

Evaluation of Green Chilli (*Capsicum annuum* L.) Grown in the Low Country Intermediate Zone of Sri Lanka

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ABSTRACT

Most of the presently recommended chilli varieties are suitable for dry chilli production than green chilli. When dry chilli varieties use as green chilli, the available recommended varieties have certain undesirable characters such as thin fruit wall, less fruit weight, less fruit diameter and shorter fruit length. These characters reduce the fresh fruit quality. An experiment was carried out at the Regional Agricultural Research and Development Center, Makandura during 2004/2005 maha to evaluate an open pollinated variety MK, as a green chilli with three recommended varieties (KA 2, Arunalu and MI Hot) and two hybrids (Hot pepper BN 012112 and Vini Vici) in open field condition. The evaluation was based on morphological, vegetative and reproductive growth, fruit quality, yield and pest and disease resistance. Variety MK showed better performance in all attributes especially in fruit quality parameters. It was recorded a thicker fruit wall (0.61 mm), the larger fruit size (fruit length and diameter 8.98 cm, 1.45 cm respectively) and the highest fruit weight (8.56 gm). The plant height was 47.27 cm and showed erect plant with comparatively lesser number of leaves. It took 44 days to first flowering and 60 days to first fruiting after transplanting the seedlings. The fruit shape was elongate and green in color. Fruits were moderately pungent and the total soluble solids were recorded as 7.94 %. Variety MK recorded an average yield of 1.71 t/ha and moderately resistant to the anthracnose and leaf curl complex. Therefore, variety MK is more suitable for green chilli production than other tested varieties.

KEY WORDS: MK Variety, Pericarp Thickness, Green Chilli

INTRODUCTION

Chilli (*Capsicum annuum* L.) is a Solanaceae crop that is widely cultivated throughout the world, more specifically in the tropical and sub tropical regions. The center of diversity of *Capsicum annuum* is probably Mexico and widely cultivated in Central and South America.

It was introduced into Europe in the fifteenth century. The fruit is rich in vitamins; especially vitamin A and C. It is an important ingredient in every kitchen as an indispensable item for its pungency, spicy taste, besides the appealing color that adds to the food. Furthermore, it is high in nutrition. Its major constituent of pericarp is a crystalline colorless substance known as capsaicin or capscutin (C₁₈H₂₇NO₃). Nutritionally, 100 g of edible green chilli pods contain 92.4 g of moisture, 24 cal of energy, 1.3 g of protein, 0.3 g of fat, 4.3 g of carbohydrates, 10 mg of calcium, 30 mg of phosphorus, 550 mg of thasin and 137 mg of vitamin C (Ranasinghe, 2000).

The green chilli production during 1999-2004 in Sri Lanka is shown in table 1.

Table 1: The green chilli production during 1999 –2004 in Sri Lanka.

| Year | Extent (ha) | Production (mt) |
|------|-------------|-----------------|
| 1999 | 21,751 | 60,031 |
| 2000 | 19,832 | 55,860 |
| 2001 | 17,410 | 49,323 |
| 2002 | 27,383 | 76,687 |
| 2003 | 21,118 | 60,388 |
| 2004 | 13,821 | 40,908 |

(Source –Agstat - Department of Census and Statistics, 2000a to 2004a)

From year 1999 to 2004, the highest extent (27,383 ha) and production (76,687 mt) were recorded in year 2002. However there is no exact pattern of

fluctuation in extent and production of green chilli in Sri Lanka.

Chilli can grow in both tropical and sub tropical areas at altitudes ranging from sea level to 2000 m. Temperatures ranging from 20°C to 25°C are ideal for chilli. A warm humid climate favors growth while dry weather enhances fruit maturity. As a rain fed crop, it is grown in areas receiving an annual precipitation of 60 -125 cm.

Major green chilli producing districts are Anuradhapura, Moneragala, and Pollonnaruwa. (Anon, 2002a, 2003a). These districts produce the major component of green chilli requirement of the country. In the wet zone, the chilli is mainly cultivated as a green chilli. The quality of green chilli reduces due to varieties, poor transportation, handling and packaging. It also drastically reduces appearance and nutritive value. Furthermore, a large amount of green chilli gets discarded everyday due to poor handling and which would affect on retail price to recover the cost of production.

