

GALKIRIYAGAMA SELECTION – AN IMPROVED CHILLI (*Capsicum annuum* L.) VARIETY

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ABSTRACT

Chilli (*Capsicum annuum* L.) is one of the major cash crops and an essential condiment grown mainly in the Dry and Intermediate zones of Sri Lanka. The productivity of the varieties developed by the Department of Agriculture, Sri Lanka during the past five decades has decreased mainly due to increase in susceptibility to pests and diseases. Therefore, new varieties with desirable characters are essential to overcome the risk associated with the pest and disease incidences in chilli cultivation. This study was conducted at the Field Crops Research and Development Institute (FCRDI), Mahalluppallama, Sri Lanka with the objective of selecting a well adapted variety coupled with better agronomic traits, through purification and selection processes from an out-crossed segregating chilli population. The selected pure line (*Galkiriyagama* selection) was evaluated with seven entries namely, MICH-1, MICH-2, MICH-6, ARL95, *Makandura* selection, MI-2 and MI-Hot in the Dry and Intermediate zones of Sri Lanka. The *Galkiriyagama* selection showed a higher positive mean deviation (D) across environments, performed better for yield and other agronomic traits and was moderately tolerant to major insect pests and diseases. Suitability for both green and dry chilli production, high storability and high pungency favored the recommendation of this variety for extensive cultivation in Sri Lanka.

KEYWORDS: Chilli, *Galkiriyagama* selection, Agronomic traits, Pure line

INTRODUCTION

Chilli (*Capsicum annuum* L.) is the most popular spice and condiment in the world and consumed daily by 25 % of the world's population. India is the largest consumer and the exporter of chilli, and consumes around 6.2 million t of chillies, *i.e.* about 90 % of the total produce of the country (Anonymous, 2009). Chilli is also one of the major cash crops grown mainly in the dry and intermediate zones of Sri Lanka. It is also an essential condiment in the Sri Lankan's daily diet. In 2009, the annual extent and production of chilli was about 13,554 ha and 46,414 t, respectively (Agstat, 2011). A large portion of the harvest reaches the market as green chillies. The total dry chilli requirement for the country is estimated 45,000 t per year. The chilli production has declined during the last two decades and the imports have increased sharply, and thus increasing the foreign exchange spent, where about 36,054 t of chilli were imported to Sri Lanka in 2009 at the cost of 4888 Rs. million (Agstat, 2011).

During the past five decades, the Department of Agriculture of Sri Lanka has developed six chilli varieties having a yield potential of 2.5 to 3 t ha⁻¹ of dry chilli. However, the national average yield is still as low as 1.0 t ha⁻¹. Among the chilli varieties, MI-2 and KA-2 are the most popular and cultivated by more than 90 % of the chilli growers. The reasons identified for the low chilli yields are the high pests and disease incidences, moisture stress, inadequate supply of quality seeds and varieties and high input cost. Farmers have also been discouraged with the unstable market situation.

Sexual reproduction in plant species enhances genetic diversity due to the random exchange of genes (Richards, 1986). The high rate of out-crossing of chilli is an advantage in breeding compared to self pollination. Development of heterogeneous progenies among the open pollinated population leads to the emergence of new landraces. New varieties can be developed from these land races through a series of selection and purification processes. Due to the generation advancement process, most of the desirable characters get fixed in the population with time, and the variation decrease within the selected progenies.

The genetic characters of the popular varieties have changed due to cross pollination and continuous cultivation. In addition, their productivity levels have decreased with increasing susceptibility to pests and diseases. Development of varieties resistant to pests and diseases, tolerant to moisture stress with acceptable quality and with high productivity would lead to reduction in the cost of production. Therefore, a variety that could be used as green as well as dried chilli with other desirable characters and resistance or tolerance to pest and disease is an urgent need.

MATERIALS AND METHODS

The *Galkiriyagama* line was selected from a segregating mixed chilli population, which was cultivated during 1990s by the farmers of Galkiriyagama village in Dambulla, Sri Lanka. The origin of the line, however, is unknown. The red, ripen pods were collected during the past ten years from the disease-free plant populations and the seeds extracted were purified at the Field Crops Research and Development Institute (FCRDI) at MahaIlluppallama, to obtain a uniform progeny. The selection procedure was started during the *maha* season 2000/2001 and was continued up to the *yala* season 2006. The single plant selection, progeny selection, and mass selection methods were followed to produce the pure line. Higher yield, resistance to major pest and diseases including leaf curl complex (LCC) and anthracnose, attractive green color, pod size and shape (for green chilli), bright red color with gloss surface and thin pericarp (of dry chilli), high pungency and good keeping quality are the characteristics considered during selection. Reaction of new

chilli lines and recommended varieties against anthracnose, cercospora leaf spot, choanephora blight, cucumber mosaic virus, chilli leaf curl virus was tested during the *maha* season 2009/2010.

