Effect of Spacing and Harvest Frequency on the Growth and Leaf Yield of Moringa (*Moringa oleifera* Lam), a Leafy Vegetable Crop

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INTRODUCTION

Vegetables are the succulent plant parts that may be eaten as supplementary foods or side dishes in the raw state or in the cooked form alone, with meat or fish, in stews, soups and various preparations (Okigbo, 1983).

They are universally recognized to have great nutritional value and form an essential part of a balanced human diet. Diets deficient in vegetables could lead to various ailments including heart diseases (McBride, 1992; Wood, 1992).

Vegetables, especially leafy vegetables, therefore feature regularly in gardens, markets and homes.

In Senegal, leafy vegetables account for as much as 50 to 85 % of the household budget of some farmers while in Cameroon, total production was estimated to be 93.600 tones in 1998 (Spore, 2005).

Nutritional Status of Some Leafy Vegetables

(Source: IIRR (1995a), FAO 1988)

	Water (ml)	Protein (g)	Carbohydrates (g)	Fat (g)	Fiber (g)	Ash (g)
African Spinach (*Amaranthus spp)*	**89.0**	**3.6**	**4.0**	**0.1**	**1.3**	**-**
Long-fruited Jute *(Corchorus olitorus L.)*	**84.1**	**5.6**	**7.6**	**0.3**	**1.7**	**-**
Roselle *(Hibiscus sabdariffa L.)*	**85.0**	**3.3**	**9.0**	**0.3**	**1.6**	**-**
Gboma *(Solanum macrocarpon)*	**86.0**	**4.6**	**6.0**	**1.0**	**1.6**	**-**
Ceylon Spinach (*Basella alba)*	**85.0**	**5.0**	**5.0**	**0.7**	**1.5**	**-**
Cocoyam Leaf Stalks (*Colocassia esculenta*)	**93.0**	**0.5**	**6.0**	**0.2**	**0.9**	**-**
Cabbage *(Brassica oleracea)*	**90.0**	**2.6**	**6.0**	**0.4**	**1.0**	**-**
Lettuce *(Lactuca sativa)*	**96.0**	**1.0**	**2.0**	**0.4**	**0.4**	**-**
Horse Radish *(Moringa oleifera*)	**81.0**	**8.36**	**6.36**	**1.39**	**1.37**	**1.52**

Traditional leafy vegetables are now recognized as an ally in the fight against deficiencies of macro and micro nutrients and one such vegetable is *Moringa oleifera,* Lam.

Moringa is commonly grown as a live fence or a backyard tree. To put more land under cultivation as a means of increasing production to meet the growing demands of the crop will be expensive, difficult and damaging to the environment (Okigbo, 1984).

Growers thus need to increase their production by adopting appropriate strategies and techniques which will lead to sufficient and reliable yields without depleting the natural resource base.

This study was carried out to establish the optimum spacing and frequency of harvest which provide the optimum leaf yield of moringa leaves for use as a vegetable, animal fodder and industrial raw material.

Methods of Moringa Culture

- Traditionally cultivated as a backyard plant
- It can also be grown as a hedge

Source: Prof Dr Klaus Becker, Germany

- Trials in Nicaragua have shown that it is ideally suited also for more intensive production

Source: N. Foidl; Nicaragua

INTENSIVELY CULTIVATED MORINGA FIELD
(About Three Weeks old at 10 x 10 cm) (Foidl 2003)

INTENSIVELY CULTIVATED MORINGA FIELD
(About Sixty Days Old Foidl 2003)

INTENSIVELY CULTIVATED MORINGA FIELD

(After First Cutting at 20 cm above Ground) (Foidl, 2003)

Materials and Methods

Location and Climate of Experimental Site

- The experiment was conducted at the Horticulture Department of the Kwame Nkrumah University of Science and Technology, Kumasi
- Kumasi lies (Latitude 5 degrees, 36 minutes North; Longitude 0 degrees, 10 minutes East) between 19th May 2004 and 21st March 2005. The area lies in the semi deciduous forest zone of Ghana.
- Kumasi enjoys a humid tropical climate. The rainfall pattern is bimodal (two wet and two dry seasons). The mean annual rainfall is 1563 mm of which about 55% occurs from March and July and 30% occurs between September to November. There is usually a short dry season in August and a long one between December to March.

Experimental Design

- A 3x2 factorial in a Randomized Complete Block Design (RCBD) was used.
- There were three levels in the spacing factor (5 x 5, 5 x 10 and 5 x 15 cm) and three levels in the harvest frequency factor (30, 35 and 40 days) and this gave a total of nine (9) treatment combinations in each block
- Three Replications

Table 1 Treatment Combinations

1. 5 x 5 cm at 30 days harvest	1.5 x 15 cm at 35 days harvest
1. 5 x 10 cm at 30 days harvest	1.5 x 5 cm at 40 days harvest
1.5 x 15 cm at 30 days harvest	1.5 x 10 cm at 40 days harvest
1.5 x 5 cm at 35 days harvest	1.5 x 15 cm at 40 days harvest
1.5 x 10 cm at 35 days harvest	

Mode of Harvesting and Agronomic Parameters Measured

- The fresh weight of shoots harvested per plot was taken using a weighing scale.
- Five (5) randomly selected individual plants were taken from each plot after harvesting and their individual fresh weights taken using an electronic beam balance.
- They were then separated into different fractions of stems, petioles and leaves and weighed. They were put into brown paper envelopes and dried at 60^{o}C for 72 hours using an electric oven.
- The dry weight of each sample was then recorded using an electric beam balance.