Green chilli is a high income crop due to high market price. Furthermore, it is being exported to the Middle East countries in large quantities. But recently the extent of chilli cultivation has been reduced mainly due to importation of dry chilli, unavailability of green chilli varieties, quality seeds, price reduction and pests and diseases. Therefore, in the present experiment, the open pollinated green chilli variety MK was evaluated with two hybrid green chilli varieties (Hot pepper BN 012112 and Vini Vici) and three varieties (MI hot, KA 2 and Arunalu) recommended by the Department of Agriculture, Sri Lanka. Therefore, the objectives of present study were to evaluate the six chilli varieties for their morphological, vegetative, reproductive, fruit

quality and yield parameters as well as for their pest and disease resistance.

MATERIALS AND METHODS

This study was carried out at the Regional Agricultural Research and Development Center (RARDC) Makandura during *maha* 2004/2005 in low country intermediate zone. The major soil group in Makandura region is Red Yellow Podsollic with hard and soft laterite. Climatic condition during experimental period (October 2004 to March 2005) in Makandura is given in table 2.

Table 2: Climatic condition at Makandura (2004/2005).

| Month | Temperature ($^{\circ}$ C) | | Rainfall (mm) | Relative humidity (%) |
|---------------|-----------------------------|---------|---------------|-----------------------|
| | Maximum | Minimum | | |
| 2004 October | 32.62 | 23.29 | 278.2 | 84.09 |
| 2004 November | 31.88 | 24.20 | 285.8 | 77.15 |
| 2004 December | 31.24 | 22.82 | 141.1 | 75.10 |
| 2005 January | 31.03 | 23.56 | 104.3 | 74.56 |
| 2005 February | 33.70 | 22.33 | 57.6 | 67.69 |
| 2005 March | 34.28 | 23.14 | 121.1 | 75.38 |

Varieties Tested;

Six chilli varieties were used as experimental treatments in the present study. They are given below.

1. Hot pepper BN 012112 – An F₁ hybrid
2. KA 2 -Recommended by Department of Agriculture
3. MI Hot - Recommended by Department of Agriculture
4. Arunalu - Recommended by Department of Agriculture
5. Vini Vici - An F₁ hybrid
6. MK – Open pollinated variety introduced from Vietnam

Crop Establishment and Management;

Chilli seedlings were raised in a nursery bed (1m x 3m) according to the recommendations of the Department of Agriculture, Sri Lanka. Land preparation was done before transplanting. Eighteen raised plots (3.6 m x 2.25 m) were prepared for transplanting the seedlings. The plots were prepared 50 cm apart. The total plot area was 145.8 m². The experiment was laid out in a Randomized Completely Block Design with three replicates.

Healthy and vigorous 28 day old seedlings were transplanted in plots and refilling was carried out to maintain the plant density. Each plot consisted 30 plants. The planting hole was prepared (30 x 30 x 30 cm) at a spacing of 45 cm x 60 cm. Fertilizer application was done according to the recommendations of the Department of Agriculture (Table 3).

Organic fertilizer, cow dung was applied two days before planting with inorganic fertilizers. During the early stage, the crop was irrigated daily. Weeding was done manually with care. Chlorothalonil was applied for anthracnose disease (*Colletotricum capsici*) and Imidachlophid was applied for controlling of vectors (*Scirtothrips dorsalis*, *Bemisia tabaci*, *Aphid gossypii*) of leaf curl complex. When the pods were

well matured (for green chilli), the harvesting was done and carried out at 7-10 day intervals.

Table 3: The DOA fertilizer recommendation for chilli.

| | Time of application | Fertilizer (kg/ha) | | |
|------------------------------|------------------------------|--------------------|--------|--------|
| | | Urea | T.S.P. | M.O.P. |
| Basal dressing | 2 days before transplanting | - | 100 | 50 |
| 1 st Top dressing | 2 weeks after transplanting | 65 | - | - |
| 2 nd Top dressing | 4 weeks after transplanting | 85 | - | - |
| 3 rd Top dressing | 8 weeks after transplanting | 85 | - | 50 |
| 4 th Top dressing | 12 weeks after transplanting | 85 | - | - |

Data Recording

Following parameters were recorded from the net plot.

2.1. Morphological characters

2.1.1. Plant growth habit - Recorded when 50 % of the plants have well matured fruits as described by Anon (1995).

2.1.2. Fruit color - Recorded from ten matured fruits of second harvest (Anon, 1995). The color was recorded using the Royal Horticultural Society Color Chart.

2.1.3. Fruit shape - Recorded using the Description given by Anon (1995).

2.2. Vegetative and reproductive parameters

2.2.1. Plant height (cm) - Recorded when 50 % of the plants have well matured fruits (Anon, 1995).

2.2.2. Days to first flowering - Recorded number of days from transplanting until 50% of plants have at least one open flower.

