4th RMUTIC 2013 organized by Rajamangala University of Technology Phra Nakhon, Bangkok-Thailand

JOURNAL OF APPLIED SCIENCES RESEARCH

JOURNAL home page: http://www.aensiweb.com/jasr.html 2013 Special, 9(12) pages: 6111-6114

Published Online :15 January 2014 **Research Article**

Heterosis of Three-Way Crosses between Thai Melon and Cantaloupe

Pramote Pornsuriya, Pornthip Pornsuriya and Sirima Teerasakulchol

Rajamangala University of Technology Tawan-Ok, Faculty of Agriculture and Natural Resources, Department of Plant Production Technology, Chonburi,Thailand

Received: 12 November 2013; **Revised:** 14 December, 2013; **Accepted:** 20 December 2013.

ABSTRACT

Information about heterosis of plant characters is useful for plant breeders to select suitable materials in their breeding programs. The objective of the present work is to study the heterosis for fruit characters and yield of crosses between Thai melon (oriental pickling melon) lines and cantaloupe cultivars. Three Thai melon lines namely W, S (cylindrical fruit) and R (round fruit) as maternal lines were crossed by two cantaloupe hybrid cultivars namely A (Argo, round fruit and netted skin) and H (Honda, round to oblong fruit and smooth skin). The six crosses and their parents (all 11 treatments) were laid out in a randomized complete block design (RCBD) with 4 replications. They were planted in a single-row system and their vines were freely climbed on plot beds, in the experimental field of The Department of Plant Production Technology, Rajamangala University of Technology Tawan-Ok, Chonburi province, from January to March, 2012. The results for the mid-parent heterosis of crosses between Thai melon and cantaloupe revealed that the cross R x H should be considered to the next breeding program since it had high and significant heterosis ($P<0.01$) in fruit weight (71.37 percent) and yield (68.39 percent). This cross also had significantly more ($P<0.01$) fruit weight and yield than its parents (heterobeltiosis). It tended to give higher fruit sweetness (TSS, 7.89 °Brix) than the other crosses. However, all crosses were not found heterosis in fruit sweetness.

Key words: Cucumis melo var. *conomon*, hybrid vigor

INTRODUCTION

Thai melon or oriental pickling melon (*Cucumis melo* L. var. *conomon*) has been one of the important local vegetables in Thailand, and it has been grown by Thai farmers for a long time for both young and ripe fruit consumptions. Thai melon is also used as Thai medicinal plant for some purposes such as thirst quenching and mouth ulcer, etc. Thai farmers usually plant Thai melon in paddy field after harvesting rice. Its mature fruits are available in the markets in the dry hot winter months or other times [3]. It has advantages as a rapidly growing plant, tolerant to high temperatures and relatively high rainfall [11]. However, the eating quality of Thai melon fruit is lower than cantaloupe fruit. Fruit flesh sweetness of Thai melon is less than that of cantaloupe. Sweetness or sugar content is the most important factor determining the eating quality of melon fruits [8]. Total soluble solid (TSS) of melon flesh, as a refractometer reading, is a relied measure of sweetness and thus a measure of quality. The crosses between Thai melon and cantaloupe were conducted in the present study to determine their heterosis that would be useful for the breeding program. Heterosis over better parents (heterobeltiosis) on yield and related traits in melon (*C. melo*) was observed by some researchers such as Kalb and Davis [4], Lian Jie *et al.* [6] and Singh and Randhawa [10]. The objective of this study was to evaluate heterosis in some characters of the three-way crosses between Thai melon lines and cantaloupe hybrid cultivars, thus the information and the breeding materials of this study would be applied to improve Thai melon quality in the next breeding program.