RESULTS

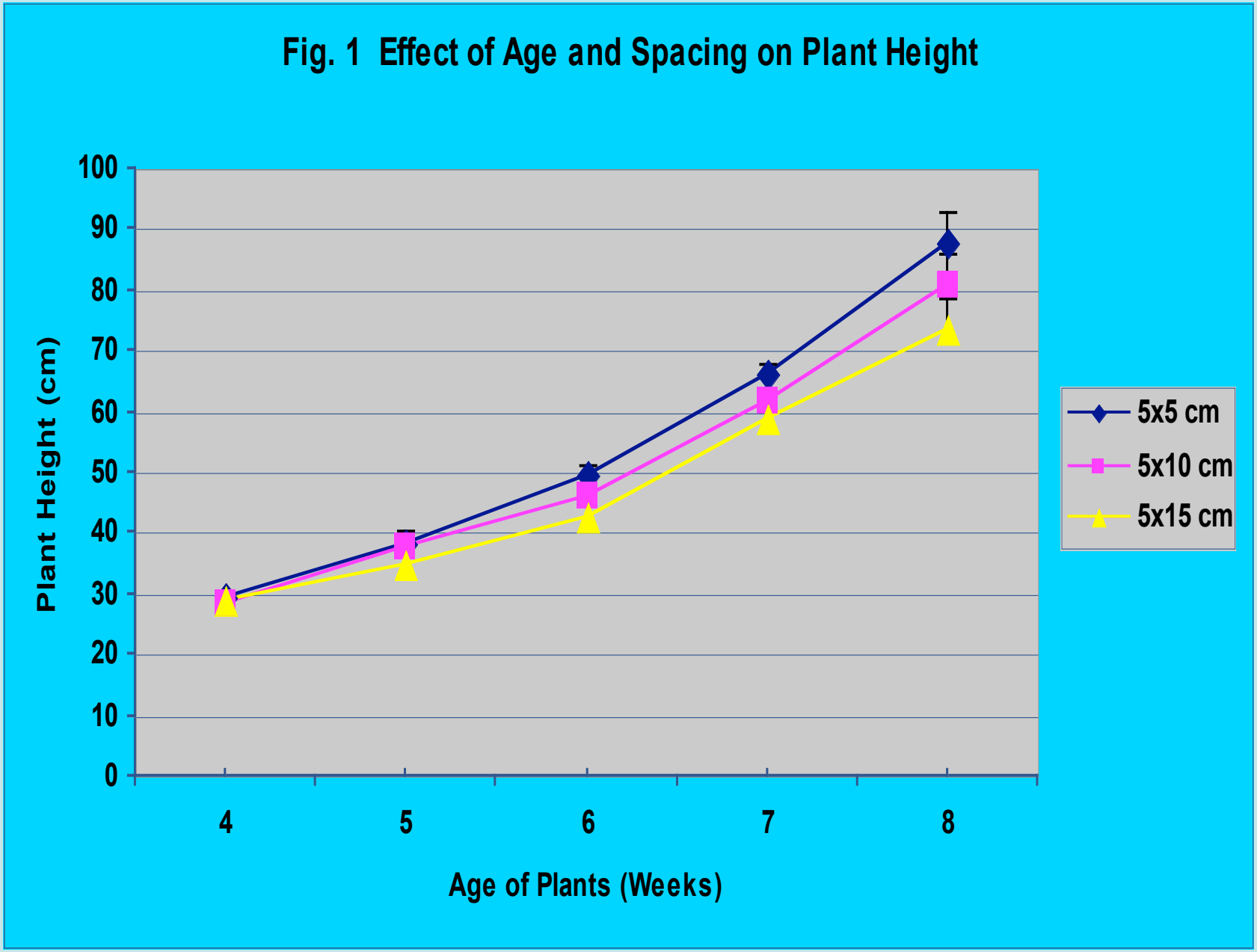


Fig. 1 Effect of Age and Spacing on Plant Height
Plant Height (cm)
100
90
80
70
60
50
40
30
20
10
0
4
5
6
7
8
Age of Plants (Weeks)
5x5 cm
5x10 cm
5x15 cm