The single plant selection was followed at the initial stage of selection. Progenies selected from the single plants were allowed to cross pollinate within the progeny to avoid the inbreeding loss. Purification was done by rouging out the undesirable plants from the progenies and seed multiplication was conducted in selected progenies. The yield and other agronomic characters of the selected pure line were evaluated with seven entries namely, MICH – 1, MICH – 2, MICH – 6, ARL 95, *Makandura* selection, MI – 2 and MI – Hot from 2006 to 2008. Screening of the selected pure line and seven entries for resistance to anthracnose and leaf curl complex was conducted at the pathology division of the FCRDI during the *yala* season 2009. The severity of LCC was scored according to 0-5 scale at 8 and 12 weeks after planting under minimum spraying condition. The disease severity of anthracnose was measured at each harvest, using 25 randomly selected fruits per plot, in a 0-9 scale.

The adaptability and stability of the selected pure line with seven recommended varieties were tested at the Regional Agriculture Research and Development Centre at Makandura and FCRDI at Mahalluppallama, under the National Coordinated Varietal Trials in the *yala* season 2007. The yield and the level of preference of the farmers of the selected pure line were evaluated in the *maha* season 2007/2008, and *yala* seasons in 2008 and 2009 under the Varietal Adaptability Trials at the farmer's fields of Anuradhapura, Madatugama, Kekirawa and Mahalluppallama in the Anuradhapura District. The social response based on the perception of farmers who conduct the adaptability trials and the extension staff of the Department of Agriculture (DOA) was assessed. Storability of the dry pods of the selected pure line was compared with the recommended varieties of KA-2, MI-2, Arunalu and MI-Hot.

The yield data were analyzed using the deviation of plot-yield from the environmental mean by the method proposed by Abeywardena *et al.* (1991). The selection of highly adaptable varieties was done based on the highest positive mean deviation (D) across environments.

RESULTS AND DISCUSSION

The *Galikiriyagama* selection performed well and showed comparable or even higher yields than the recommended variety MI-2, and showed a higher

average number of pods plant⁻¹, which not significantly different to that of the entry showing the highest number of pods plant⁻¹ (MICH-6; Tables 1 and 2).

Table 1. Yield and other agronomic characters of new chilli lines with two recommended varieties in yala season 2006 at Mahailuppallama

<i>Variety/Breeding line</i>	<i>Total yield (t ha⁻¹)</i>	<i>Average number of pods plant⁻¹</i>	<i>Average plant height (cm)</i>	<i>Average length of the pod (cm)</i>
MICH-1	11.20 b	68 ab	62	9.2
MICH-2	8.75 b	41 d	60	7.9
<i>Galkiriyagama</i> selection	12.28 ab	74 ab	58	8.6
MICH-6	14.48 a	81 a	62	8.7
ARL95	8.92 b	52 bcd	60	9.0
<i>Makandura</i> selection	11.30 b	50 cd	66	11.6
MI-2 (std)*	10.17 b	63 bc	42	6.2
MI-Hot (std)	10.66 b	62 bc	58	8.5
CV %	19.42	18.89		

Within a column, the means followed by the same letter are not significantly different at p=0.05;

*Std - Stranded Recommended Line

Table 2. Yield and other agronomic characters of new chilli lines with standard varieties in maha season 2006/2007 at Mahailuppallama

<i>Variety/Breeding line</i>	<i>Total yield (t ha⁻¹)</i>	<i>Average number of pods plant⁻¹</i>
MICH-1	9.41 d	48.5 c
MICH-2	8.12 e	48.4 c
<i>Galkiriyagama</i> selection	13.71 b	91.0 a
MICH-6	14.28 a	94.0 a
<i>Makandura</i> selection	10.41 c	68.5 b
MI-2	9.36 d	100.0 a
CV %	1.47	9.80
LSD	241.3	6.70

Within each column, the means followed by the same letter are not significantly at different p=0.05.

The entry MICH-6 and *Galkiriyagama* selection showed higher positive mean deviations in yala season 2007 (Table 3). As the stability parameter was non-significant (p>0.05), it could be concluded that both varieties were highly adaptable compared to the recommended varieties (MI-2 and MI-hot). The MICH-6 and *Galkiriyagama* selection recorded higher positive mean deviations in all seasons (Tables 4, 5 and 6). The stability parameter of the selected pure line is not significant (p>0.05) and showed a high adaptability compared to the other tested varieties.