2.2.3. Days to first fruiting - Recorded number of days from transplanting until 50% of the plants bear mature fruits at the first and second bifurcation.

2.3. Fruit quality parameters

2.3.1. Fruit length (cm) - Measured from stem-end to blossom-end of the fruit in average of ten well-matured fruits of the second harvest (Anon, 1995).

2.3.2. Fruit diameter (mm) - Measured at the widest point in average of ten well-matured fruits of the second harvest using the Vernier Caliper (15-100-500 Manosat).

2.3.3. Pericarp thickness (mm) - Measured at point of maximum diameter in average of ten well-matured fruits of second harvest using the Vernier Caliper (15-100-500 Manosat).

2.3.4. Total soluble solids (Brix value) - Measured from well-matured fruits using the Hand Refractor- meter [ATAGO, N-1_E (Brix 0-32%)].

2.3.5. Pungency - Pungency was evaluated using small pieces of well-matured fruits. Thirty

panelists were selected for pungency evaluation. They were asked to rank each sample depending on pungency (not pungent, low, moderate, high).

2.4. Yield parameters

2.4.1. Yield per plant (gm) - Yield per plant was calculated from randomly selected 5 plants from each plot.

2.4.2. Number of fruits per plant - An average number of fruits was calculated from each plot. The number of fruits was counted in 100 gm fruit weight and it was back calculated to yield per plant.

2.4.3. Fruit weight (gm) - Measured the average fruits weight in ten well-matured fruits taken from second harvest using the Triple Beam Balance (700 series).

2.4.4. Total yield (t/ha) - Total yield was calculated from randomly selected 5 plants from each plot.

2.5. Pest and disease resistance

Visually observed from the 50% of affected plants.

Statistical Analysis

The parametric data were subjected to ANOVA in SAS statistical package, while the non-parametric data were analyzed using Kruskal -Wallis test.

RESULTS AND DISCUSSION

3.1. Morphological Characters

Table 4: Morphological characters of six chilli varieties tested at Makandura during 2004/2005 maha

| Character | Hot pepper | KA 2 | MI Hot | Arunalu | Vini Vici | MK |
|--------------------|------------|------|--------|---------|-----------|-----|
| Plant growth habit | ER | I | ER | ER | ER | ER |
| Fruit Shape | E | E | E | E | E | E |
| Fruit color | G | G | G | G | G | G |
| | 137 | 137 | 137 | 137 | 139 | 137 |
| | A | A | A | A | A | A |

ER-Erect, I-Intermediate, E-Elongate, G-Green

3.1.1. Plant growth habit -

Variety KA 2 has shown intermediate growth habit while other varieties were erect (Table 4). When plant growth habit is erect, it reduces the mutual shading of leaves and allows more light to penetrate through the canopy (Anon, 2004b). The photosynthesis rate is accelerated by more light penetration and it would result in high accumulation of carbohydrates within the plant. Further, it contributes in producing more fruits and increasing the yield

3.1.2. Fruit color -

The variety Vini Vici gave a dark green (139 A) appearance at intermediate stage (Table 4). But, other five varieties were green in whole (137A).

3.1.3. Fruit shape -

All the tested varieties were shown elongated fruit shape (Table 4). Anon (1995) reported

that *Capsicum spp.* have elongate, almost round, triangular, campanulate and blocky fruit shapes. However, the tested green chilli varieties were in elongate group of fruit shape.

3.2. Vegetative and Reproductive growth parameters

Table 5: Vegetative and Reproductive parameters of six chilli varieties tested at Makandura during 2004/2005 maha

| Treatment | Plant height (cm) | Days to first flowering | Days to first fruiting |
|------------|--------------------|-------------------------|------------------------|
| Hot pepper | 56.7 ^A | 54 ^A | 63 ^A |
| KA 2 | 41.1 ^C | 51 ^{AB} | 59 ^B |
| MI Hot | 52.2 ^{AB} | 51 ^{AB} | 59 ^B |
| Arunalu | 47.3 ^{BC} | 48 ^{BC} | 60 ^B |
| Vini Vici | 58.0 ^A | 50 ^{AB} | 60 ^B |
| MK | 47.3 ^{BC} | 44 ^C | 60 ^B |
| CV | 9.7 | 8.7 | 3.0 |
| LSD | 8.9 | 7.7 | 3.3 |

Means in a column followed by the same letter are not significantly different at 0.05 level

3.2.1. Plant height-

The plant height of variety MK at first harvest was 47.3 cm (Table 5) and it was not significantly different from DOA recommended varieties. Further, in DOA recommended varieties, the plant height ranged from 41.1 to 47.3 cm. Both hybrids, Hot pepper and Vini Vici, were taller (56.7 and 58.0 cm respectively) than others. When plants are taller, there is a possibility to lodge and create problems in harvesting. However, the plant height was medium in variety MK, there is less chances to lodge.