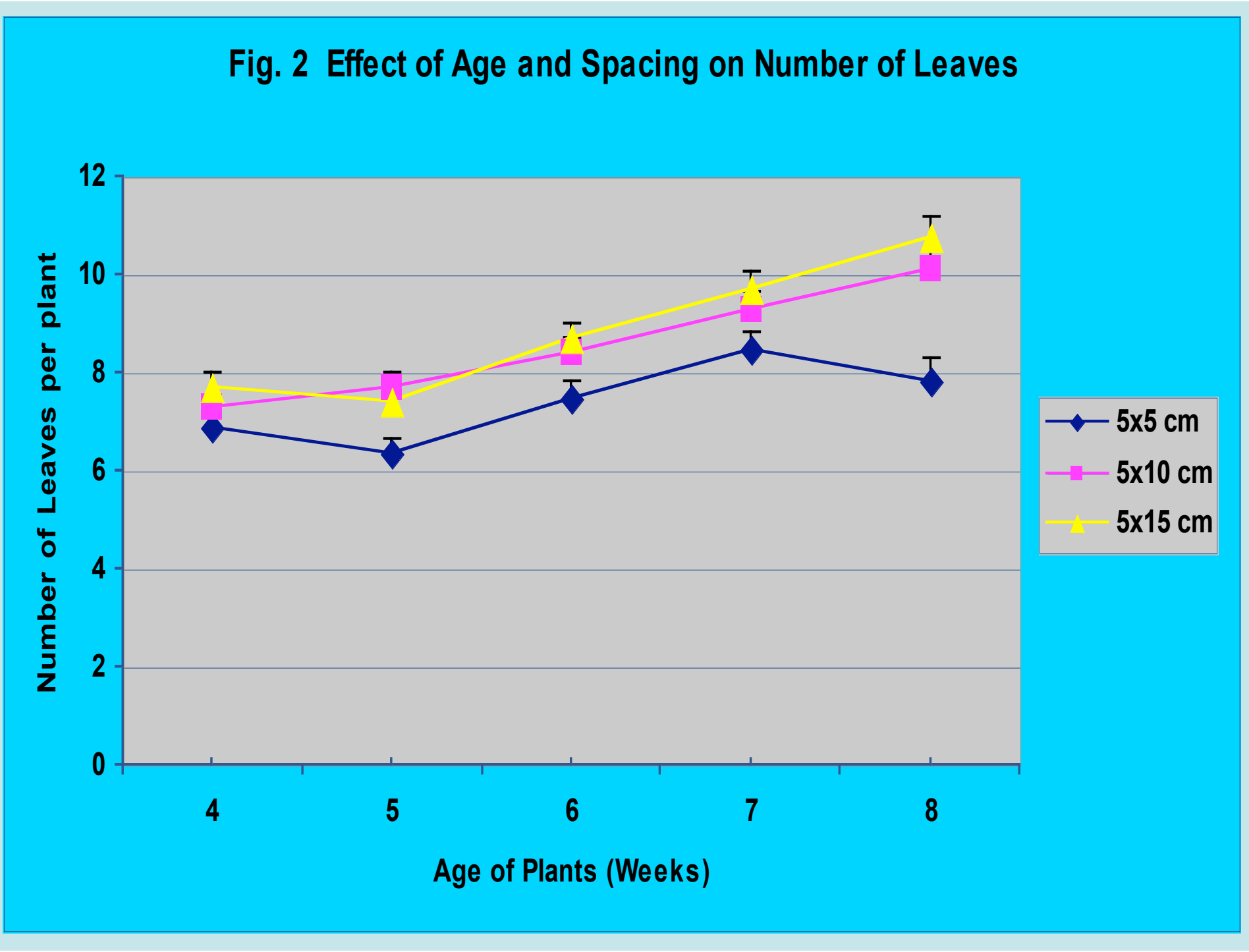


Fig. 2 Effect of Age and Spacing on Number of Leaves
Number of Leaves per plant
12
10
8
6
4
2
0
4
5
6
7
8
Age of Plants (Weeks)
5x5 cm
5x10 cm
5x15 cm

