EFFECT OF PLANT SPACING AND HARVEST INTERVAL ON THE GROWTH AND YIELD OF GIMAKALMI (*Ipomoea reptans* poir)

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EFFECT OF PLANT SPACING AND HARVEST INTERVAL ON THE GROWTH AND YIELD OF GIMAKALMI (*Ipomoea reptans* poir)

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This is to certify that the thesis entitled **"Effect of Plant Spacing and Harvest Interval on the Growth and Yield of Gimakalmi** (*Ipomoea reptans* poir)**"** 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 **Mohammad Mosaraf Hossain**, Registration number 00703 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 source of information, received during the course of this investigation has been duly acknowledged.

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TO

MY BELOVED PARENTS

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By

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ABSTRACT

The present experiment was conducted to investigate the effect of different plant spacing and harvesting intervals on the growth and yield of Gimakalmi at the Horticulture Farm of the Sher-e-Bangla Agricultural University, Dhaka during the period from May to August 2006. There were four levels of plant spacing viz. S_1: 30 cm× 5 cm, S_2: 30 cm × 10 cm, S_3: 30 cm × 15 cm and S_4: 30 cm × 20 cm and three harvest intervals viz. 10, 15 and 20 days as treatments of the experiment. Plant spacing S_3 as 30 cm × 15 cm gave the longest (32.43 cm) plant per harvest and the shortest (28.17 cm) plant was recorded from S_1 at plant spacing 30 cm × 5 cm. Plant spacing S_3 gave the maximum (59.78 g) fresh weight of plant and the minimum (50.26 g) fresh weight of plant was recorded from S_1. The maximum (14.56%) dry matter content was recorded from S_3 and the minimum (10.82%) was obtained from S_1. The highest (83.62%) foliage coverage was recorded from S_3 and the lowest (76.12%) was recorded from S_2. The highest (67.00 t/ha) yield was recorded from S_3 and the lowest (54.38 t/ha) was recorded from S_1. Harvesting time at 15 days interval (H_2) gave the longest (39.17 cm) plant per harvest and the shortest (17.31 cm) plant was recorded from H_1 at 10 days harvesting interval. Harvesting time H_2 gave the maximum (63.12 g) fresh weight of plant and the minimum (46.02 g) was recorded from H_1. Harvesting time H_2 gave the maximum (13.43%) dry matter content and the minimum (12.02%) was recorded from H_1. Harvesting time H_2 gave the highest (81.50%) foliage coverage and the lowest (73.93%) was recorded from H_1. Harvesting time H_2 gave the highest (63.78 t/ha) yield and the lowest (59.42 t/ha) was recorded from H_3. The longest (42.15 cm) plant was recorded from S_3H_2 (30 cm × 15 cm plant spacing and harvesting at 15 days interval) and the shortest (16.03 cm) plant was recorded from S_1H_1 (30 cm × 5 cm plant spacing and harvesting at 10 days interval). The maximum (68.72 g) fresh weight of plant was recorded from S_3H_2 and the minimum (40.32 g) was recorded from S_1H_1. The maximum (15.89%) dry matter content was recorded from S_3H_2 and the minimum (10.01%) was recorded from S_1H_1. The highest (88.00%) foliage coverage was recorded from S_3H_2 and the lowest (70.71%) was obtained from S_1H_1. The highest (70.36 t/ha) yield was recorded from S_3H_2 and the lowest (50.99 t/ha) was recorded from S_1H_1.

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Chapter I

INTRODUCTION

Gimakalmi (*Ipomoea reptans* poir), a leafy vegetable belongs to the family Convolvulaceae. It is an important leafy vegetable of the South East Asia, and is widely grown throughout the South East Asian countries, Australia and some parts of Africa (Hossain and Siddique, 1982). The crop is also known as kangkong, swamp cabbage, water convolvulus, water spinach etc. (Tindal, 1983). Gimakalmi was developed from an introduced strain of Kangkong brought from Taiwan by the Citrus and Vegetable Seed Research Centre of Bangladesh Agricultural Research Institute, Joydevpur, Gazipur (Rashid *et al*., 1985).

In Bangladesh most of the vegetables are produced in summer and winter season, while in between these two seasons, there is a lag period when scarcity of vegetables occur. Introduction of Gimakalmi is a positive achievement since it can be grown in summer and rainy season (Shinohara, 1980). Although similar, but aquatic type of local Kalmi is naturally grown in ponds or marshy land of Bangladesh, Gimakalmi has a special significance, because it grows in upland soil with an appreciable yield potential of foliage. Unlike the Bangladeshi local Kalmi, Gimakalmi grows erect producing heavy foliage.

Gimakalmi is a very important leafy vegetable from the nutritional point of view. Like other leafy vegetable, it is nutritionally rich in vitamins, minerals, calories etc. It is an excellent source of Vitamin A. Leafy vegetable of 100 g of its edible portion contains 87.6 g water, 1.1 g minerals, 0.1 g fat, 9.4 g carbohydrates, 107 mg calcium, 3.9 mg iron, 10740 microgram carotene, 0.14 mg vitamin B_1, 0.40 mg vitamin B_2, 42 mg vitamin C, 1.8 g protein and 46 kilocalories (Anon., 1983). Since it requires low input, easy to grow, and is suitable for growing in summer, its cultivation should be increased. There are, however, signs of its gaining popularity among the Bangladeshi vegetable growers and consumers.

At present Gimakalmi is produced in very small area of land following less or minimum management practices. To attain the maximum production and quality yield it is necessary to adopt proper management practices ensuring proper space and availability of essential nutrients. Gimakalmi thrives well in a fertile, clay loam soil because it requires considerable amounts of nutrients for rapid growth within short period of time. In our country most of the growers cultivate this crop in fallow land without proper care, spacing and management practices.

Plant spacing is an important aspect of crop production for maximizing the yield. Optimum plant spacing ensures judicious use of natural resources and makes the intercultural operations easier. It helps increase the number of leaves, branches and healthy foliage. Densely planted crop obstruct the proper growth and development. On the other hand, wider spacing ensures the basic requirements but decrease the total number of plants as well as total yield. Yield may be increased upto 25% by using optimum spacing (Bansal, *et al.*, 1995). In Bangladesh like other management practices information about spacing to be used in Gimakalmi cultivation is scanty. The farmers of Bangladesh cultivate this crop according to their own choice due to the absence or unavailability of standard production technique. As a result, they do not get satisfactory yield and return from investment.

The harvest interval can also influence the yield of Gimakalmi. It has been recommended to start harvesting the crop at the 30th day after sowing (Anon., 1983). The leaves and tender stems are the edible portion of this crop. Naturally hard fibrous shoots are unfit for its consumption. For the production of Gimakalmi harvesting time is particularly important when several harvests are done from a single plant.

So plant spacing and the harvest interval are to be taken into consideration simultaneously for attaining good quality and reasonable yield. One can not sacrifice much to achieve the other. Moreover, harvest interval is correlated with the economic return by ensuring the highest market price. Considering the above circumstances, the present investigation was undertaken with the following objectives:

1. To determine the suitable plant spacing for optimum growth and higher yield of Gimakalmi.
2. To determine the optimum schedule of harvest interval of Gimakalmi for attaining quality and maximum yield.
3. To measure the interaction effect of plant spacing and harvest interval for attaining desirable yield.

Chapter II

REVIEW OF LITERATURE

Gimakalmi is one of the important vegetables grown in Bangladesh as well as in many other countries of the world. The crop has received conventional less attention of the researchers on its various aspects because normally it grows with less care or management practices. For that a very few studies on growth, yield and development of Gimakalmi have been carried out in our country as well as in many other countries of the world. Hence, the research work so far done in Bangladesh is not adequate and conclusive. Nevertheless, some of the important works and researches related to the plant spacing and harvest interval so far done at home and abroad on different vegetable crops production including Gimakalmi have been reviewed in this chapter under the following headings.

2.1 Effect of plant spacing

Moore *et al.* (2004) conducted an experiment to study the effects of spacing on harvesting and yield of stem amaranth with 6, 9, 12 and 18 plants/5 m or row. In these experiments the yield increased upto a certain level and then decreased. With highest spacing per plant yield increased upto a certain level but the total per hectare decreased.

A field experiment was conducted to determine the effect of crop densities (10, 20 and 40 plants m^{-1}) of amaranth by Abbasdokht *et al.* (2003) in Iran. Yield and yield contributing characters were statistically significant in different density. The density with 40 plants m^{-1} gave the minimum yield, whereas 10 plants m^{-1} gave the highest single plant yield but lowest yield was found when yield in hectare was considered.

Field trials were conducted in South Florida, United States, between 1996 and 1999 by Santos *et al.* (2003) to determine the extent of yield reduction due to population densities of stem amaranth. They recorded that yield reductions reached 24% with densities higher than

8 plants/6 m row planting. Missinga and Currie (2002) conducted an experiment to assess the impact of plant densities of amaranth on yield and yield contributing characters and reported that spacing didn't affect the individual plant yield but the yield per hectare was greatly influenced due to plant spacing.

A field experiment was conducted by Bali *et al*., (2000) in Jammu and Kashmir, India, during the rabi seasons of 1995-1996 and 1996-1997, to study the effect of planting density and different N and P fertilizer rates on cabbage cultivar KS 101. Plants were sown at 25, 33 and 50 plants per square m, and at 40 × 10, 30 × 10 and 20 × 10, respectively. N was applied at 30, 60 and 90 kg/ha, while P was applied @ 30, 45 and 60 kg/ha. Seed yield was highest at 33 plants per square m and at 30 × 10 cm spacing. Seed yield increased with increasing N rates up to 60 kg/ha, and also increased with increasing P rates. N at 60 kg/ha gave the highest returns and cost benefit ratio.

Das and Ghosh (1999) conducted an experiment from March to August 1999 in Salna, Gazipur, Bangladesh to evaluate the seed yield potential of 3 amaranthus cultivars (Drutaraj, Bashpata and Sureshsari) grown under 5 different spacing levels (30 × 10, 30 × 15, 30 × 20, 30 × 25 and 30 × 30 cm). Spacing had pronounced effect on the seed yield and yield contributing characters. Plants grown at the widest spacing of 30 × 30 cm produced the longest stem (95.25 cm), maximum seed yield per plant (24.24 g) and had germination percentage of 80.60%. However, plants grown at a spacing of 30 × 20 cm recorded the highest seed yield/ha (3.64 t/ha).

Jehangir *et al*. (1999) conducted an experiment to study the response of different varieties to row spacing was conducted on a silty clay-loam soil of Shalimar (Kashmir) during rabi, [winter] 1993-1994. cabbage Cv. KS-101 gave seed yield 8.4, 18.2 and 20.2% higher than KS-103, KS-102 and KOS-1, respectively. The row spacing of 30 × 10 cm recorded a significant increase of 11.9 and 19.2% in seed yield over 15 × 10 cm and 45 × 10 cm row spacing, respectively.

Gupta and Arvind (1995) carried our a field studies in 1990-1991 at Pantnagar, Naintal and noted that seed and oil yields of *B. campestris* were highest with spacing 30 × 15 cm and harvest index was highest with spacing at 40 × 10 cm. Gupta and Panda (1995) reported from field trial in winter 1989-1990 at Pantnagar, Uttar Pradesh that *B. campestris* (var. toria cv. PT 303) was line sown or broadcast at various spacings to give 160000-500000 plants/ha. Seed yield was higher with broadcasting than line sowing and was highest at a density of 220 000 plants/ha (30 x 15 cm spacing).

Bansal *et al.* (1995) reported from an experiment that closer inter row (40 cm) and intra row spacing (10 cm) significantly reduced the dry matter accumulation, number of functional leaves and hence yield/plant. An experiment was conducted by Quasem and Hossain (1995) to evaluate 16 germplasms of local stem amaranth in summer. Spacing was maintained at 30 × 15 cm. Plant height at last harvest was found to be the maximum in SAT 0034 (88.3 cm) and minimum in SAT 0062 (13.4 cm). The highest yield was recorded in SAT 0054 (54 t/ha) and lowest in SAT 0024 (15.5 t/ha).