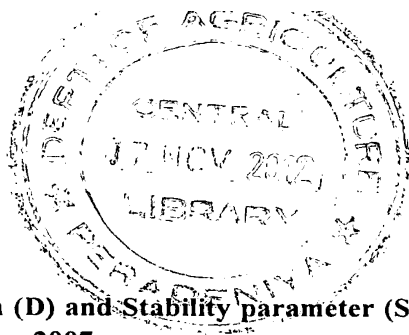


Table 3. Mean deviation (D) and Stability parameter (S²) values of tested entries under NCVT in the yala season 2007

Variety/Breeding line	Mean Green chilli Yield (t ha ⁻¹)	Mean Deviation (D)	Stability Parameter (S ²)
MICH-1	9.40 c	- 1.443 c	Ns
MICH-2	8.10 d	- 2.69 d	ns
MICH-6	14.12 a	+ 3.32 a	ns
Galkiriyagama Selection	13.61 a	+ 2.76 a	ns
MI-2	9.23 c	- 1.619 c	ns
MI-Hot	10.53 b	- 0.314 b	ns
C.V.%	7.84		

Within each column, the means followed by the same letter are not significantly different at p=0.05 by the Duncan's Multiple Range Test; ns - Not significant

Table 4. The mean deviation (D) and stability parameter (S²) values of tested entries in farmer's fields of Eppawala, Thambuththegama and Mahalluppallama in the Anuradhapura District in the maha season 2007/2008

Variety/Breeding line	Mean green chilli yield (t ha ⁻¹)	Mean Deviation (D)	Stability Parameter (S ²)
MI-2	11.092 c	- 1.469 c	8.31 s
Galkiriyagama Selection	12.760 b	+ 0.197 b	0.41 ns
MICH-6	13.834 a	+ 1.271 a	8.04 s
CV %	2.40		

Within each column, the means followed by the same letter are not significantly different at p=0.05 by the Duncan's Multiple Range Test; ns - Not significant

Table 5. The mean deviation (D) and Stability parameter (S²) values of tested entries in farmer's fields of Anuradhapura, Madatugama, Kalaththewa and Mahalluppallama in the Anuradhapura District in the yala season 2008

Variety/Breeding line	Mean green chilli yield (t ha ⁻¹)	Mean Deviation (D)	Stability Parameter (S ²)
MI-2	10.10 b	- 1.906 b	Ns
Galkiriyagama selection	12.70 a	+ 0.680 a	ns
MICH-6	13.30 a	+ 1.220 a	ns
CV %	4.87		

Within each column, the means followed by the same letter are not significantly different at p=0.05 by the Duncan's Multiple Range Test; ns - Not significant

The dry pods of the selected pure line can be stored for more than six months without changing the colour and the appearance of the pods, while the color change was observed within three months in the variety KA-2 and within five months in MI-2. The slender pods with moderate length (8-10 cm) of the *Galkiriyagama* selection can easily attract the green chilli market due to its pungent taste and shine greenish appearance. Even at 84 days after planting, the

Galkiriyagama selection showed a lower susceptibility to LCC than the recommended varieties tested (Table 7).

Table 6. The mean deviation (D) and Stability parameter (S²) values of tested entries season in farmer's fields of Anuradhapura, Madatugama, Kekirawa and Mahalluppallama in the Anuradhapura District in the *maha* season 2007/2008

<i>Variety/Breeding line</i>	<i>Mean green chilli yield (t ha⁻¹)</i>	<i>Mean Deviation (D)</i>	<i>Stability Parameter (S²)</i>
MI-2	10.94 b	- 1.609 b	0.514 s
<i>Galkiriyagama</i> selection	13.32 a	+ 0.776 a	0.023 ns
MICH-6	13.30 a	+ 1.220 a	1.61 s
CV %	2.59		

Within a column, the means followed by the same letter are not significantly different at $p=0.05$ by the Duncan's Multiple Range Test; s – significant, ns - Not significant

Table 7. The severity of LCC of new breeding lines with the recommended varieties in the *yala* seasons in 2006 and 2010 at Mahailuppallama