Fig 3 Effect of Spacing on Stem Diameter

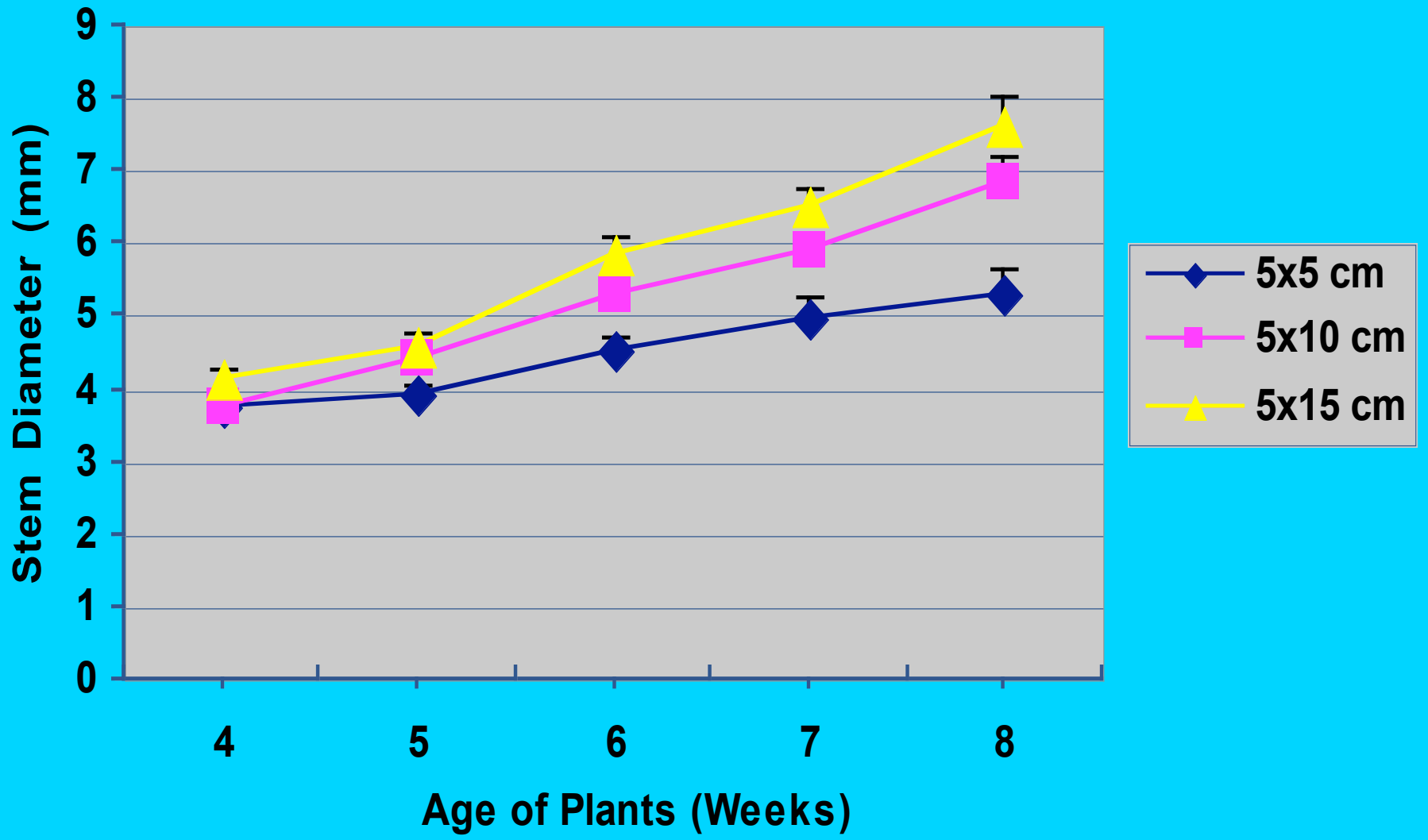


Fig. 4 Effect of Spacing on Fresh and Dry Shoot Yields 60 days After Sowing