Two field experiments were conducted by Norman and Shongwe (1993) on a sandy clay loam soil during the summer seasons of 1990-1991 and 1991-1992. Seeds were sown in for the 1st experiment with 4 spacings (60 × 45, 60 × 60, 90 × 45 and 90 × 60, cm) and in the second experiment with 5 spacings (45 × 45, 60 × 45, 60 × 60, 90 × 45, 90 × 60). These spacings recorded no significant improvement in shoot, leaf or stem quality.

Damrong and Krung (1994) conducted an experiment with Chinese cabbage 2 varieties, ASVEG no.1 and commercial cultivar Elephant brand which were planted under different spacing of 40×40, 40×30, 40×25, 30×30, 30×25 cm during July to September 1987 at

Kasetsart University Kamphaengsaen Nakhon Pathom. They found that closer spacing had more number of plants per unit area. Increasing of plant population did not produce better yield because the percent of non-heading plant was increased and consequently their mean head weight. The most suitable spacing between plant for growing Chinese cabbage variety ASVEG no.1 was 40 cm the commercial cultivar Elephant brand gave very low yield only 4-11 t/ha while ASVEG no.1 produced 26-28 t/ha.

Plant spacing is an important factor which affects the growth and yield of Gimakalmi. Park *et al.* (1993) conducted an experiment on plant spacing. From their findings it was clear that 30 cm × 30 cm was better than 15 cm × 15 cm or 45 cm × 45 cm in consideration of growth and yield of the crop.

Kler, *et al.* (1992) conducted a field trial at Ludhiana, Indian Punjab in 1988-1990, Chinese cabbage seedling were sown with 30 cm spacing between N-S rows, or with bidirectional sowing with 30 cm between N-S and E-W rows, or with 30 cm row spacing between N-S rows and 45 cm between E-W rows. Crops received 60, 90 or 120 kg N/ha. Seed yield was increased by cross-sowing and by increasing N rate from 60 to 90 kg/ha. Correlation coefficients between different yield components were calculated. Seed yield was positively correlated with plant height, days to maturity and harvest index. These parameters, and seed yield, were all positively correlated with light interception.

In an experiment conducted by Hill (1990) at Manjimup Research Station, Australia on a sandy loam over clay at 60 cm, Chinese cabbage cv. Early Jade Pagoda was grown at spacing of 25 × 25, 30 × 30, 35 × 35 or 40 × 40 cm with 0, 50, 100, 200, 300 or 400 kg N/ha. The highest marketable yields, 126.6 and 123.6 t/ha, were produced at the closest spacing, marketable yield for this spacing increased as N rate increased from 0 to 200 kg/ha, and remained constant from 200 to 300 kg/ha but decreased when the N rate was increased to 400 kg/ha. The yield potential of Chinese cabbage was higher at closer spacing than at the wider.

Vogel and Paschold (1989) conducted an experiment in Germany on Pak-choi (*Brassica chinesis* L.) in relation to different spacing and dates of planting. A crop density of 160,000 plants per hectare with a spacings of 25 cm × 25 cm gave the highest yields and high proportion of plant weighing 200-600 g.

Koay and Chua (1979) conducted an experiment to study the effect of appropriate planting method and density for economical production of Pak-choi (*Brassica chinensis* L.) in Singapore. The treatment compared were direct seeding, bare root transplanting or ball root transplanting in rows 30 cm apart with inter plant spacing of 10 cm, 20 cm, 30 cm. The highest yield (50 t/ha) was obtained from the transplanted plants at the closest spacing. Lee (1983) studied the effects of plant densities on some leafy vegetables including Pak-choi. Four plant densities viz. 10 cm × 10 cm, 15 cm × 15 cm, 20 cm × 20 cm and 30 cm × 30 cm were included in the study. The highest yield was obtained in 15 cm × 15 cm spacing but had no significant difference with 10 cm × 10 cm spacing.

Davey (1965) observed maximum head size in cabbage with a spacing of 25-40 cm in row. However, closer spacing resulted in higher yields per hectare with greater variability in head size. Somos (1954) reported that wider spacing resulted in better growth and rapid development than closer spacing.

2.2 Effect of harvest intervals

At the time of harvesting, two things are to be taken into consideration simultaneously i) good quality and ii) reasonable yield. In wider harvest interval, higher yield per harvest is obtained, but most of the foliage became fibrous and unfit for consumption. In kanghong, three to four harvests could be obtained from one plant (Tindal, 1983). In a trial after three weeks from first harvest, the ratoon of Gimakalmi became fit for harvesting, and by following this practice, maximum yield was obtained (Rashid, 1993).

From a study on adaptability and performance of kanghong (Ipomoea reptans), the maximum yield was obtained at the second harvest. Thereafter, the yield decreased. It was also observed that after 4th harvest, the yield declined abruptly and the foliage was no longer tender to be consumed as vegetable (Anon., 1982).

Singh and Chatterjee (1968) found increased yield at the lower frequency of cutting of 12 perennial grasses. When the frequency of cutting grasses was reduced from 8 to 4 weeks, the mean number of tillers and leaves and total dry matter yield were reduced to half and the leaf area to a quarter (Hill and Pearson, 1985). It was reported by Wolf *et al.* (1962) that the productivity of many grass species decreases with increasing clippling frequency. Beaty *et al.* (1965) mentioned that 5 weeks harvest frequency produced 46% more yield than two weeks harvest frequency.

Oakes (1966) found increased forage yield with increasing harvest interval although the protein content of forage crop decreased. Moline and Wedin (1963) found that reduced yield of alfalfa due to early first harvest was compensated for by the increased yield of dry matter of the second harvest. They found an increase in the crude with advanced maturity of alfalfa.

Rahman *et al.* (1985) conducted an experiment to see the effect of spacing and harvesting interval on the growth and yield of Indian spinach (Puisak) at the Central Research Station of BARI at Joydevpur. They reported that the highest number of shoots per plant was obtained from the quicker harvesting (8 days interval) and this was reflected as the highest yield (41.11 t/ha), while yield per hectare decreased with the increase of harvesting interval.

Rahman and Hossain (1985) studied the growth and yield of Indian spinach under trellis vs non-trellis when harvested at different intervals. First harvest of shoots was done after 35 days of sowing, and subsequent harvesting was done at intervals of 8, 12 and 16 days from first harvest. Harvesting at different intervals showed wide variation in the weight of shoot per plant. The highest shoot weight (0.95 kg/plant) from the quickest harvesting interval of 8 days contributed towards the highest yield (20.32 t/ha) and yield gradually decreased with the increase of harvesting interval.

An experiment was carried out at IPSA, Salna, Gazipur during Kharif season of 1986 to study the effect of four manuring doses (0, 10, 30 and 60 t/ha of cowdung) and harvest frequency (17, 21 and 25 days) on growth and yield of Gimakalmi. The total yield was highest (68.82 t/ha) at 25 days harvest frequency which was statistically similar to that (65.82 t/ha) produced by 17 days harvest frequency. Although 25 days harvest frequency produced the highest yield, most of the foliage became fibrous and unfit for consumption (Awal, 1989).

In Gimakalmi, first harvest should be done after 30 days of seed sowing and the subsequent harvest should be done at 15 days interval from first harvest for obtaining the good quality and maximum yield of Gimakalmi (Anon., 1983).

Chapter III

MATERIALS AND METHODS

The experiment was carried out in the Horticulture field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from May to August 2006 to find out the effect of plant spacing and harvest interval on the growth and yield of Gimakalmi. The materials and methods were used for conducting the experiment which presented in this chapter under the following headings-

3.1 Experimental site

The present experiment was carried out in the field of Sher-e-Bangla Agricultural University farm Sher-e-Bangla Nagar, Dhaka, Bangladesh. The location of the experimental site is $23^{0}74^{/}$N latitude and $90^{0}35^{/}$E longitude an elevation of 8.2 m from the sea level (Anon., 1989).

3.2 Characteristics of soil

The experimental site belongs to the Modhupur Tract (UNDP, 1988) under AEZ No. 28 and had dark grey terrace soil. The selected plot was medium high land and the soil series was Tejgaon (FAO, 1988). The characteristics of the soil under the experimental plot were analyzed in the Soil Testing Laboratory, SRDI Khamarbari, Dhaka. Details of the recorded soil characteristics were presented in Appendix I.

3.3 Weather condition of the experimental site

The experimental site was under the subtropical climate, characterized by three distinct seasons, the monsoon or the rainy season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al.*, 1979). Details of the meteorological data related to the temperature, relative humidity and rainfall during the period of the experiment was collected from the Bangladesh Meteorological Department, Dhaka and presented in Appendix II.

3.4 Planting materials

In this research work, Gima Kalmi seed was used as the planting material. The seed of Gima Kalmi were collected from Siddique Bazar, Gulistan, Dhaka. Seeds were used @ 1235 g/ha.

3.5 Treatment of the experiment

The experiment had of two factors. Details were presented below:

Factor A: Four levels of plant spacing

i. $S_1 = 30$ cm × 5 cm
ii. $S_2 = 30$ cm × 10 cm
iii. $S_3 = 30$ cm × 15 cm
iv. $S_4 = 30$ cm × 20 cm

Factor A: Three levels of harvesting interval

i. H_1 = Harvesting at 10 days interval
ii. H_2 = Harvesting at 15 days interval
iii. H_3 = Harvesting at 20 days interval

There were 12 (4 × 3) treatment combinations such as S_1H_1, S_1H_2, S_1H_3, S_2H_1, S_2H_2, S_2H_3, S_3H_1, S_3H_2, S_2H_3, S_4H_1, S_4H_2 and S_4H_3.

3.6 Design and layout of the experiment

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. An area 21.9 m × 8.0 m was divided into three equal blocks. The layout of the experiment was prepared for distributing the treatment combinations in every individual plot of each block. Each block was divided into 12 plots where 12 treatment combinations were allotted at random. There were 36 unit plots altogether in the experiment. The size of the each plot was 1.5 m × 1.0 m. The distance maintained between two blocks and two plots were 0.75 m and 0.5 m respectively. The layout of the experiment is shown in Figure 1.

