	1400	7000	19320	35320
$V2S_1$	7000	420	700	2800	1400	7000	19320	35320
$V2S_2$	7000	420	700	2800	1400	7000	19320	35320
$V2S_3$	7000	420	700	2800	1400	7000	19320	35320
$V3S_1$	7000	420	700	2800	1400	7000	19320	35320
$V3S_2$	7000	420	700	2800	1400	7000	19320	35320
$V3S_3$	7000	420	700	2800	1400	7000	19320	35320

[x] V1, Tasakisan; V2, SAU Line-1; V3, Red bombay

S_1, 1 Nov Sowing; S2,16 Nov Sowing; S3, 1December Sowing

[y] Labour Cost @ Tk 70/day

Table V(c). Overhead Cost and Total Cost of Production (Tk)

Treatment Combination [x]	Overhead Cost		Miscellaneous Cost (5% of Total input cost)	Sube Total (Overhead cost)	Total Cost of Production (Tk/ha) Total Input Cost + Overhead Cost
	Cost of use of land	Interest on running capital for 6 month (13% of total input cost)			
$V1S_1$	7500	22.95.8	883	10678.8	45998.8
$V1S_2$	7500	22.95.8	883	10678.8	45998.8
$V1S_3$	7500	22.95.8	883	10678.8	45998.8
$V2S_1$	7500	22.95.8	883	10678.8	45998.8
$V2S_2$	7500	22.95.8	883	10678.8	45998.8
$V2S_3$	7500	22.95.8	883	10678.8	45998.8
$V3S_1$	7500	22.95.8	883	10678.8	45998.8
$V3S_2$	7500	22.95.8	883	10678.8	45998.8
$V3S_3$	7500	22.95.8	883	10678.8	45998.8

[x] V1,Tasakisan;V2, SAU Line-1; V3, Red bombay

S_1, 1 Nov Sowing; S2,16 Nov Sowing; S3, 1December Sowing

Table V(c). Overhead Cost and Total Cost of Production (Tk)

Treatment Combination x	Overhead Cost		Miscellaneous Cost (5% of Total input cost)	Sube Total (Overhead cost)	Total Cost of Production (Tk/ha) Total Input Cost + Overhead Cost
	Cost of use of land	Interest on running capital for 6 month (13% of total input cost)			
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$V1S_2$	7500	22.95.8	883	10678.8	45998.8
$V1S_3$	7500	22.95.8	883	10678.8	45998.8
$V2S_1$	7500	22.95.8	883	10678.8	45998.8
$V2S_2$	7500	22.95.8	883	10678.8	45998.8
$V2S_3$	7500	22.95.8	883	10678.8	45998.8
$V3S_1$	7500	22.95.8	883	10678.8	45998.8
$V3S_2$	7500	22.95.8	883	10678.8	45998.8
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[x] V1,Tasakisan;V2, SAU Line-1; V3, Red bombay

S_1, 1 Nov Sowing; S2,16 Nov Sowing; S3, 1December Sowing