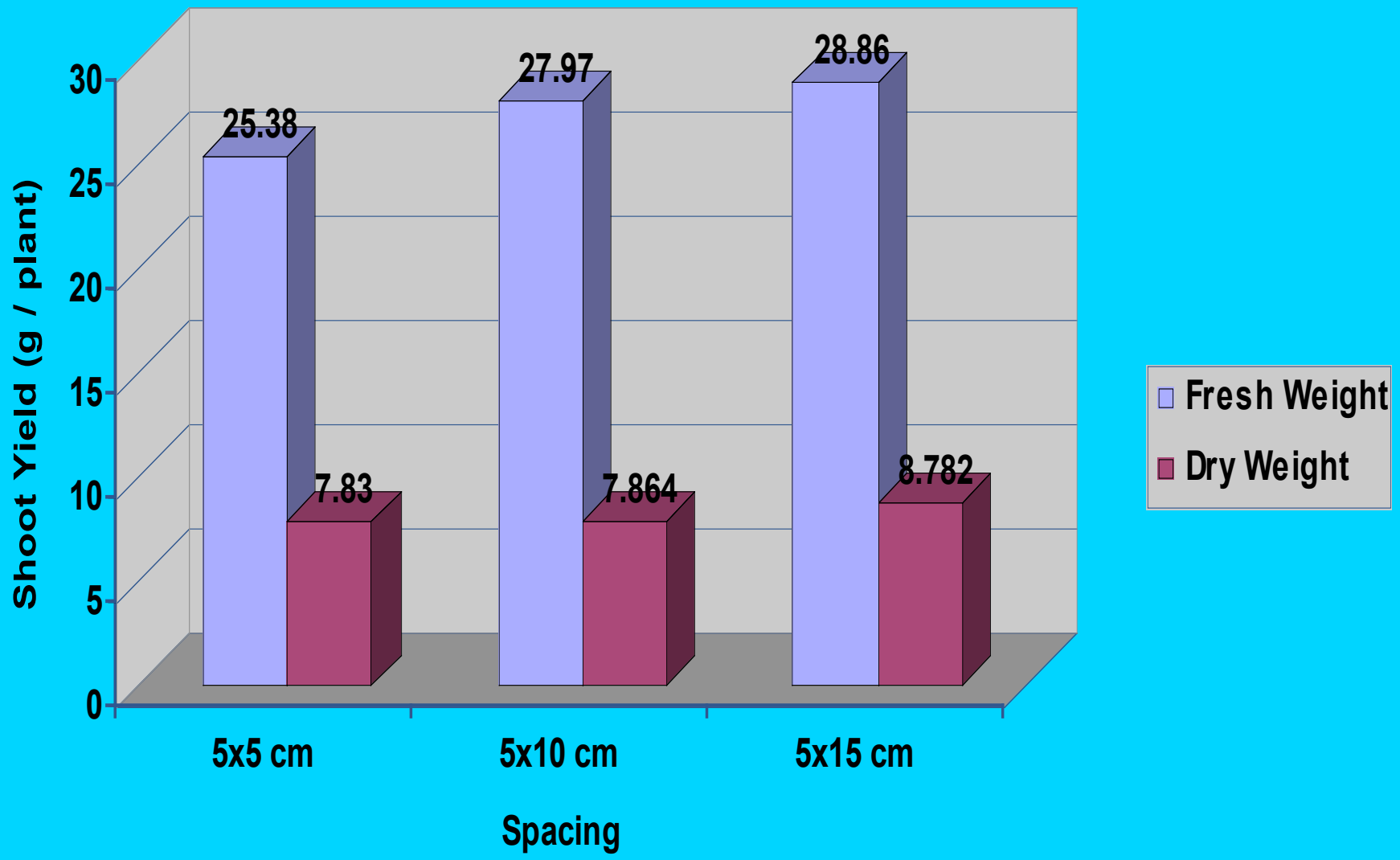


Fig. 5 Effect of Spacing on Yield Components per Plant 60 Days After Sowing

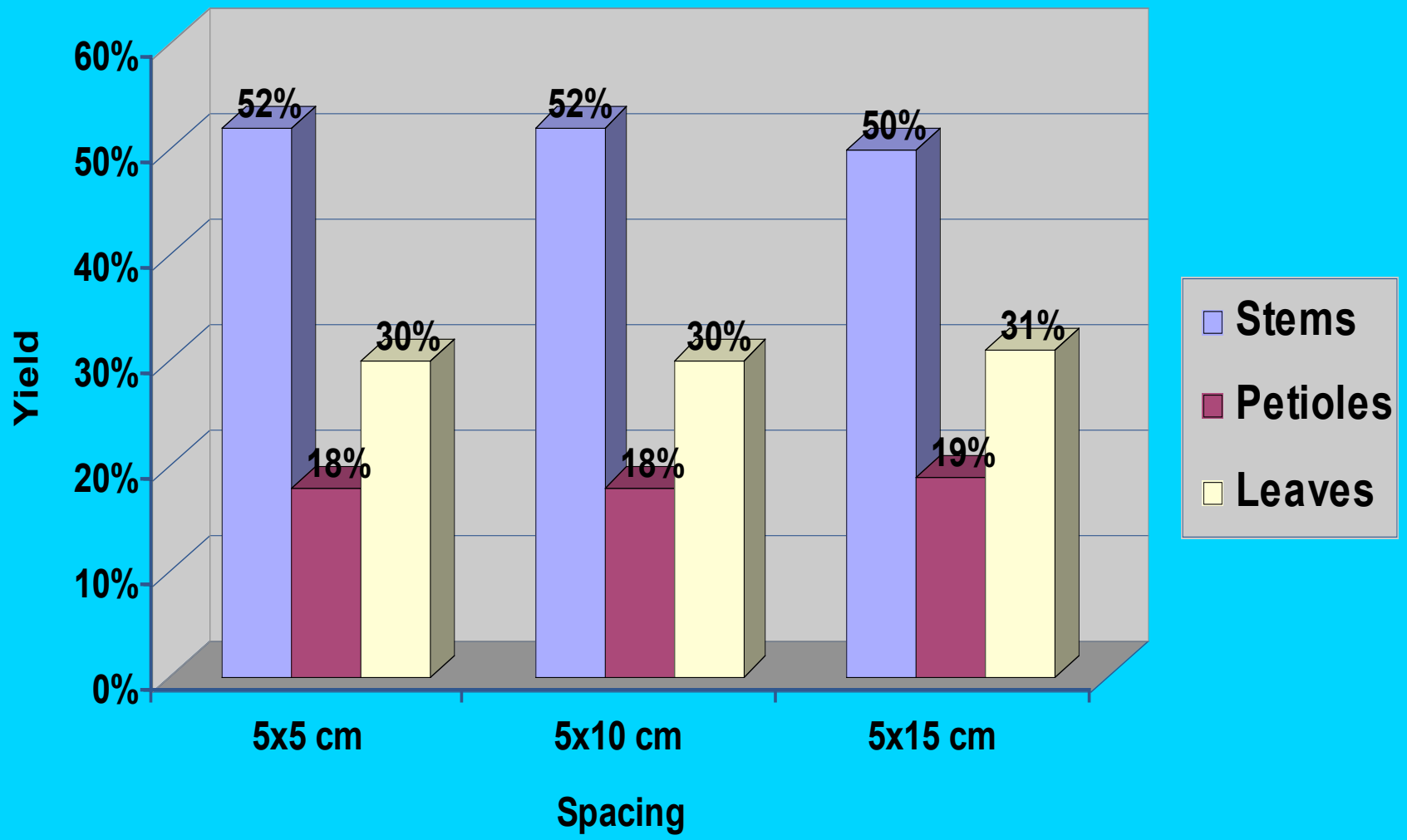