<i>Variety/Breeding line</i>	<i>LCC Severity - Days after planting (DAP)</i>					
	28	42	56	70	84	98
	<i>Yala season 2006</i>					
MICH-1	1	1	2	3	4	5
MICH-2	1	1	2	3	4	5
<i>Galkiriyagama</i> selection	1	1	2	2	3	4
MICH-6	1	1	2	2	3	4
ARL95	1	1	3	4	5	5
<i>Makandura</i> selection	1	2	2	4	4	5
MI-2	1	2	3	4	4	5
MI-Hot	1	1	2	3	4	4
	<i>Yala season 2010</i>					
MICH-6	0	0	1	1	2	3
PC-1	0	0	1	1	2	3
<i>Galkiriyagama</i> selection	0	1	1	2	2	3
TVC-4	1	2	2	3	4	4
TVC-5	1	2	2	3	4	5
<i>Waraniya</i> Selection	0	0	0	0	1	1
MI-2	1	1	2	3	4	5
KA-2	0	0	1	2	2	3
MI-Green	0	1	1	2	3	3

The two varieties namely, MI-Green and *Galkiriyagama* selection and the recommended variety Arunalu were moderately-resistant to the anthracnose disease (Table 8). All the tested varieties were susceptible to cercospora leaf spot and choanephora blight. The variety breeding line waraniaya selection showed moderate resistance the both the cucumber mosaic virus and chilli leaf curl virus (Table 8).

Table 8. The reaction of new chilli lines and recommended varieties against Anthracnose cercospora leaf spot, choanephora blight, cucumber mosaic virus, chilli leaf curl virus during the maha season 2009/2010

Variety/Breeding line	Anthracnose	Cercospora leaf spot	Choanephora blight	Cucumber mosaic virus (CMV)	Chilli leaf curl virus (CLCV)
Arunalu	2.66 c	63.89 abc	96.29 a	16.66 d	34.26 c
MI-Green	5.78 c	50.92 c	74.07 cd	55.55 a	51.85 bc
<i>Galkiriyagama</i> selection	9.92 c	49.2 c	84.92 abc	23.57 cd	52.80 bc
MICH-6	49.48 ab	87.96 a	93.21 a	41.66 b	65.74 b
Hot beauty	60.89 a	91.66 a	75.92 bcd	35.18 b	96.29 a
ICPN-18	59.55 a	86.11 ab	82.41 abcd	19.44 d	57.40 b
CAH-36	34.26 b	80.21 ab	67.93 d	23.57 cd	68.99 b
<i>Waraniya</i> selection	32.14 b	66.56 abc	79.36 abcd	9.26 e	7.40 d
KA-2	45.59 ab	58.65 bc	91.53 ab	65.42 a	67.26 b
CV %	34.71	22.74	11.69	21.46	21.29

Within each column, the means followed by the same letter are not significantly different at $p=0.05$ by the Duncan's Multiple Range Test; CMV - Cucumber mosaic virus; CLCV - Chilli leaf curl virus

CONCLUSIONS

Selection of the better line from a segregating population is an important breakthrough in chilli varietal improvement. The selected pure line in this study, the *Galkiriyagama* selection, showed a high yield potential for both dry and green chilli production with longer storability. The *Galkiriyagama* selection has erect plant type, which allows better penetration of sunlight through the canopy. The variety has a yield potential of more than 12 t ha^{-1} and 3 t ha^{-1} of green and dry chilli, respectively. The moderate size of pods (8-10 cm in length) have attractive green colour for green chilli. The bright red colour with glossy surface at red ripened stage with high pungent characters increase the quality and thin pericarp favors easy drying. The dry pod colour does not change as fast as in the case KA-2 or MI-2 during storage and it has good keeping quality. The candidate variety possesses moderate level of resistance to leaf curl complex and anthracnose disease at the field level. The pure line was nominated for the Varietal Releasing Committee of the DOA in 2009 and recommended for extensive cultivation especially in the north central province of Sri Lanka.

ACKNOWLEDGEMENTS

Sincere thanks are offered to all the past Directors and Deputy Directors (Research) of FCRDI at Mahailuppallama for their keen interest, continuous guidance and constant encouragement as well as for providing the required facilities at the Institute during the past twelve-year period of research. The guidance

provided by Dr. W.M.W. Weerakoon, the Director, FCRDI is gratefully acknowledged. The contributions of Ms. K.D.A. Perera (Former Additional Director, FCRDC) Research Officers of; Mr. S. J. Arsakesary, Mr. S.N.Jayawardena and Mr. J.P. Sumanarathne and Agriculture Instructors of; Mrs. Kumari Chandrarathne, Mr. G.M. Guanawansa and Mr. Prabath Kumara and all the members served in the Chilli Breeding division during past twelve year period are deeply acknowledged. Author wished to thank the extension staff and the farmers of the north central province and Mahaweli System H for their immense support during the adaptability testing of the promising lines. The contribution of Ms. Shalika Nadeeshani (Research Officer) during compiling of this paper and useful suggestions is duly acknowledged.

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