3.2.2. Days to first flowering and first fruiting -

Variety MK has taken significantly lesser number of days to first flowering than other varieties (44 days) after transplanting. DOA recommended varieties and two hybrids have taken 48 days to 54 days for first flowering (Table 5).

Furthermore, variety MK has taken 60 days for first fruiting. Except the hybrid variety Hot pepper (63 days), all other varieties have taken 59 to 60 days for first fruiting (Table 5).

3.3 Fruit Characters

Table 6: Fruit characters of six chilli varieties tested at Makandura during 2004/2005 maha

| Treatment | Fruit length (cm) | Fruit diameter (mm) | Pericarp thickness (mm) | Total soluble solid (%) |
|------------|--------------------|---------------------|-------------------------|-------------------------|
| Hot Pepper | 9.57 ^A | 10.04 ^{CD} | 0.32 ^B | 9.57 ^A |
| KA 2 | 5.91 ^{CB} | 10.95 ^{BC} | 0.35 ^B | 8.27 ^A |
| MI Hot | 5.40 ^C | 11.14 ^B | 0.32 ^B | 8.10 ^A |
| Arunalu | 6.01 ^{CB} | 9.40 ^D | 0.28 ^B | 9.19 ^A |
| Vini Vici | 7.13 ^B | 9.71 ^D | 0.27 ^B | 7.80 ^A |
| MK | 8.98 ^A | 14.58 ^A | 0.61 ^A | 7.94 ^A |
| CV | 10.18 | 5.45 | 29.38 | 19.26 |
| LSD | 1.32 | 1.08 | 0.19 | 2.97 |

Means in a column followed by the same letter are not significantly different at 0.05 level

3.3.1. Fruit length-

Longer fruits were observed in variety MK (8.98 cm) and hybrid Hot Pepper (9.57 cm). There was no significant difference in fruit lengths between KA 2, MI Hot, Vini Vici and Arunalu (Table 6). Longer fruits would give a better market appearance and would have a higher demand than shorter varieties.

3.3.2. Fruit diameter –

Variety MK recorded the highest fruit diameter (14.58mm) than other varieties (Table 6). DOA recommended varieties and hybrids ranged from 9.4 to 11.14 mm. Green chilli is mainly exported to the Middle East countries such as Saudi Arabia, Oman, Kuwait (Anon, 2002b). Variety MI 2 has the highest demand in the export market and the ideal fruit diameter should be 10 mm (Anon, 2004b). As variety MK showed a fruit diameter of more than 10 mm (14.58 mm), it is not suitable for export market.

3.3.3. Pericarp thickness -

Pods of variety MK recorded the thickest fruit wall (0.61 mm). Values of other varieties ranged from 0.27 to 0.35 mm in pericarp thickness (Table 6). Due to high fruit wall thickness in variety MK, it is more suitable for green chilli production than dry chilli. Thick fruit wall takes longer time for drying (Anon, 2004b). During longer period of drying, it can be affected by secondary infections and the reduction in fruit quality appearance.

3.3.4. Total soluble solids-

The variety MK recorded 7.94 % of total soluble solids (TSS). There were no significant differences in total soluble solids (TSS) among the varieties and it ranged from 8.10 % to 9.57% (Table 6). Normally, TSS of chilli varieties ranged from 7.0 % to 9.5% and it is mainly due to soluble carbohydrates (Sarananda, 2005).

3.3.5. Pungency –

According to statistical analysis of probability value and mean scores for pungency, it was evident that there were significant differences in pungency among the varieties (Table 7). The variety Arunalu recorded the highest pungency mean score (123.2), while variety MI Hot recorded the lowest pungency mean score (31.0). The variety MK scored a moderate mean value (92.2) in pungency. The cause of the pungency and spicy taste in chilli is mainly due to the presence of crystalline, colorless capsaicin or capscutin compound (C₁₈H₂₇NO₃). Its content is more in the pericarp of the fruit. (Bose *et al.*, 2002).