Fig 6 Effect of Spacing and Number of Harvests on Fresh Shoots Yield

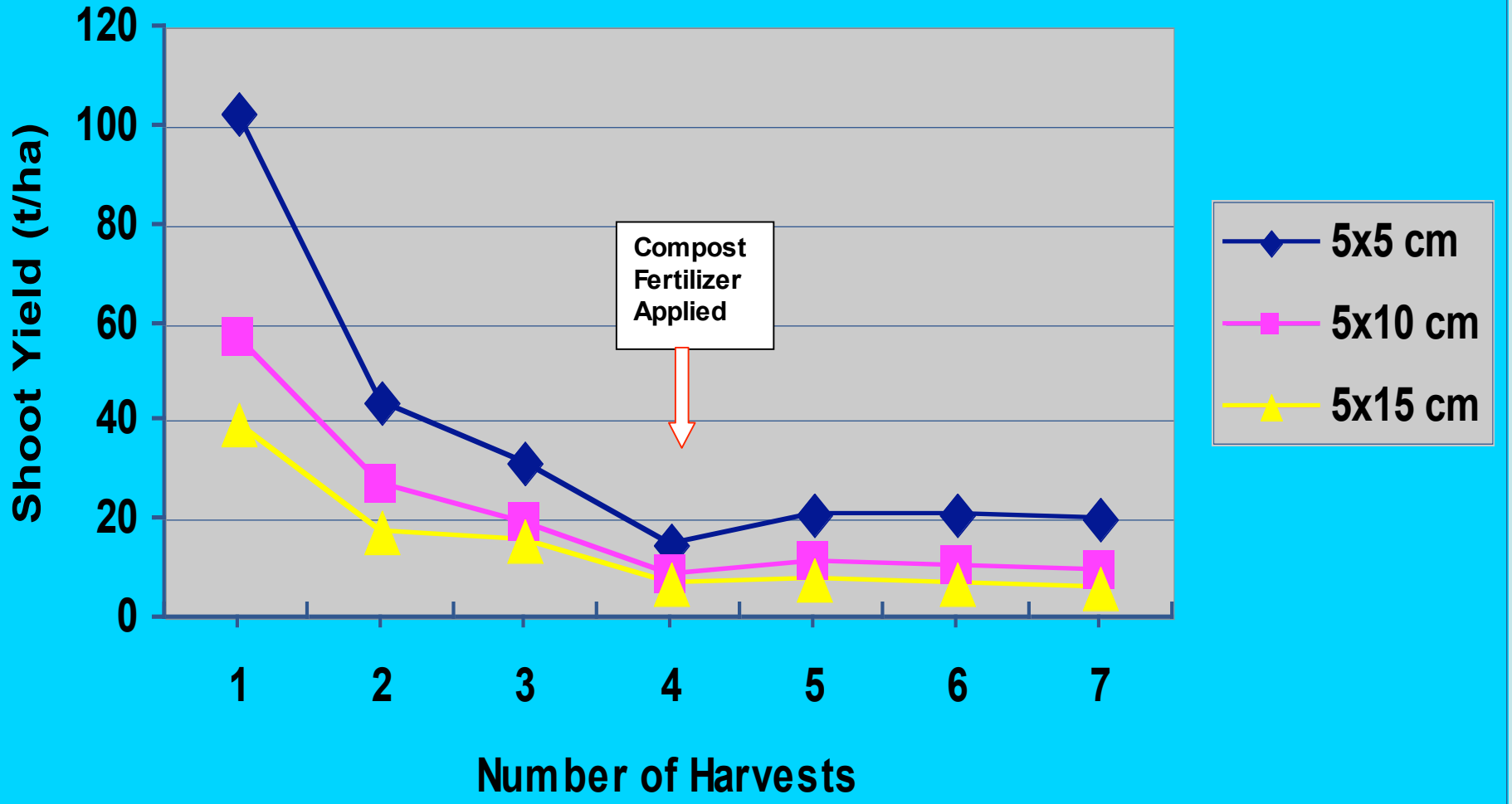


Fig. 7 Effect of Spacing and Number of Harvests on Fresh Leaf Yield