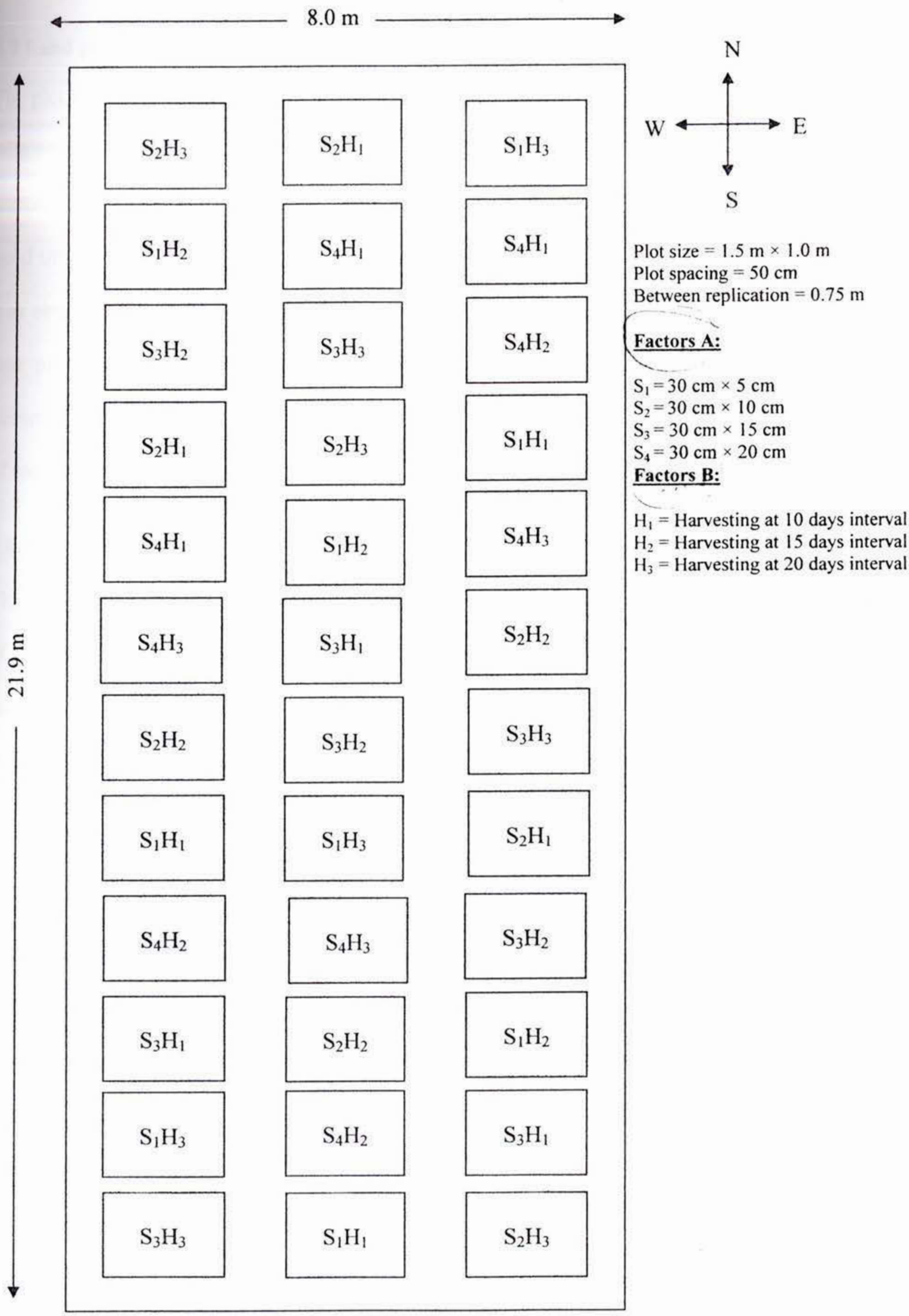

Figure 1. Layout of the experimental plot

3.7 Land preparation

The plot selected for conducting the experiment was opened in the first week of May 2006 with a power tiller, and was kept exposed to the sun for a week, after one week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth condition. Weeds and stubbles were removed, and finally a desirable tilth of soil was obtained for sowing seeds of Gimakalmi. The experimental plot was partitioned into unit plots in accordance with the experimental design. Recommended doses of well-decomposed cowdung and chemical fertilizers as indicated below were mixed with the soil of each unit plot.

3.8 Application of manure and fertilizers

The fertilizers of N and K_2O as urea and MP were applied, respectively. The entire amounts of MP were applied during the final preparation of land. Urea was applied in three equal installments at 15, 30 and 45 days after seed sowing of Gimakalmi. Well-rotten cowdung 10 t/ha also applied during final land preparation. The following amount of manure and fertilizers were used as shown in Table 1 (Rashid, 1993).

Table 1. Dose and method of application of fertilizers in Gimakalmi field

Fertilizers	Dose/ha	Application (%)			
		Basal	15 DAT	30 DAT	45 DAT
Cowdung	10 tons	100	--	--	--
Nitrogen (as urea)	200 kg	--	33.33	33.33	33.33
P_2O_5 (as TSP)	100 kg	100	--	--	--
K_2O (as MP)	80 kg	100	--	--	--

3.9 Intercultural operation

After emergence of seedlings, various intercultural operations like irrigation, thinning, weeding, top dressing etc were accomplished for better growth and development of the Gimakalmi seedlings.

3.9.1 Irrigation and drainage

Over-head irrigation was provided with a watering can to the plots once immediately after germination in every alternate day in the evening. Further irrigation was provided as and when needed. Stagnant water was drained out at the time of heavy rain.

3.9.2 Weeding

Weeding was done to keep the plots free from weeds and for better aeration of soil, which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully after complete emergence of seedling of Gimakalmi. Breaking the crust of the soil was done when needed.

3.9.3 Top dressing

After basal dose, the remaining doses of urea were top-dressed in 3 equal installments at 15, 25 and 35 DAS. The fertilizers were applied on both sides of plant rows and mixed well with the soil. Eathing up operation was done immediately after top-dressing with nitrogen fertilizer.

3.10 Plant protection

For controlling leaf caterpillars Nogos @ 1 ml/L water were applied 2 times at an interval of 10 days starting soon after the appearance of infestation. There was no appreciable attack of disease.

3.11 Harvesting

The first harvest was done from all plots at 30 days of sowing of Gimakalmi seeds. The border plants were not included in harvest. The plants were cut at a height of 2 cm from the ground level and data were recorded on several characters. The crop was allowed to grow and the subsequent harvests were done at three intervals i.e. after 10, 15 and 20 days of the first harvest. Thus upto 90 DAS harvested were done according to the treatment of harvest interval. For 10 days interval harvesting was done 30, 40, 50, 60, 70, 80 and 90 DAS. For 15 days interval harvesting was done at 30, 45, 60, 75 and 90 DAS and for 20 days interval harvesting was done at 30, 50, 70 and 90 DAS. Details were presented in Appendix III to XII.

3.12 Data collection

Data were recorded on the following parameters from the sample plants during the course of experiment. Ten plants were randomly selected from each unit plot for the collection of data according to the harvesting interval. The whole plot crop was harvested to record per plot data. The average value for each recorded character was estimated by adding different harvested data and dividing the total number of harvesting period. The plants in the outer rows and the extreme end of the middle rows were excluded from the random selection to avoid the border effect.

3.12.1 Plant height (cm)

Plant height was measured in centimetre (cm) from the ground level to the tip of the plant at each harvest and the average was calculated from 10 sample plants.

3.12.2 Number of branches per plant

The total number of branches was counted from the randomly selected plants and their average was calculated as the umber of branches per plant.

3.12.3 Number of leaves per plant

The total number of leaf was counted from the sampled plants and their average was calculated as the number of leaves per plant.

3.12.4 Fresh weight of leaves per plant (g)

Leaves from sampled selected plants were separated and weighed. The average was calculated to get the weight of per plant in gram (g)

3.12.5 Fresh weight of stems per plant (g)

Stem from sampled selected plants were separated and weighed. The average was calculated to get the weight of stem per plant in gram (g)

3.12.6 Fresh weight of plant

Fresh weight from ten randomly selected plants were separated and weighed. The average was calculated to get the weight of individual plant and was expressed in gram (g)

3.12.7 Dry matter content of plant

Fresh foliage of the randomly selected plants was dried in the sun followed by drying in an electrical oven at 72^0 C for 48 hrs. The dry matter contents of plants were computed by according to the following formula

$$\% \text{ Dry matter of leaves} = \frac{\text{Dry weight of plant}}{\text{Fresh weight of plant}} \times 100 \quad (\text{g})$$

3.12.8 Foliage coverage

Foliage coverage was estimated by eye estimation at the time of harvesting and expressed in percentage.

3.12.9 Yield per plot

Foliage yield per plot was recorded by harvesting all plants in each plot and taking their weight by a simple balance and the weight was recoded in kilogram (kg.)

3.12.10 Yield per hectare

Per plot yield was converted into yield per hectare and it was expressed in metric ton (t) per hectare.

3.13 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the difference for plant spacing and harvesting interval on yield and yield contributing characters of Gimakalmi. The mean values of all the recorded characters were evaluated and analysis of variance was performed by 'F' (variance ratio) test. The significance of the difference among the treatment of means was estimated by Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

Chapter IV

RESULTS AND DISCUSSION

The present experiment was conducted to determine the effect of plant spacing and harvest interval on growth and yield of Gimakalmi. Data on different yield contributing characters and yield were recorded to find out the optimum plant spacing and harvesting interval. For different harvesting interval data were recorded. At 10 days interval harvesting was done at 30, 40, 50, 60, 70, 80 and 90 DAS. For 15 days interval harvesting was done at 30, 45, 60, 75 and 90 DAS and for 20 days interval harvesting was done at 30, 50, 70 and 90 DAS (Appendix III to XII). The average value for each recorded character was estimated by adding different harvested data by dividing the total number of harvesting period. The analysis of variance (ANOVA) of the data on different yield components and yield are given in Appendix XIII-XV. The results have been presented and discussed, and possible interpretations are given under the following headings-

4.1 Plant height

Plant height recorded from the average of different harvesting interval varied significantly due to plant spacings and harvest intervals that were used in this experiment (Appendix XIII). Plant spacing S_3 (30 cm × 15 cm) gave the longest (32.43 cm) plant and the shortest (28.17 cm) plant was recorded from S_1 (30 cm × 5 cm) which was statistically similar (29.22 cm) with S_4 (Figure 2). These results indicated that both wider and closer spacings reduced plant height of Gimakalmi. The variations in plant height among the spacing treatments were prominent. Similar result was also reported by Rai (1981). Plants grown with widest spacing received higher amount of light, nutrient and water and the reverse happened to plants grown with closest spacing. This finding coincided with that of Bruemmer and Roe (1979), Rashid *et al.* (1981), Anon., (1982) and Islam *et al.* (1984).

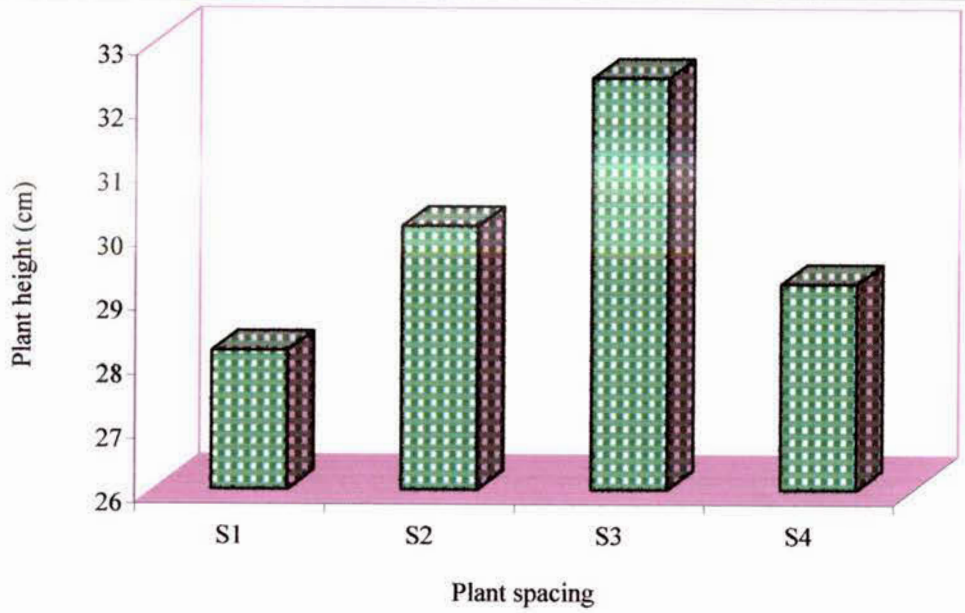

Figure 2. Effect of plant spacing on plant height of Gimakalmi

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

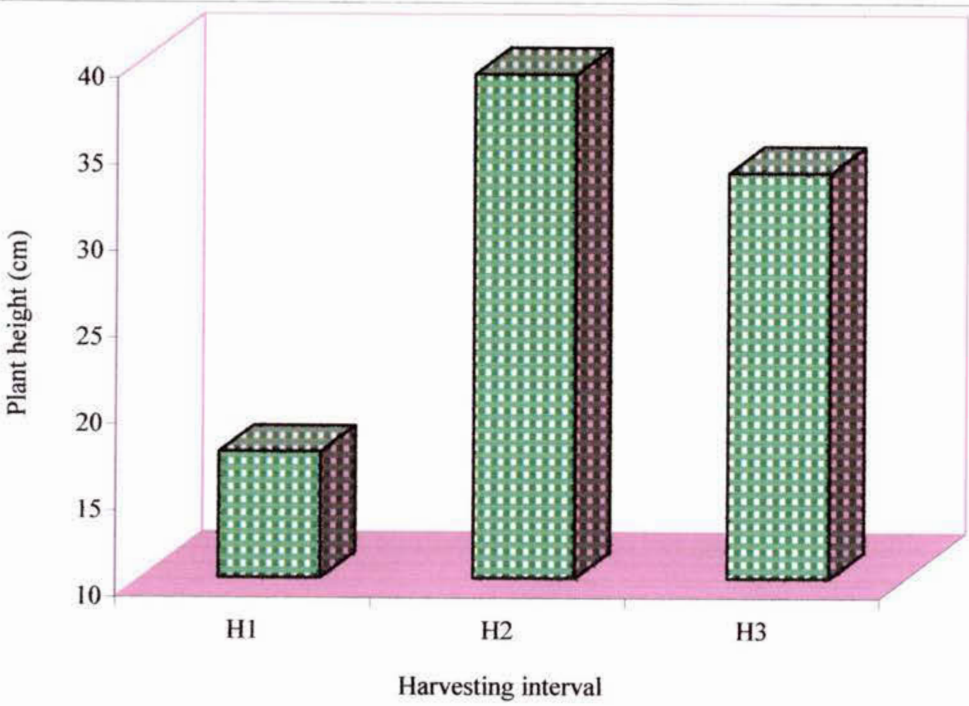

Figure 3. Effect of harvesting interval on plant height of Gimakalmi

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Different harvesting time showed different plant heights under the present trial. Harvesting time at 15 days interval (H_2) gave the longest (39.17 cm) plant which was closely (33.48 cm) followed by H_3 at 20 days harvesting interval and the shortest (17.31 cm) plant was recorded from H_1 at 10 days harvesting interval (Figure 3). This finding was in agreement with the report of Sehunphan and Postel (1958), Wiggans *et al.* (1963), Purushothman (1978), Rashid *et al.* (1985) and Hossain (1990) in leafy vegetable.