Table 7: Probability (P) value and mean scores of pungency evaluation of six chilli varieties tested at Makandura during 2004/2005 maha

| Treatment | Pungency (Means sore) |
|------------|-----------------------|
| Hot pepper | 85.7 |
| KA 2 | 108.8 |
| MI Hot | 31.0 |
| Arunalu | 123.2 |
| Vini Vici | 102.0 |
| MK | 92.2 |
| P-value | < 0.0001 |

Probability value (*p* < 0.05) significant different

3.4. Yield Parameters

3.4.1. Yield per plant-

There were no significant yield differences among the treatments. The yield / plant ranged from 263.3 gm to 399.7 gm (Table 8).

Table 8: Yield parameters of six chilli varieties tested at Makandura during 2004/2005 maha

| Treatment | Yield/plant (gm) | Fruits /plant | Fruit weight (gm) | Total yield (t/ha) |
|------------|--------------------|------------------|--------------------|--------------------|
| Hot Pepper | 339.0 ^A | 58 ^{AB} | 5.53 ^B | 2.06 ^A |
| KA 2 | 314.7 ^A | 77 ^{AB} | 4.40 ^C | 1.59 ^{AB} |
| MI Hot | 351.3 ^A | 59 ^{AB} | 4.52 ^C | 1.95 ^A |
| Arunalu | 363.0 ^A | 102 ^A | 3.50 ^D | 1.66 ^{AB} |
| Vini Vici | 399.7 ^A | 76 ^{AB} | 4.74 ^{BC} | 1.34 ^B |
| MK | 263.3 ^A | 29 ^B | 8.56 ^A | 1.71 ^{AB} |
| CV | 35.0 | 41.64 | 9.43 | 19.13 |
| LSD | 216.0 | 50.96 | 0.89 | 0.59 |

Means in a column followed by the same letter are not significantly different at 0.05 level.

3.4.2. Fruits/plant-

Variety MK recorded the lowest number of fruits per plant (29), while variety Arunalu recorded the highest number of fruits (102). Even though the variety MK showed a lower fruit number, the yield had no difference with other recommended varieties. This could be attributed to the heavier fruits than other varieties.

3.4.3. Fruit weight-

The average fruit weight of variety MK was 8.56 gm. Except for the variety Arunalu (3.50 gm) in all other four varieties, the fruit weight ranged from 4.40 to 5.53 gm (Table 8). Arunalu that has a thin pericarp is more suitable for dry chilli production due to minimum weight losses in drying process (Anon, 2004b). However, MK variety due to thick pericarp is more suitable for green chilli production than dry chilli production.

3.4.4. Total yield-

The average yield ranged from 1.34 to 2.06 t/ha (Table 8). The variety MI Hot and variety Hot pepper recorded significant average yield differences (1.96 and 2.06 t/ha, respectively) from the average yield of variety Vini Vici (1.34 t/ha). The Department of Agriculture recommended varieties recorded potential average yield of 1.5 to 2.0 t/ha under irrigated condition in *maha* season (Anon, 2004). Therefore, variety MK reported comparable yields as recommended varieties.

3.5 Pest and Disease Resistance

All the tested varieties showed moderate level of resistance to the anthracnose and leaf curl complex diseases. Chilli leaf curl complex is associated with four insect pests namely, thrips, white flies, aphids and mites and several viruses and the anthracnose causes serious crop losses, especially during *maha* season (Priyantha *et al.*, 2004). Therefore, the integrated pest management approach is the best way to control the anthracnose and leaf curl complex diseases.

CONCLUSIONS

Chilli variety MK is most suitable for green chilli production than dry chilli production. It was mainly due to better performance in fruit quality parameters. Variety MK showed the thicker fruit wall (0.61 mm), the longer fruit (8.98 cm), higher fruit weight (8.56 gm) and higher fruit diameter (14.58 mm). The plant height was 47.27 cm and showed erect plant with comparatively less leafy allowing more light to penetrate through the canopy. It took less number of days (44 days) for first flowering and recorded 60 days for first fruiting after transplanting. The fruit shape was elongate and green in color. Fruits were moderately pungent and the total soluble solids were recorded as 7.94 %. Variety MK reported comparable total yield (1.71 t/ha) with presently recommended DOA varieties. The average yield per plant was 263.3 gm. Variety MK was moderately resistant to the anthracnose and leaf curl complex diseases. Therefore, the variety MK shows better performance in all attributes as a green chilli in the Low Country Intermediate Zone.

Further testing need to be carried out to test its adaptability and performance in farmer fields.

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