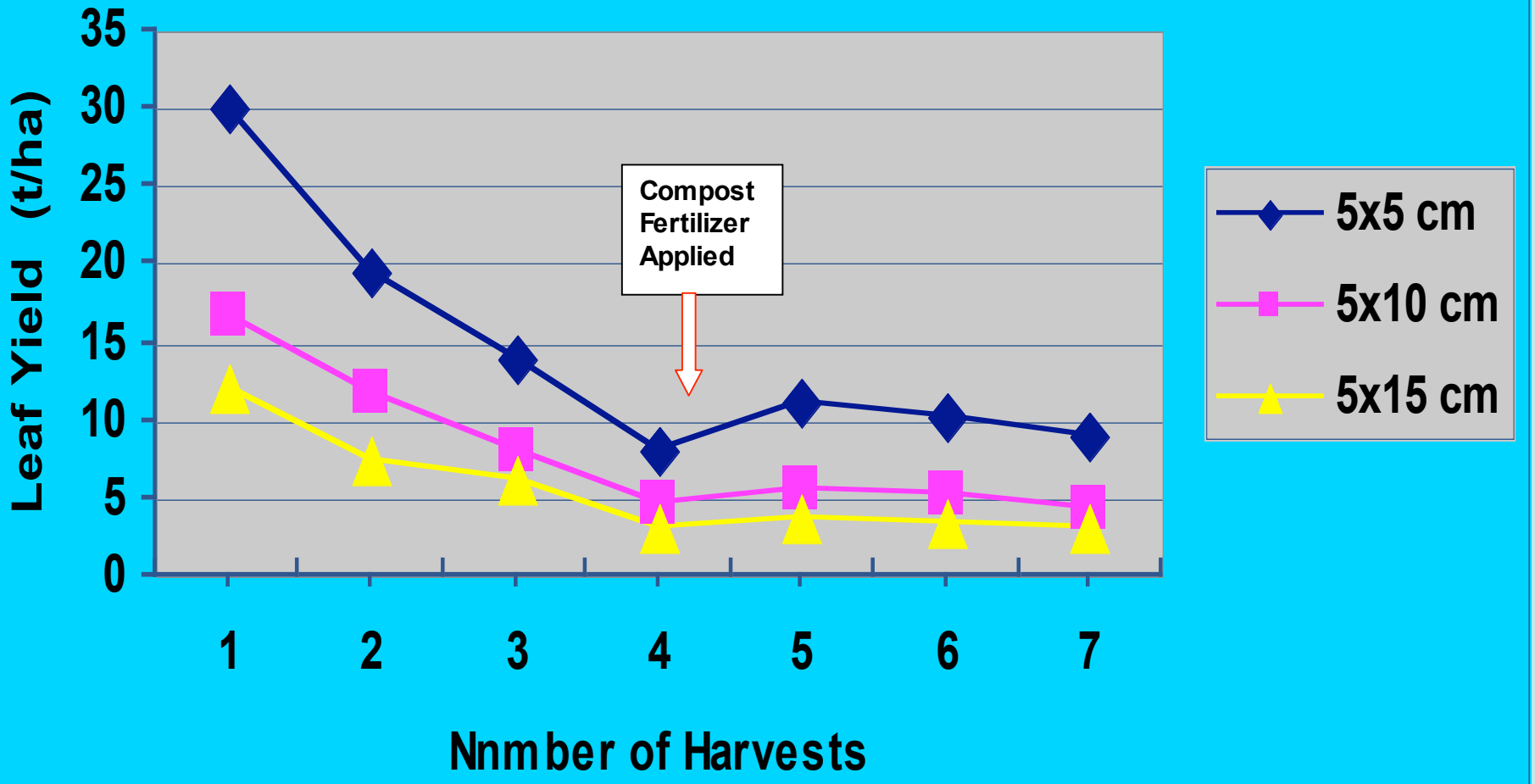


Fig. 8 Effect of Spacing and Age on Main Stem Diameter

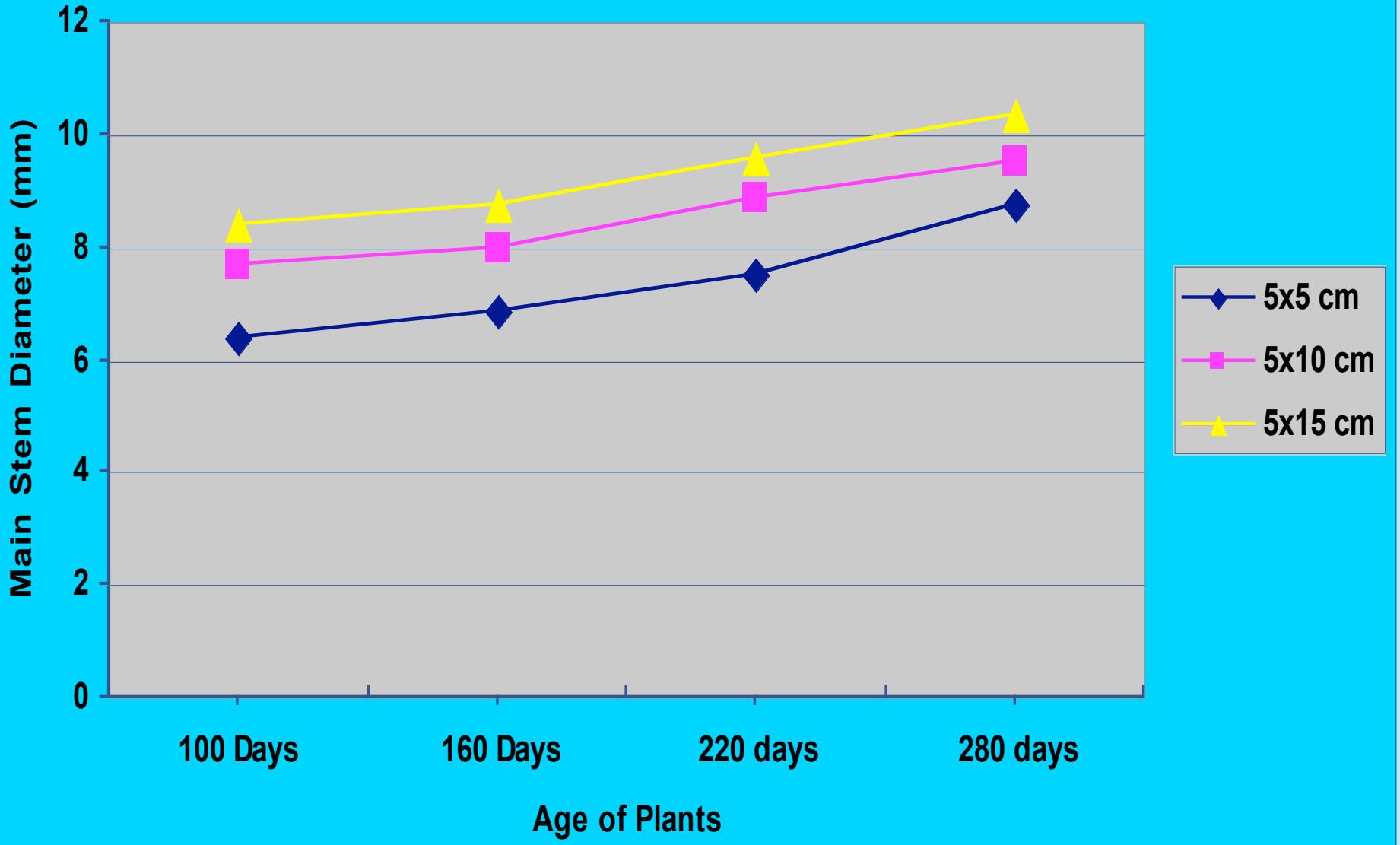
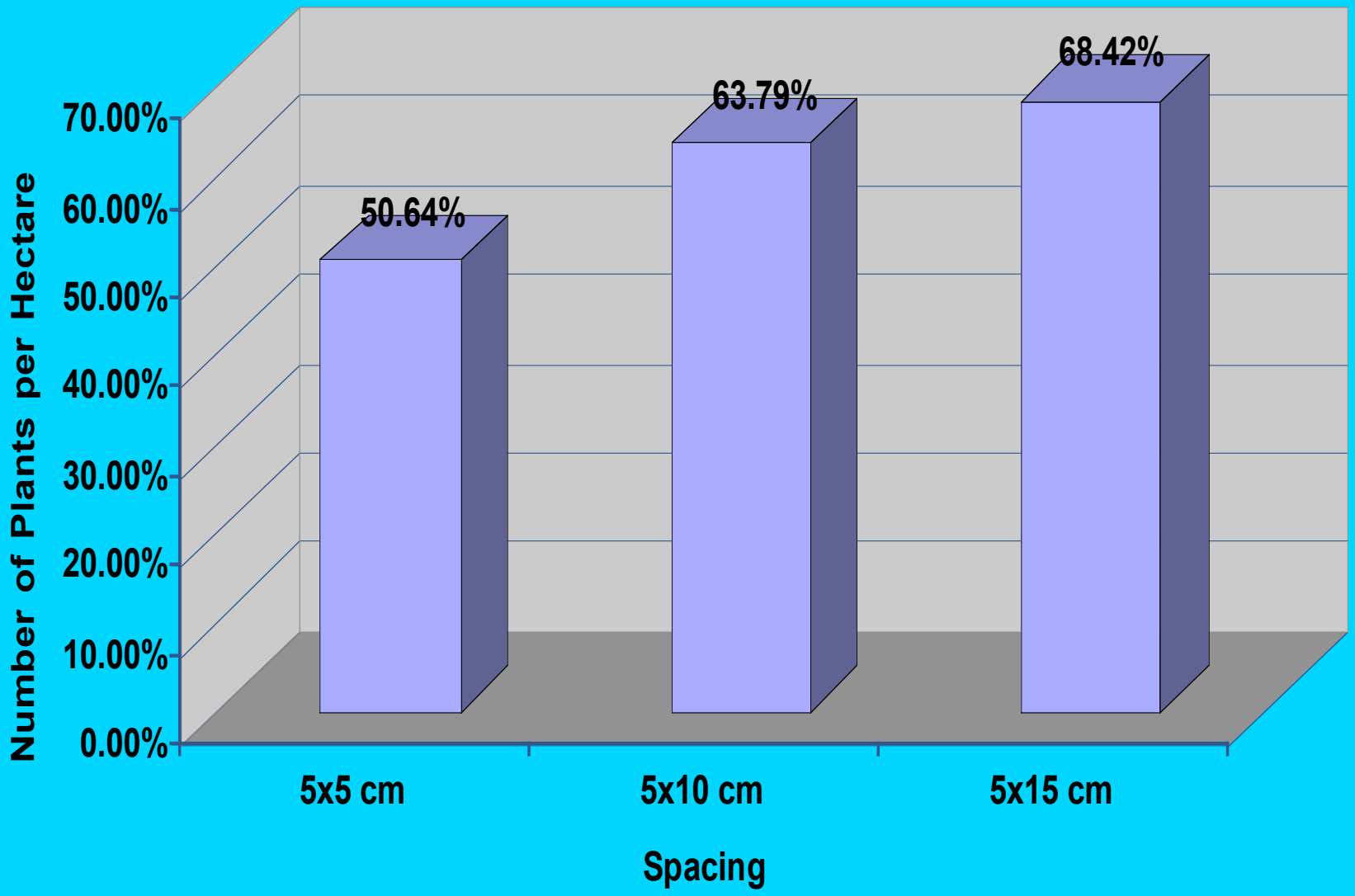