The variation was found due to the combined effect of plant spacing and harvesting interval on plant height (Appendix XIII). The longest (42.15 cm) plant was recorded from S_3H_2 (30 cm × 15 cm plant spacing and harvesting at 15 days interval). On the other hand the lowest (16.03 cm) plant was recorded from S_1H_1 (30 cm × 5 cm plant spacing and harvesting at 10 days interval) treatment (Figure 4). All the spacing treatments gave the lowest plant height at the subsequent harvests at 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and development, and attained the maximum height at 20 days interval but the average was highest for 15 days interval harvesting.

4.2 Number of branches per plant

Different harvesting interval varied significantly due to the plant spacings and harvest intervals used in this experiment for number of branches per plant (Appendix XIII). The maximum (5.88) number of branches per plant was recorded from S_3 which was statistically identical (5.57 and 5.51) with S_4 and S_2 and the minimum (5.20) was recorded from S_1 (Table 2). In each harvest, maximum number of branches per plant was recorded at widest spacing, while the minimum was recorded from closest spacing. Plants grown with widest spacing received higher amount of light, nutrient and water enhancing more number of branches per plant and the reverse happened to plants grown with closest. This finding coincided with that of Verma *et al.* (1969), Islam *et al.* (1984) and Hamid *et al.* (1986).

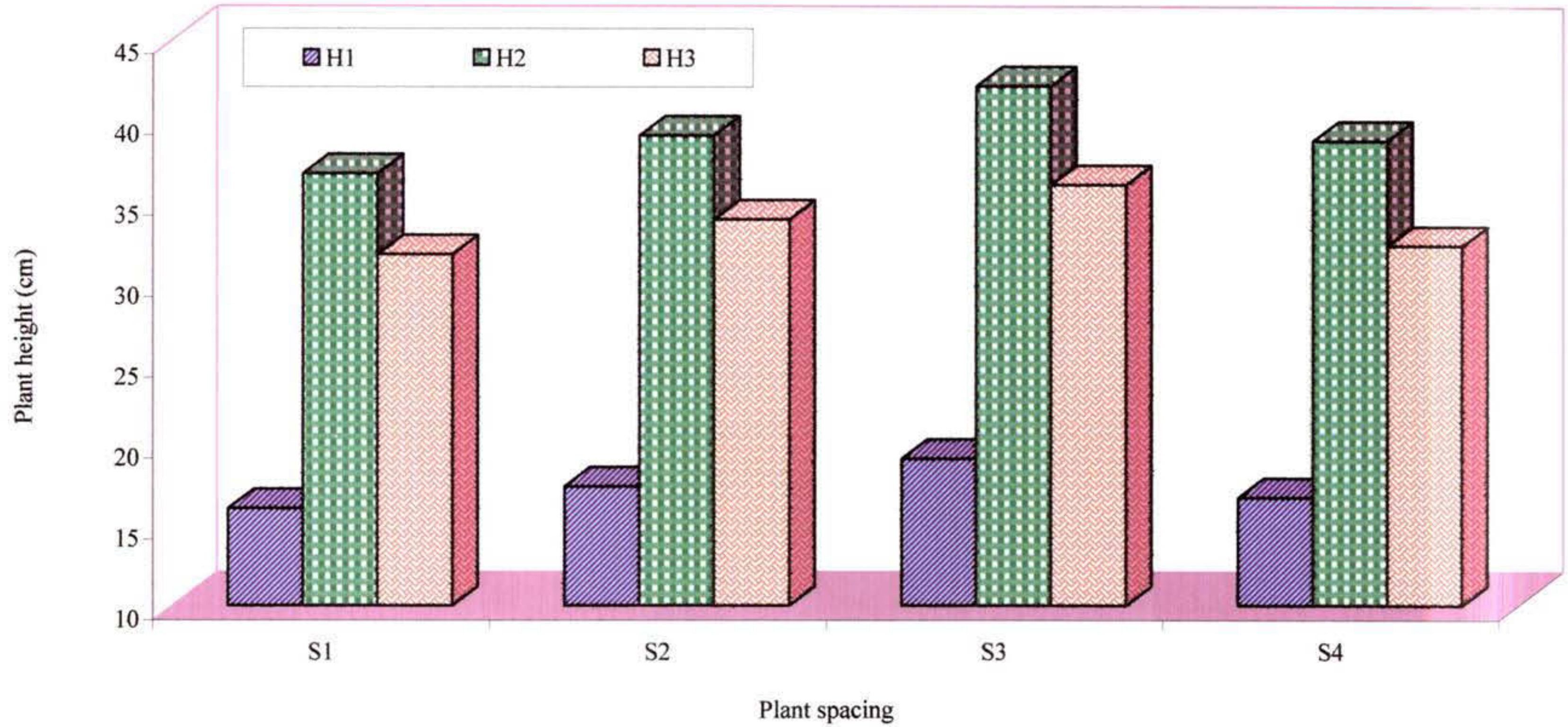

Figure 4. Interaction effect of plant spacing and harvesting interval on plant height of Gimakalmi

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Table 2. Main effect of plant spacing and harvest interval on number of branches and leaves per plant of Gimakalmi

Treatment	Number of branches per plant	Number of leaves per plant
Plant Spacing		
S_1	5.20 b	33.85 c
S_2	5.51 ab	36.12 b
S_3	5.88 a	38.83 a
S_4	5.57 ab	35.27 bc
Harvest Interval		
H_1	5.30 b	34.21 b
H_2	5.69 a	38.67 a
H_3	5.63 a	35.18 b
CV(%)	6.73	10.75

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Number of branches per plant under the present trial showed significant differences on different harvesting time. The maximum (5.69) number of branches per plant was recorded from H_2 which was statistically similar (5.63) with H_3, while the minimum (5.30) number of branches per plant was obtained from H_1 (Table 2). Number of branches per plant gradually increased with the increase of interval time and the highest number of branches per plant was produced at 15 days interval. This finding coincided with that of Westgate *et al.* (1958), More (1965) and Awal (1989). At 10 days interval, plants did not get enough time for their growth and development, and thus remained small with less number of branches during harvest. On the contrary, plants of 20 days interval got enough time for their growth and were found to produce the highest number of branches per plant.

The variation was recorded from the combined effect of plant spacing and harvesting interval for number of branches per plant (Appendix XIII). The maximum (6.17) number of branches per plant was recorded from S_3H_2. On the other hand the minimum (5.11) number of branches per plant was recorded from S_1H_1 (Table 3). All the spacing treatments revealed the lowest number of branches per plant at the subsequent harvests at 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and development, and produced the maximum number of branches per plant at 20 days interval but the average was highest for 15 days interval harvesting period.

4.3 Number of leaves per plant

Number of leaves per plant that was recorded from the average of different harvesting interval due to plant spacings and harvest intervals used in this experiment (Appendix XIII). Plant spacing S_3 gave the maximum (38.83) number of leaves per plant and the minimum (33.85) number of leaves per plant was recorded from S_1 which was statistically identical (35.27) with S_4 (Table 2).

Table 3. Interaction effect of plant spacing and harvest interval on number of branches and leaves per plant of Gimakalmi

Treatment		Number of branches per plant	Number of leaves per plant
S_1	H_1	5.11 c	32.25 e
	H_2	5.32 bc	36.08 bcde
	H_3	5.16 c	33.23 de
S_2	H_1	5.36 bc	34.59 cde
	H_2	5.69 abc	38.66 b
	H_3	5.47 abc	35.12 bcde
S_3	H_1	5.52 abc	37.03 bcd
	H_2	6.17 a	42.24 a
	H_3	5.96 ab	37.22 ab
S_4	H_1	5.19 c	32.97 e
	H_2	5.58 abc	37.70 bc
	H_3	5.93 ab	35.14 bcde
CV(%)		6.73	10.75

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Similar trends of result were also obtained by Smith and Salaman (1947), Chowdhury *et al.* (1974), Bhore and Patil (1978), Anon, (1984), Miah (1987) Zaman and Rahman (1988) and Etman (1993). Plants grown with wider spacing received higher amount of light, nutrient, water thus attaining more height along with more number of leaves per plant and the reverse happened to plants grown with closer spacing.

Number of leaves per plant under the present trial showed variation for different harvesting time. Harvesting time H_2 gave the maximum (38.67) number of leaves per plant. On the other hand, the minimum (34.21) number of leaves per plant was recorded from H_1 which was statistically similar (35.18) with H_3 (Table 2). The minimum number of leaves per plant was produced at 10 days interval. Number of leaves per plant gradually increased with the increase of interval time and the highest number of leaves per plant was produced at 15 days interval. At 10 days interval, plants did not get enough time for their growth and development, and thus remained short with less branches and leaves during harvest. On the contrary, plants of 15 days interval got enough time for their growth and development and were found to be tallest with maximum branches and leaves per plant. although 20 days interval the plants got more time but did not show the maximum number of leaves per plant.

The variation was found due to the combined effect of plant spacing and harvesting interval on number of leaves per plant (Appendix XIII). The maximum (42.24) number of leaves per plant was found from S_3H_2. On the other hand the minimum (32.25) number of leaves per plant was recorded from S_1H_1 (Table 3). All the spacing treatments revealed the lowest number of leaves per plant at the subsequent harvests of 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and development, and produced the maximum number of leaves per plant at 15 days interval.

4.4 Fresh weight of leaves per plant

Fresh weight of leaves per plant that was recorded from the average of different harvesting interval varied significantly due to plant spacings and harvest intervals used in this experiment (Appendix XIV). Plant spacing S_3 gave the maximum (36.70 g) fresh weight of leaves per plant which was closely (34.62 g) followed by S_4 and the minimum (31.36 g) fresh weight of leaves per plant was recorded from S_1 (Table 4). The variations in fresh weight of leaves per plant among the spacing treatments were prominent. Similar result was also reported by Rai (1981).

Different harvesting time showed different fresh weight of leaves per plant under the present trial. Harvesting time H_2 gave maximum (39.03 g) fresh weight of leaves per plant. On the other hand the minimum (28.32 g) fresh weight of leaves per plant was recorded from H_1 (Table 4).

The variation was found due to the combined effect of plant spacing and harvesting interval for of fresh weight of leaves per plant (Appendix XIV). The maximum (41.87 g) fresh weight of leaves per plant was recorded from S_3H_2. On the other hand, the minimum (24.87 g) fresh weight of leaves per plant was obtained from S_1H_1 (Table 5). All the spacing treatments gave the minimum fresh weight of leaves per plant at the subsequent harvests at 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and development, and produced the maximum fresh weight of leaves per plant 15 days interval harvesting period.