Materials and Methods

Three Thai melon lines (S_5) namely R (round fruit), S and W (cylindrical fruit) and two hybrid cultivars of cantaloupe namely A (Argo) and H (Honda), were planted in the first season for the crossing by hand-pollination (Thai melon and cantaloupe as female and male, respectively). They were grown in 2-row plots with 50x60-cm. spacing (plant x row) under the trellising system available for hand-pollination. The seeds of six crosses (RxA, SxA, WxA, RxH, SxH and WxH) were obtained for the next planting. For the second season, the six crosses and their parents (all 11 treatments) were laid out in a randomized complete block design (RCBD) with 4 replications. Plants were grown in a single-row system and their vines were freely climbed on plot beds (using plastic mulch), plot size 1 x 3 m^2, plant spacing 0.5 m, 6 plants per plot. The experiment was conducted under standard furrow

Corresponding Author: Pramote Pornsuriya, Rajamangala University of Technology Tawan-Ok, Faculty of Agriculture and Natural Resources, Department of Plant Production Technology, Chonburi,Thailand
E-mail: pornsuriya@hotmail.com Tel. +6638-358-137 ext.1251

irrigation, cultural practices, and pest control practices. Of each plot, data were separately recorded on fruit length and width (cm), fruit shape index (fruit length/fruit width), fruit cavity length and width (cm), fruit flesh thickness (cm), flesh sweetness (°brix), flesh weight (g), fruit weight (g) and yield (kg/4.5 m^2). Data were analyzed statistically by analysis of variance according to the RCBD. Mid-parent heterosis (%) was significantly tested by the functional analysis of variance (single-df comparison). The study was performed at Faculty of Agriculture and Natural Resources, Rajamangala University of Technology Tawan- ok, Chonburi province from January to March, 2012 (the second season).

Results and Discussion

Heterosis (mid-parent heterosis):

The cross W x H had significantly positive heterosis on six characters ranking from maximum to minimum as follows: yield per plot, flesh weight, fruit weight, fruit cavity length, fruit length and fruit shape index (56.33, 55.43, 54.03, 51.82, 38.83 and 29.06 %, respectively) (Table 1).

The cross R x H had significantly positive heterosis on seven characters ranking from maximum to minimum as follows: flesh weight, fruit weight, yield per plot, fruit cavity width, fruit width, fruit cavity length and fruit length (74.48, 71.37, 68.39, 47.53, 26.27, 23.60 and 14.79 %, respectively) (Table 2).

The cross W x A had significantly positive heterosis on four characters ranking from maximum to minimum as follows: fruit cavity length, yield per plot, fruit shape index and fruit length (28.17, 24.80, 17.47 and 16.82 %, respectively), and significantly negative heterosis on fruit flesh thickness and fruit width (-20.52 and -8.90, respectively) (Table 3).

The cross S x A had significantly positive heterosis on fruit cavity length and fruit length (22.85 and 15.51 %, respectively) (Table 4).

The cross R x A had significantly positive heterosis on fruit cavity length and fruit cavity width (21.61 and 20.44 %, respectively), and significantly negative heterosis on fruit flesh thickness (-13.64 %) (Table 5).

(**Note:** the cross S x H was excluded because of problems about seed germination and transplanting.)

Table 1: Heterosis for horticultural traits of a cross between Thai melon line (W) and cantaloupe cultivar (H).

Horticultural traits	Thai melon lines (W)	Cantaloupe cultivars (H)	Mid-parents [(W + H)/2]	Cross (W x H)	Heterosis (%)
Fruit length (cm)	26.17	16.71	21.44	29.76	38.83**
Fruit width (cm)	11.19	13.08	12.13	12.76	5.17 ns
Fruit shape index	2.34	1.28	1.81	2.34	29.06**
Fruit cavity length (cm)	19.71	11.50	15.60	23.69	51.82**
Fruit cavity width (cm)	4.96	6.19	5.57	6.37	14.32 ns
Fruit flesh thickness (cm)	3.06	3.69	3.38	3.36	-0.49 ns
Flesh sweetness (°Brix)	5.33	9.72	7.53	7.67	1.88 ns
Flesh weight (g)	1,375	1,273	1,324	2,058	55.43**
Fruit weight (g)	1,597	1,373	1,485	2,287	54.03**
Yield (kg/4.5 m^2)	17.62	10.05	13.84	21.63	56.33**

ns, * and ** = not significant and significant at $P < 0.05$ and 0.01, respectively, according to a single df comparison.

Table 2: Heterosis for horticultural traits of a cross between Thai melon line (R) and cantaloupe cultivar (H).