Fig. 9 Effect of Spacing on the Number of Plants which Survived From 100 to 280 Days



DISCUSSION

Production Parameters of Moringa at First Cutting (Foidl, *et. al.*, 2001)

Plant Density (Plants / ha)	Fresh Matter (Metric tons/ha/ cutting)	Dry Matter (Metric tons/ha)	Protein (kg/ha)	Loss of plants after first cutting
95,000	19.6	3.33	566	n.d
350,000	29.7	5.05	859	n.d.
900,000	52.6	8.94	1,520	n.d.
1,000,000 4 million 16 million	78.0 97.4 259.0	13.26 16.56 44.03	2,254 2,815 7,485	Approx. 2% Approx. 25 Approx. 40

n.d. = not determined

The results showed that, during a period of 60 days after sowing, plant height increased steadily reaching 87.76, 80.76 and 73.57 cm for the 5 x 5, 5 x 10 and 5 x 15 cm spacings respectively.

Similarly average stem diameter during the same period reached 5.28 mm, 6.84 mm and 7.64 mm for the close, medium and wide spacings respectively giving significant differences ($P<0.05$).

Average number of leaves produced per plant increased with time and reached 10.09 and 10.76 for the medium and wide spacings respectively. In the close spacing, however, the number increased steadily but declined from 8.49 to 7.84 between the 7th and 8th weeks.

The wide spacing produced more leaf yield per plant than the medium and close spacings, however, the total leaf yield per hectare was higher in the close than the medium and wide spacings.

Total plant losses were higher in the close spacing than the medium and wide spacings.

CONCLUSIONS

- **The optimum spacing for vegetable leaf yield of M. oleifera in a well drained sandy loam soil was 5 x 15 cm (1.333 m plants per hectare).**
- **The study showed that, after the initial harvest (60 Days after sowing) successive harvests should be made at 35 Days intervals.**

RECOMMENDATION

- **FERTILIZER and IRRIGATION is a must for the high levels of production to be sustained.**
- **Research is needed to establish the appropriate levels**