4.5 Fresh weight of stem per plant

Fresh weight of stem per plant that was recorded from the average of different harvesting interval varied significantly due to plant spacings and harvest intervals used in this experiment (Appendix XIV). The maximum (23.08 g) fresh weight of stem per plant

Table 4. Main effect of plant spacing and harvest interval on fresh weight of leaves and stem per plant and dry matter content of Gimakalmi

Treatment	Fresh weight of leaves per plant (g)	Fresh weight of stem per plant (g)	Dry matter content (%)
Plant Spacing			
S_1	31.36 c	18.90 c	10.82 c
S_2	34.53 b	21.11 b	12.44 b
S_3	36.70 a	23.08 a	14.56 a
S_4	34.62 b	20.67 bc	13.02 b
Harvest Interval			
H_1	28.32 c	17.70 c	12.02 b
H_2	39.03 a	24.09 a	13.43 a
H_3	35.56 b	21.03 b	12.68 ab
CV(%)	9.75	8.88	7.19

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Table 5. Interaction effect of plant spacing and harvest interval on fresh weight of leaves and stem per plant and dry matter content of Gimakalmi

Treatment		Fresh weight of leaves per plant (g)	Fresh weight of stem per plant (g)	Dry matter content (%)
S_1	H_1	24.87 f	15.45 e	10.01 f
	H_2	36.09 bc	21.48 bc	11.49 def
	H_3	33.12 cd	19.77 cd	10.97 ef
S_2	H_1	28.50 e	17.63 de	11.96 cde
	H_2	38.88 ab	24.06 ab	12.78 bcd
	H_3	36.20 bc	21.65 bc	12.58 bcde
S_3	H_1	31.22 de	19.76 cd	13.61 bc
	H_2	41.87 a	26.85 a	15.89 a
	H_3	37.01 b	22.63 bc	14.18 b
S_4	H_1	28.69 e	17.97 de	12.52 bcde
	H_2	39.27 ab	23.96 ab	13.56 bc
	H_3	35.89 bc	20.07 cd	12.99 bcd
CV(%)		9.75	8.88	7.19

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

was recorded from S_3 and the minimum (18.90 g) fresh weight of stem per plant was recorded from S_1 which was statistically identical (20.67 g) with S_4 (Table 4). Every increase in spacing significantly increased the fresh weight of stem which was also observed by Beaty *et al.* (1965), Islam *et al.* (1984), Rahman *et al.* (1985) and Hamid *et al.* (1986) and Dhillon *et al.* (1987)

Different harvesting time showed different fresh weight of stem per plant under the present experiment. Harvesting time H_2 gave the maximum (24.09 g) fresh weight of stem per plant. On the other hand, the minimum (17.70 g) fresh weight of stem per plant was recorded from H_1 (Table 4). This finding was in conformity with that of Anon, (1980), Hamid *et al.* (1986) and Awal (1989). Among the harvest intervals, 15 days interval gave the highest fresh weight of stem per plant.

The variation was found due to the combined effect of plant spacing and harvesting interval for fresh weight of stem per plant (Appendix XIV). The maximum (26.85 g) fresh weight of stem per plant was recorded from S_3H_2. On the other hand, the minimum (15.45 g) fresh weight of stem per plant was recorded from S_1H_1 (Table 5). All the spacing treatments revealed the lowest fresh weight of stem per plant at the subsequent harvests at 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and development, and produced the maximum fresh weight of stem per plant at 15 days interval.

4.6 Fresh weight of plant

Fresh weight of plant that was recorded from the average of different harvesting interval varied significantly due to plant spacings and harvest intervals used in this experiment (Appendix XIV). Plant spacing S_3 gave the maximum (59.78 g) fresh weight of plant which was closely (55.64 g and 55.28 g) followed by S_2 and S_4, respectively and the minimum

(50.26 g) fresh weight of plant was recorded from S_1 (Figure 5). Similar result was also reported by Rai (1981), Hossain (1980). Plants grown with widest spacing received higher amount of light, nutrient and water and the reverse happened to plants grown with closest spacing. This finding coincided with that of Anon., (1982) and Islam *et al.* (1984).

Different harvesting time showed different fresh weight of plant under the present trial. Harvesting time H_2 gave maximum (63.12 g) fresh weight of plant which was closely (56.58 g) followed by H_3. On the other hand, the minimum (46.02 g) fresh weight of plant was recorded from H_1 (Figure 6).

The variation was found due to the combined effect of plant spacing and harvesting interval for fresh weight of plant (Appendix XIV). The maximum (68.72 g) fresh weight of plant was recorded from S_3H_2, while the minimum (40.32 g) fresh weight of plant was recorded from S_1H_1 (Figure 7). All the spacing treatments revealed the lowest fresh weight of plant at the subsequent harvests of 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and produced maximum fresh weight of plant at 15 days interval.

4.7 Dry matter content of plant

Dry matter content of plant that was recorded from the average of different harvesting interval varied significantly due to plant spacings and harvest intervals used in this experiment (Appendix XIV). The maximum (14.56%) dry matter content was recorded from S_3 and the minimum (10.82%) dry matter content was found from S_1 (Table 4). Similar trends of result were also reported by Rai (1981). Plants grown with widest spacing received higher amount of light nutrient and water and the reverse happened to plants grown with closest spacing. This finding coincided with Anon. (1982) and Islam *et al.* (1984), Aditya *et al.* (1995).

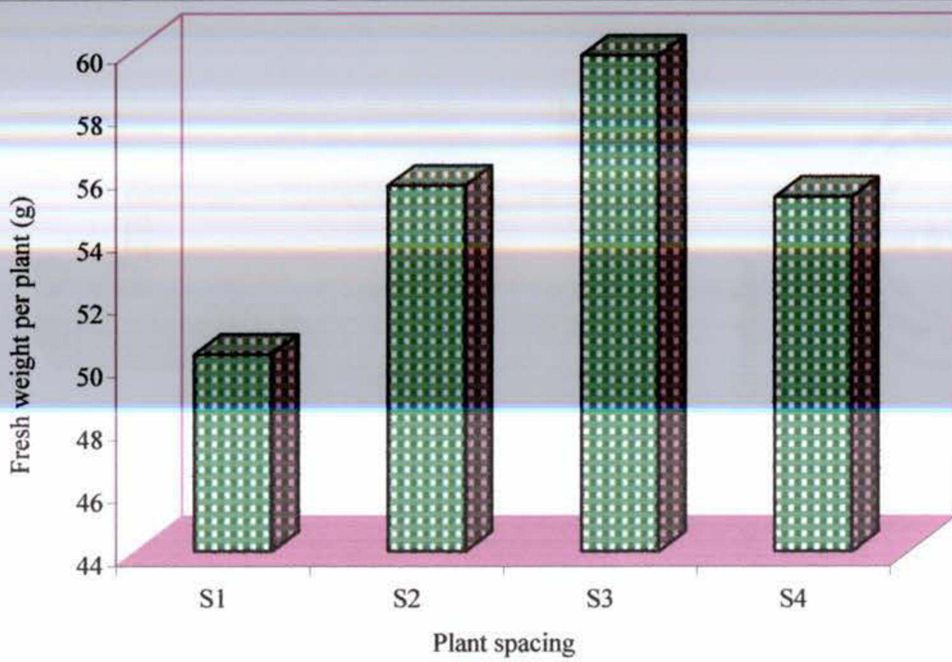

Figure 5. Effect of plant spacing on fresh weight per plant of Gimakalmi

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

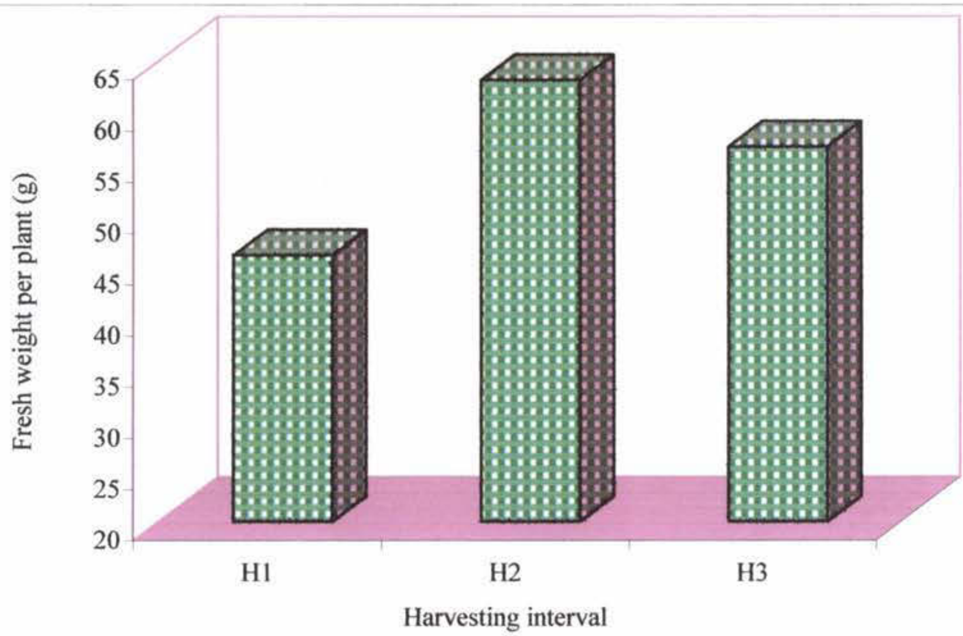

Figure 6. Effect of harvesting interval on fresh weight per plant of Gimakalmi

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

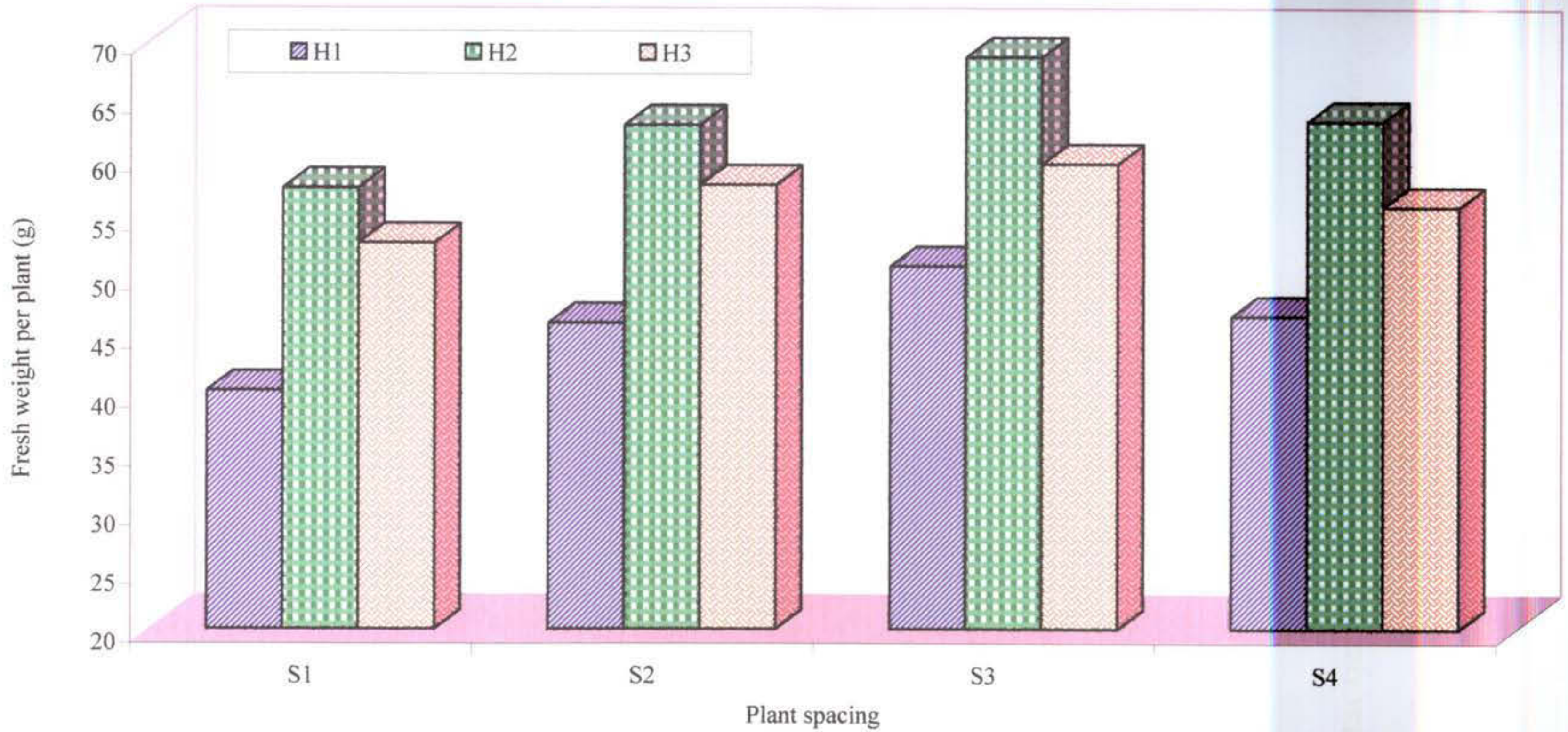

Figure 7. Interaction effect of plant spacing and harvesting interval on fresh weight per plant of **Gimakalmi**

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Different harvesting time showed variation in dry matter content under the present trial. Harvesting time H_2 gave the maximum (13.43%) dry matter content which was statistically identical (12.68%) with H_3. On the other hand the minimum (12.02%) dry matter content was recorded from H_1 (Table 4). This finding was in agreement with the report of Purushothaman (1978) who conducted experiment with leafy vegetable.

The variation was recorded due to the combined effect of plant spacing and harvesting interval for dry matter content (Appendix XIV). The maximum (15.89%) dry matter content was recorded from S_3H_2, while the minimum (10.01%) dry matter content was recorded from S_1H_1 (Table 5). All the spacing treatments revealed the lowest dry matter content at the subsequent harvests of 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and development, and attained maximum dry matter content at 20 days interval but the average was highest for 15 days interval harvesting period.

4.8 Foliage coverage

Foliage coverage by plant that was recorded from the average of different harvesting interval varied significantly due to plant spacings and harvest intervals used in this experiment (Appendix XV). The highest (83.62%) foliage coverage was recorded from S_3 and the lowest (76.12%) foliage coverage was recorded from S_2 which was similar with S_1 and S_4.

Different harvesting time showed different foliage coverage under the present experiment. Harvesting time H_2 gave the highest (81.50%) foliage coverage which was statistically similar (79.69%) with H_3. On the other hand the lowest (73.93%) foliage coverage was recorded from H_1 (Table 6). This finding was in agreement with the report of Purushothaman (1978) who conducted trial with leafy vegetable.

Table 6. Main effect of plant spacing and harvest interval on foliage coverage and yield per plot of Gimakalmi

Treatment	Foliage coverage (%)	Yield (kg/plot)
Plant Spacing		
S_1	76.40 b	8.16 c
S_2	76.12 b	9.08 b
S_3	83.62 a	10.05 a
S_4	77.35 b	9.25 b
Harvest Interval		
H_1	73.93 b	8.93 b
H_2	81.50 a	9.57 a
H_3	79.69 a	8.91 b
CV(%)	11.93	6.10

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

The variation was found due to the combined effect of plant spacing and harvesting interval for of foliage coverage (Appendix XV). The highest (88.00%) foliage coverage was recorded from S_3H_2 which was identical with S_3H_3. On the other hand, the lowest (70.71%) foliage coverage was obtained from S_1H_1 (Table 7). All the spacing treatments revealed the lowest foliage coverage at the subsequent harvests of 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and development, and attained maximum foliage coverage at 20 days interval but the average was highest for 15 days interval harvesting period.

4.9 Yield per plot

Yield per plot that was recorded from the average of different harvesting interval varied significantly due to plant spacings and harvest intervals used in this experiment (Appendix XV). The highest (10.05 kg/plot) yield was observed from S_3 and the lowest (8.16 kg/plot) yield was recorded from S_1 (Table 6). This finding was supported by Rodionova (1989), Salunkhe *et al.* (1980), Goh and Vityakon (1983).

Different harvesting time showed different yield per plot. Harvesting time H_2 gave the highest (9.57 kg/plot) yield, while the lowest (8.91 kg/plot) was recorded from H_3 which was statistically identical (8.93 kg/plot) with H_1 (Table 6). Among three harvest intervals, 15 days interval gave the highest yield per plot. Although maximum harvests were done in case of 10 days interval, but total yield per plot was minimum. This was due to the fact that plants did not get sufficient time for more vegetative growth and that was why 10 days interval gave fewer yields per plot. In case of 20 days interval, although plants got maximum time for vegetative growth and each harvest gave maximum yield per plot, but the total yield was not maximum, because minimum harvests were done in this interval.

Table 7. Interaction effect of plant spacing and harvest interval on foliage coverage and yield per plot of Gimakalmi

Treatment		Foliage coverage (%)	Yield (kg/plot)
S_1	H_1	70.71 e	7.65 f
	H_2	81.00 bc	8.53 def
	H_3	77.50 cde	8.29 ef
S_2	H_1	72.86 de	8.71 cde
	H_2	78.00 bcde	9.52 bcd
	H_3	77.50 cde	9.02 cde
S_3	H_1	77.86 bcde	10.09 ab
	H_2	88.00 a	10.55 a
	H_3	85.00 ab	9.51 bcd
S_4	H_1	74.29 cde	9.25 bcde
	H_2	79.00 bcd	9.67 abc
	H_3	78.75 bcd	8.83 cde
CV(%)		11.93	6.10

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

The variation was found due to combined effect of plant spacing and harvesting interval for of yield per plot (Appendix XV). The highest (10.55 kg/plot) yield was recorded from S_3H_2. On the other hand, the lowest (7.65 kg/plot) yield was recorded from S_1H_1 (Table 7). All the spacing treatments revealed the lowest yield per plot at the subsequent harvests at 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and development, and produced maximum yield per plot at 15 days interval.

4.10 Yield per hectare

Yield per hectare that was recorded from the average of different harvesting interval varied significantly due to the different plant spacing and harvest interval used in this experiment (Appendix XV). The highest (67.00 t/ha) yield was recorded from S_3 which was closely (61.67 t/ha and 60.56 t/ha) followed by S_4 and S_2, respectively and the lowest (54.38 t/ha) yield was recorded from S_1 (Figure 8).

Different harvesting time showed different yield per hectare under the present trial. Harvesting time H_2 gave the highest (63.78 t/ha) yield. On the other hand the lowest (59.42 t/ha) yield was recorded from H_3 which was statistically similar (59.50 t/ha) with H_1 (Figure 9). This finding was supported by Oakes (1966), Cervato (1969). Among three harvest intervals, 15 days interval gave the highest total yield per hectare. This finding was supported by Anonymous (1983). Although maximum harvests were done in case of 10 days interval, but total yield per plot was minimum. This was due to the fact that plants did not get sufficient time for more vegetative growth and that was why 10 days interval gave fewer yields per hectare. In case of 20 days harvest interval, although plants got maximum time for vegetative growth and each harvest gave maximum yield per hectare, but the total yield was not maximum because of the least harvests done in this interval.

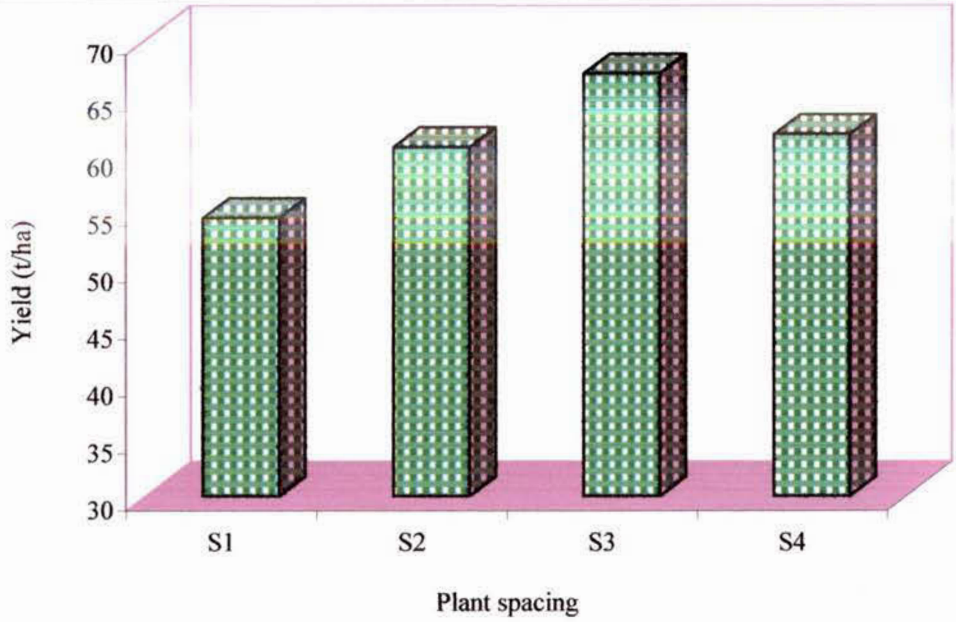

Figure 8. Effect of plant spacing on yield per hectare of Gimakalmi

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

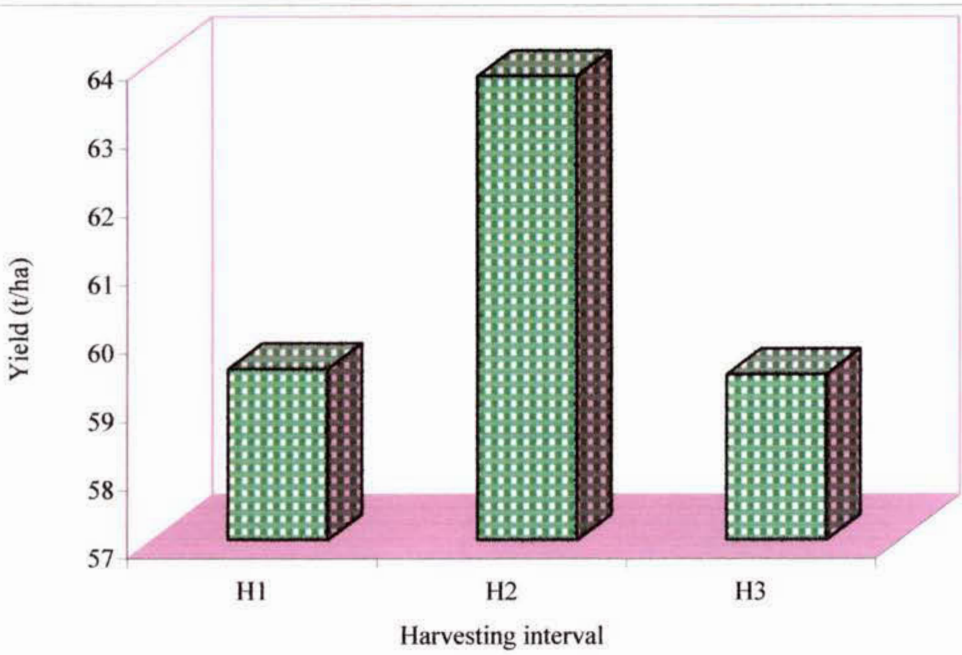

Figure 9. Effect of harvesting interval on yield per hectare of Gimakalmi

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Similar result was also stated by Rahman and Awal (1989). After first harvest, 2nd harvest gave the maximum yield per hectare at each harvest interval and then the total yield per hectare gradually decreased which was also stated by Anonymous (1982).

The variation was found due to the combined effect of plant spacing and harvesting interval for of yield per hectare (Appendix XV). The highest (70.36 t/ha) yield was recorded from S_3H_2. On the other hand, the lowest (50.99 t/ha) yield was recorded from S_1H_1 (Figure 10). All the spacing treatments revealed the lowest yield per hectare at the subsequent harvests of 10 days interval. With the increase of harvest interval, plants obtained longer time for their growth and development, and attained the maximum yield per hectare at 20 days interval but the average was highest for 15 days interval harvesting period.

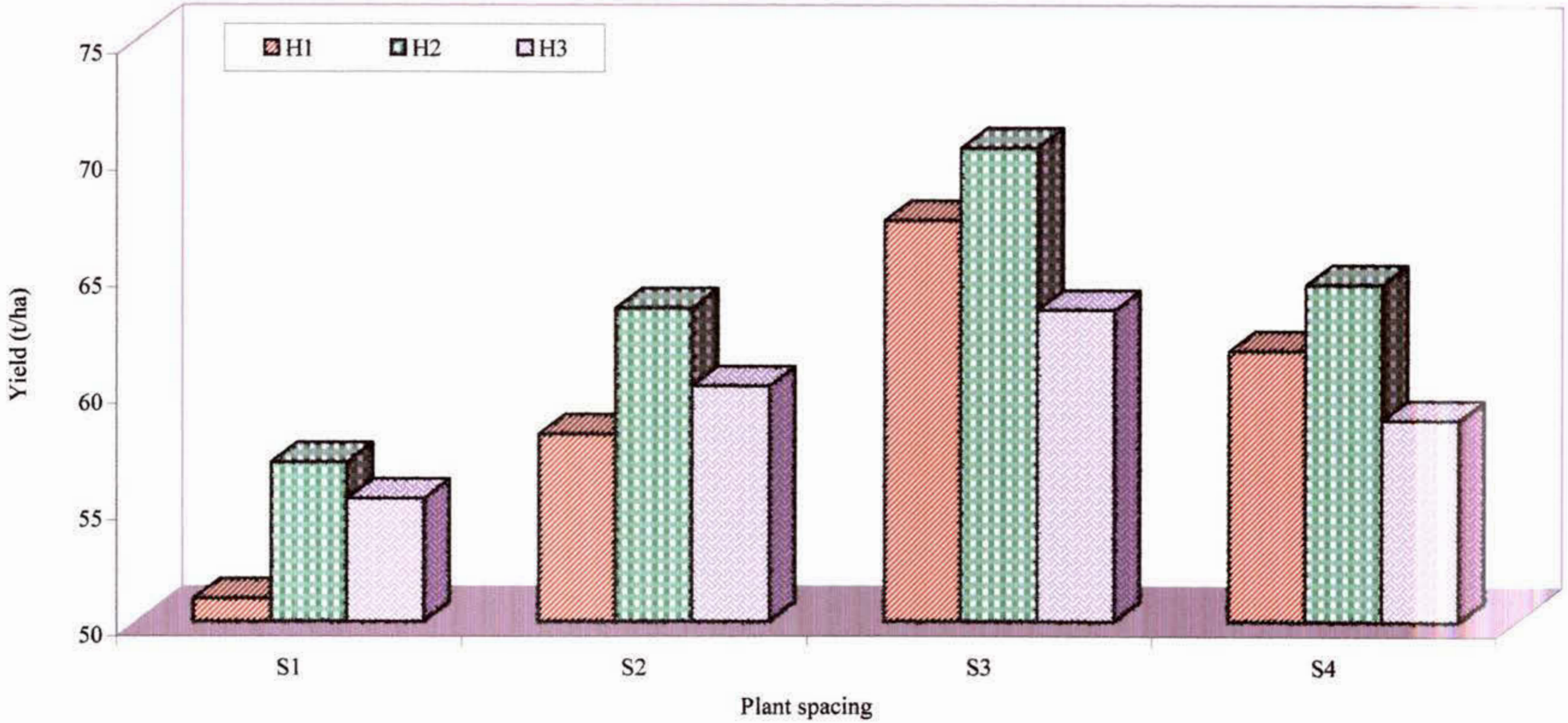

Figure 10. Interaction effect of plant spacing and harvesting interval on yield per hectare of Gimakalmi

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Chapter V

SUMMARY AND CONCLUSION

The present experiment was conducted to investigate the effect of different plant spacing and harvesting intervals on the growth and yield of Gimakalmi at the Horticulture Farm of the Sher-e-Bangla Agricultural University, Dhaka during the period from May to August 2006. There were four levels of plant spacing viz. S_1: 30 cm× 5 cm, S_2: 30 cm × 10 cm, S_3: 30 cm × 15 cm and S_4: 30 cm × 20 cm and three levels of harvest intervals viz. 10, 15 and 20 days as treatments of the experiment. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The crop was allowed to grow and the subsequent harvests were done at three intervals i.e. after 10, 15 and 20 days of the first harvest. Thus upto 90 DAS harvests were done according to the treatment of harvest interval. For 10 days interval harvesting was done at 30, 40, 50, 60, 70, 80 and 90 DAS. For 15 days interval harvesting was done at 30, 45, 60, 75 and 90 DAS and for 20 days interval harvesting was done at 30, 50, 70 and 90 DAS. Data on yield components were collected from 10 randomly selected plants from each plot except the total yield which was determined by taking weights of all plants harvested from each plot.

Plant spacing S_3 (30 cm × 15 cm) gave the longest (32.43 cm) plant per harvest and the shortest (28.17 cm) plant was recorded from S_1 as plant spacing 30 cm × 5 cm. The maximum (5.88) number of branches per plant was recorded from S_3, while the minimum (5.20) was recorded from S_1. Plant spacing S_3 gave the maximum (38.83) number of leaves per plant and the minimum (33.85) was recorded from S_1. Plant spacing S_3 gave the maximum (36.70 g) fresh weight of leaves per plant and the minimum (31.36 g) was recorded from S_1. The maximum (23.08 g) fresh weight of stem per plant was recorded from S_3 and the minimum (18.90 g) was recorded from S_1. Plant spacing S_3 gave the maximum (59.78 g) fresh weight of plant and the minimum (50.26 g) fresh weight of plant was recorded from S_1. The maximum (14.56%) dry matter content was recorded from S_3 and the minimum (10.82%) was recorded from S_1. The highest (83.62%) foliage coverage was recorded from S_3 and the lowest (76.12%) was recorded from S_2. The highest (10.05 kg/plot) yield was observed from S_3, while the lowest (8.16 kg/plot) was recorded from S_1. The highest (67.00 t/ha) yield was recorded from S_3 and the lowest (54.38 t/ha) was recorded from S_1.

Harvesting time at 15 days interval (H_2) gave the longest (39.17 cm) plant per harvest and the shortest (17.31 cm) plant was recorded from H_1 as 10 days harvesting interval. The maximum (5.69) number of branches per plant was recorded from H_2 and the minimum (5.30) was recorded from H_1. Harvesting time H_2 gave the maximum (38.67) number of leaves per plant. On the other hand the minimum (34.21) was recorded from H_1. Harvesting time H_2 gave the maximum (39.03 g) fresh weight of leaves per plant. On the other hand the minimum (28.32 g) fresh weight of leaves per plant was recorded from H_1. Harvesting time H_2 gave the maximum (24.09 g) fresh weight of stem per plant, while the minimum (17.70 g) was recorded from H_1. Harvesting time H_2 gave the maximum (63.12 g) fresh weight of plant and the minimum (46.02 g) was recorded from H_1. Harvesting time H_2 gave the maximum (13.43%) dry matter content and the minimum (12.02%) was recorded from H_1. Harvesting time H_2 gave the highest (81.50%) foliage coverage and the lowest (73.93%) was recorded from H_1. Harvesting time H_2 gave the highest (9.57 kg/plot) yield and the lowest (8.91 kg/plot) was recorded from H_3. Harvesting time H_2 gave the highest (63.78 t/ha) yield and the lowest (59.42 t/ha) was recorded from H_3.

The longest (42.15 cm) plant was recorded from S_3H_2 (30 cm × 15 cm plant spacing and harvesting at 15 days interval) and the shortest (16.03 cm) plant was recorded from S_1H_1 (30 cm × 5 cm plant spacing and harvesting at 10 days interval). The maximum (6.17) number of branches per plant was recorded from S_1H_2. On the other hand the minimum (5.11) number of branches per plant was recorded from S_1H_1. The maximum (42.24) number of leaves per plant was recorded from S_3H_2 and the minimum (32.25) was recorded from S_1H_1. The maximum (41.87 g) fresh weight of leaves per plant was recorded from S_3H_2, while the minimum (24.87 g) fresh weight of leaves per plant was recorded from S_1H_1. The maximum (26.85 g) fresh weight of stem per plant was recorded from S_3H_2. On the other hand the minimum (15.45 g) was recorded from S_1H_1. The maximum (68.72 g) fresh weight of plant was recorded from S_3H_2 and the minimum (40.32 g) was recorded from S_1H_1. The maximum (15.89%) dry matter content was recorded from S_1H_2 and the minimum (10.01%) was recorded from S_1H_1. The highest (88.00%) foliage coverage was recorded from S_3H_2 and the lowest (70.71%) was recorded from S_1H_1. The highest (10.55 kg/plot) yield was recorded from S_3H_2, while the lowest (7.65 kg/plot) was recorded from S_1H_1. The highest (70.36 t/ha) yield was recorded from S_3H_2 and the lowest (50.99 t/ha) was recorded from S_1H_1.

CONCLUSION :

Considering the findings of the present experiment, further studies in the following areas may be suggested:

1. The study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability;
2. Additional plant spacing may be included in the future program;
3. More harvesting intervals may also be included for further study.

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APPENDICES

Appendix I. Results of mechanical and chemical analysis of soil of the experimental plot

Mechanical analysis

Constituents	Percent
Sand	33.23
Silt	60.59
Clay	6.17
Textural class	Silty loam

Chemical analysis

Soil properties	Amount
Soil pH	6.17
Organic carbon (%)	1.44
Total nitrogen (%)	0.08
Available P (ppm)	21.3
Exchangeable K (%)	0.19

Appendix II. Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from March to June 2006

Month	Air temperature (^{0}C)		RH (%)	Total rainfall (mm)	Sunshine (hr)
	Maximum	Minimum			
March	29.55	18.25	61.51	24	225.4
April	33.74	23.87	69.41	185	234.6
May	34.7	25.9	70	185	241.8
June	33.40	26.80	91	279	96.0
July	31.52	25.35	88	233	127.1

Source : Dhaka metrological center

Appendix III. Effect of plant spacing and harvest interval on plant height of Gimakalmi at different times of harvesting

Treatment		Plant height (cm)									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	20.35	17.25	--	23.64	12.25	11.09	--	17.25	10.36	16.03
	H_2	20.24	--	30.89	--	53.22	--	44.52	--	34.78	36.73
	H_3	20.17	--	--	42.85	--	34.66	--	--	29.28	31.74
S_2	H_1	21.08	18.67	--	24.55	13.89	12.67	--	19.47	11.38	17.39
	H_2	21.12	--	32.84	--	56.78	--	48.62	--	36.05	39.08
	H_3	21.36	--	--	44.89	--	36.78	--	--	32.56	33.90
S_3	H_1	23.22	20.67	--	26.08	14.97	13.63	--	20.45	14.78	19.11
	H_2	23.36	--	38.78	--	58.95	--	48.79	--	40.89	42.15
	H_3	23.81	--	--	45.62	--	39.55	--	--	35.19	36.04
S_4	H_1	21.33	19.05	--	22.41	14.12	13.68	--	15.25	11.02	16.69
	H_2	21.94	--	33.25	--	55.14	--	47.58	--	35.78	38.74
	H_3	21.04	--	--	40.15	--	38.45	--	--	29.33	32.24

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix IV. Effect of plant spacing and harvest interval on number of branches per plant of Gimakalmi at different times of harvesting

Treatment		Number of branches per plant at									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	3.07	5.93	--	6.77	6.63	5.40	--	4.07	3.93	5.11
	H_2	3.43	--	6.87	--	6.00	--	5.23	--	5.07	5.32
	H_3	3.09	--	--	7.53	--	5.00	--	--	5.00	5.16
S_2	H_1	3.90	6.07	--	7.20	5.40	6.20	--	4.72	4.00	5.36
	H_2	4.02	--	7.07	--	6.25	--	5.77	--	5.33	5.69
	H_3	4.13	--	--	7.90	--	4.63	--	--	5.23	5.47
S_3	H_1	4.50	6.70	--	6.37	5.27	4.07	--	6.87	4.83	5.52
	H_2	4.33	--	7.63	--	7.00	--	5.93	--	5.97	6.17
	H_3	4.61	--	--	7.77	--	5.23	--	--	6.22	5.96
S_4	H_1	3.97	6.13	--	6.50	5.77	4.00	--	6.00	3.97	5.19
	H_2	4.07	--	7.00	--	5.93	--	5.63	--	5.27	5.58
	H_3	4.20	--	--	8.97	--	4.93	--	--	5.63	5.93

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix V. Effect of plant spacing and harvest interval on number of leaves per plant of Gimakalmi at different times of harvesting

Treatment		Number of leaves per plant at									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	16.50	31.40	--	43.67	51.07	38.67	--	25.60	18.83	32.25
	H_2	16.97	--	30.89	--	53.22	--	44.52	--	34.78	36.08
	H_3	16.37	--	--	48.85	--	37.85	--	--	29.85	33.23
S_2	H_1	17.20	33.56	--	47.42	54.87	41.45	--	27.47	20.13	34.59
	H_2	17.03	--	34.23	--	56.87	--	48.20	--	36.97	38.66
	H_3	17.17	--	--	51.47	--	40.27	--	--	31.57	35.12
S_3	H_1	18.80	36.87	--	48.97	57.33	44.53	--	30.23	22.47	37.03
	H_2	19.13	--	38.77	--	61.20	--	52.43	--	39.67	42.24
	H_3	18.97	--	--	54.26	--	42.23	--	--	33.43	37.22
S_4	H_1	18.07	33.97	--	48.23	42.57	36.87	--	30.00	21.10	32.97
	H_2	18.43	--	37.23	--	58.87	--	49.63	--	24.33	37.70
	H_3	19.20	--	--	51.20	--	39.87	--	--	30.27	35.14

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix VI. Effect of plant spacing and harvest interval on foliage coverage of Gimakalmi at different times of harvesting

Treatment		Foliage coverage (%) at									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	65.00	65.00	--	80.00	75.00	75.00	--	75.00	60.00	70.71
	H_2	70.00	--	95.00	--	95.00	--	80.00	--	65.00	81.00
	H_3	65.00	--	--	95.00	--	85.00	--	--	65.00	77.50
S_2	H_1	65.00	70.00	--	80.00	80.00	80.00	--	70.00	65.00	72.86
	H_2	65.00	--	95.00	--	85.00	--	75.00	--	70.00	78.00
	H_3	70.00	--	--	85.00	--	85.00	--	--	70.00	77.50
S_3	H_1	70.00	65.00	--	95.00	90.00	80.00	--	70.00	75.00	77.86
	H_2	65.00	--	100.00	--	100.00	--	90.00	--	85.00	88.00
	H_3	65.00	--	--	100.00	--	95.00	--	--	80.00	85.00
S_4	H_1	70.00	65.00	--	85.00	80.00	80.00	--	75.00	65.00	74.29
	H_2	65.00	--	90.00	--	90.00	--	75.00	--	75.00	79.00
	H_3	65.00	--	--	100.00	--	85.00	--	--	65.00	78.75

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix VII. Effect of plant spacing and harvest interval on fresh weight of leaves per plant of Gimakalmi at different times of harvesting

Treatment		Fresh weight of leaves per plant (g) at									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	17.32	26.84	--	35.25	29.81	23.84	--	21.68	19.32	24.87
	H_2	17.05	--	30.89	--	53.22	--	44.52	--	34.78	36.09
	H_3	16.94	--	--	47.85	--	37.85	--	--	29.85	33.12
S_2	H_1	20.61	29.55	--	37.22	30.84	31.78		25.89	23.63	28.50
	H_2	20.45	--	32.64	--	55.91	--	47.52	--	37.89	38.88
	H_3	20.06	--	--	50.73	--	42.58	--	--	31.43	36.20
S_3	H_1	22.94	32.45	--	39.36	32.68	33.92	--	31.22	25.94	31.22
	H_2	22.81	--	35.98	--	58.79	--	50.97	--	40.78	41.87
	H_3	23.06	--	--	52.12	--	38.21	--	--	34.66	37.01
S_4	H_1	21.02	30.04	--	38.51	31.05	30.95	--	26.38	22.87	28.69
	H_2	21.25	--	31.86	--	56.33	--	48.71	--	38.21	39.27
	H_3	21.83	--	--	49.37	--	41.78	--	--	30.57	35.89

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix VIII. Effect of plant spacing and harvest interval on fresh weight of stem of Gimakalmi at different times of harvesting

Treatment		Fresh weight of stem per plant (g) at									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	11.25	16.45	--	19.85	18.22	15.33	--	14.92	12.13	15.45
	H_2	11.48	--	31.87	--	23.87	--	26.42	--	13.78	21.48
	H_3	11.21	--	--	29.87	--	24.78	--	--	13.22	19.77
S_2	H_1	12.87	18.67	--	21.61	20.33	18.63	--	15.88	15.43	17.63
	H_2	12.78	--	34.12	--	26.74	--	29.78	--	16.89	24.06
	H_3	12.05	--	--	32.78	--	25.67	--	--	16.11	21.65
S_3	H_1	13.97	21.33	--	22.98	22.58	22.10	--	17.54	17.84	19.76
	H_2	13.64	--	38.69	--	29.95	--	32.44	--	19.55	26.85
	H_3	14.26	--	--	32.06	--	25.31	--	--	18.89	22.63
S_4	H_1	13.07	19.04	--	22.34	20.00	19.02	--	16.03	16.28	17.97
	H_2	12.98	--	33.81	--	25.94	--	30.05	--	17.00	23.96
	H_3	12.61	--	--	29.68	--	18.92	--	--	19.05	20.07

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix IX. Effect of plant spacing and harvest interval on fresh weight per plant of Gimakalmi at different times of harvesting

Treatment		Fresh weight per plant (g) at									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	28.57	43.29	--	55.10	48.03	39.17	--	36.60	31.45	40.32
	H_2	28.53	--	62.76	--	77.09	--	70.94	--	48.56	57.58
	H_3	28.15	--	--	77.72	--	62.63	--	--	43.07	52.89
S_2	H_1	33.48	48.22	--	58.83	51.17	50.41	--	41.77	39.06	46.13
	H_2	33.23	--	66.76	--	82.65	--	77.30	--	54.78	62.94
	H_3	32.11	--	--	83.51	--	68.25	--	--	47.54	57.85
S_3	H_1	36.91	53.78	--	62.34	55.26	56.02	--	48.76	43.78	50.98
	H_2	36.45	--	74.67	--	88.74	--	83.41	--	60.33	68.72
	H_3	37.32	--	--	84.18	--	63.52	--	--	53.55	59.64
S_4	H_1	34.09	49.08	--	60.85	51.05	49.97	--	42.41	39.15	46.66
	H_2	34.23	--	65.67	--	82.27	--	78.76	--	55.21	63.23
	H_3	34.44	--	--	79.05	--	60.70	--	--	49.62	55.95

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix X. Effect of plant spacing and harvest interval on dry matter content per plant of Gimakalmi at different times of harvesting

Treatment		Dry matter content (%) in plant at									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	8.45	9.05	--	9.22	9.89	10.56	--	11.06	11.85	10.01
	H_2	8.28	--	11.33	--	12.62	--	13.22	--	12.02	11.49
	H_3	8.37	--	--	10.25	--	12.33	--	--	12.94	10.97
S_2	H_1	8.99	10.33	--	12.61	11.33	13.52	--	13.68	13.24	11.96
	H_2	9.45	--	11.89	--	12.56	--	13.78	--	16.24	12.78
	H_3	9.86	--	--	11.36	--	13.96	--	--	15.12	12.58
S_3	H_1	10.23	11.67	--	12.22	12.87	15.04	--	15.78	17.45	13.61
	H_2	10.91	--	15.02	--	15.69	--	18.36	--	19.48	15.89
	H_3	11.62	--	--	13.03	--	14.63	--	--	17.45	14.18
S_4	H_1	9.05	10.48	--	11.32	11.45	14.22	--	15.03	16.07	12.52
	H_2	9.78	--	11.58	--	13.28	--	16.03	--	17.12	13.56
	H_3	10.03	--	--	12.32	--	14.28	--	--	15.33	12.99

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix XI. Effect of plant spacing and harvest interval on yield per plot of Gimakalmi at different times of harvesting

Treatment		Yield per plot (kg) at									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	5.38	8.45	--	9.02	9.22	7.68	--	7.34	6.45	7.65
	H_2	5.26	--	10.68	--	10.06	--	9.37	--	7.26	8.53
	H_3	5.31	--	--	10.25	--	10.56	--	--	7.05	8.29
S_2	H_1	6.08	9.22	--	10.05	10.09	10.25	--	7.93	7.33	8.71
	H_2	6.00	--	11.39	--	11.51	--	10.74	--	7.98	9.52
	H_3	6.13	--	--	10.97	--	10.86	--	--	8.12	9.02
S_3	H_1	7.45	10.56	--	11.13	11.45	12.02	--	8.64	9.36	10.09
	H_2	7.24	--	12.54	--	11.39	--	11.37	--	10.23	10.55
	H_3	7.31	--	--	10.37	--	10.74	--	--	9.62	9.51
S_4	H_1	6.33	9.38	--	10.61	10.15	11.26	--	9.05	7.95	9.25
	H_2	6.54	--	11.42	--	11.78	--	10.61	--	8.02	9.67
	H_3	6.28	--	--	10.64	--	10.45	--	--	7.83	8.80

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix XII. Effect of plant spacing and harvest interval on yield per hectare of Gimakalmi at different times of harvesting

Treatment		Yield per hectare (t) at									
		30DAS	40DAS	45DAS	50DAS	60DAS	70DAS	75DAS	80DAS	90DAS	Average per harvest
S_1	H_1	35.87	56.33	--	60.13	61.47	51.20	--	48.93	43.00	50.99
	H_2	35.07	--	71.20	--	67.07	--	62.47	--	48.40	56.84
	H_3	35.40	--	--	68.33	--	70.40	--	--	47.00	55.28
S_2	H_1	40.53	61.47	--	67.00	67.27	68.33	--	52.87	48.87	58.05
	H_2	40.00	--	75.93	--	76.73	--	71.60	--	53.20	63.49
	H_3	40.87	--	--	73.13	--	72.40	--	--	54.13	60.13
S_3	H_1	49.67	70.40	--	74.20	76.33	80.13	--	57.60	62.40	67.25
	H_2	48.27	--	83.60	--	75.93	--	75.80	--	68.20	70.36
	H_3	48.73	--	--	69.13	--	71.60	--	--	64.13	63.40
S_4	H_1	42.20	62.53	--	70.73	67.67	75.07	--	60.33	53.00	61.65
	H_2	43.60	--	76.13	--	78.53	--	70.73	--	53.47	64.49
	H_3	41.87	--	--	70.93	--	69.67	--	--	52.20	58.67

S_1: 30 cm × 5 cm
S_2: 30 cm × 10 cm
S_3: 30 cm × 15 cm
S_4: 30 cm × 20 cm

H_1: Harvesting at 10 days interval
H_2: Harvesting at 15 days interval
H_3: Harvesting at 20 days interval

Appendix XIII. Analysis of variance of the data on plant height, number of branches and leaves per plant of Gimakalmi as influenced by plant spacing and harvest interval

Source of variation	Degrees of freedom	Mean square		
		Plant height	Number of branches per plant	Number of leaves per plant
Replication	2	2.176	0.141	3.009
Plant spacing (A)	3	29.700**	0.713**	39.491**
Harvesting interval (B)	2	1544.721**	0.544*	66.050**
Interaction (A×B)	6	0.946	0.106	1.174
Error	22	4.908	0.139	4.289

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix XIV. Analysis of variance of the data on fresh weight of leaves and stem per plant, fresh weight per plant and dry matter content of Gimakalmi as influenced by plant spacing and harvest interval

Source of variation	Degrees of freedom	Mean square			
		Fresh weight of leaves per plant (g)	Fresh weight of stem per plant (g)	Fresh weight of plant (g)	Dry matter content (%)
Replication	2	4.453	9.052	11.767	0.347
Plant spacing (A)	3	43.666**	26.538**	136.621**	21.459**
Harvesting interval (B)	2	358.108**	122.378**	892.918**	5.931**
Interaction (A×B)	6	1.090	1.374	3.989	0.449
Error	22	3.890	3.459	9.201	0.835

**: Significant at 0.01 level of probability

Appendix XV. Analysis of variance of the data on foliage coverage and yield per plot and hectare of Gimakalmi as influenced by plant spacing and harvest interval

Source of variation	Degrees of freedom	Mean square		
		Foliage coverage (%)	Yield (kg/plot)	Yield (t/ha)
Replication	2	8.151	0.255	11.340
Plant spacing (A)	3	112.620**	5.432**	241.402**
Harvesting interval (B)	2	187.478**	1.682**	74.745**
Interaction (A×B)	6	7.070	0.260	11.555
Error	22	14.928	0.310	13.795

**: Significant at 0.01 level of probability