Horticultural traits	Thai melon lines (R)	Cantaloupe cultivars (H)	Mid-parents [(R + H)/2]	Cross (R x H)	Heterosis (%)
Fruit length (cm)	11.60	16.71	14.16	16.25	14.79*
Fruit width (cm)	12.83	13.08	12.95	16.35	26.27**
Fruit shape index	0.91	1.28	1.09	1.00	-8.66 ns
Fruit cavity length (cm)	7.85	11.50	9.68	11.96	23.60*
Fruit cavity width (cm)	6.04	6.19	6.11	9.02	47.53**
Fruit flesh thickness (cm)	3.37	3.69	3.53	3.80	7.56 ns
Flesh sweetness (°Brix)	4.22	9.72	6.97	7.98	14.49 ns
Flesh weight (g)	895	1,273	1,084	1,891	74.48**
Fruit weight (g)	1,029	1,373	1,201	2,058	71.37**
Yield (kg/4.5 m^2)	11.84	10.05	10.94	18.43	68.39**

ns, * and ** = not significant and significant at $P < 0.05$ and 0.01, respectively, according to a single df comparison.

Table 3: Heterosis for horticultural traits of a cross between Thai melon line (W) and cantaloupe cultivar (A).

Horticultural traits	Thai melon lines (W)	Cantaloupe cultivars (A)	Mid-parents [(W + A)/2]	Cross (W x A)	Heterosis (%)
Fruit length (cm)	26.17	15.42	20.79	24.29	16.82**
Fruit width (cm)	11.19	16.76	13.97	12.73	-8.90*
Fruit shape index	2.34	0.92	1.63	1.92	17.47**
Fruit cavity length (cm)	19.71	9.52	14.61	18.73	28.17**
Fruit cavity width (cm)	4.96	7.55	6.26	6.69	6.89 ns
Fruit flesh thickness (cm)	3.06	4.94	4.00	3.18	-20.52**
Flesh sweetness (°Brix)	5.33	9.47	7.40	7.43	0.38 ns
Flesh weight (g)	1,375	2,030	1,702	1,748	2.66 ns

Fruit weight (g)	1,597	2,119	1,858	1,948	4.86 ns
Yield (kg/4.5 m^2)	17.62	14.26	15.94	19.89	24.80*

ns, * and ** = not significant and significant at $P < 0.05$ and 0.01, respectively, according to a single df comparison.

Table 4: Heterosis for horticultural traits of a cross between Thai melon line (S) and cantaloupe cultivar (A).

Horticultural traits	Thai melon lines (S)	Cantaloupe cultivars (A)	Mid-parents [(S + A)/2]	Cross (S x A)	Heterosis (%)
Fruit length (cm)	24.98	15.42	20.20	23.33	15.51**
Fruit width (cm)	11.92	16.76	14.34	14.35	0.12 ns
Fruit shape index	2.10	0.92	1.51	1.62	7.43 ns
Fruit cavity length (cm)	19.85	9.52	14.69	18.04	22.85**
Fruit cavity width (cm)	5.88	7.55	6.71	6.75	0.53 ns
Fruit flesh thickness (cm)	3.05	4.94	3.99	3.73	-6.68 ns
Flesh sweetness (°Brix)	4.63	9.47	7.05	6.58	-6.60 ns
Flesh weight (g)	1,485	2,030	1,758	2,024	15.15 ns
Fruit weight (g)	1,780	2,119	1,950	2,245	15.17 ns
Yield (kg/4.5 m^2)	20.37	14.26	17.31	21.21	22.52 ns

ns and ** = not significant and significant at $P < 0.01$, respectively, according to a single df comparison.

Table 5: Heterosis for horticultural traits of a cross between Thai melon line (R) and cantaloupe cultivar (A).

Horticultural traits	Thai melon lines (R)	Cantaloupe cultivars (A)	Mid-parents [(R + A)/2]	Cross (R x A)	Heterosis (%)
Fruit length (cm)	11.60	15.42	13.51	14.81	9.62 ns
Fruit width (cm)	12.83	16.76	14.79	15.11	2.13 ns
Fruit shape index	0.91	0.92	0.91	0.98	7.39 ns
Fruit cavity length (cm)	7.85	9.52	8.69	10.56	21.61*
Fruit cavity width (cm)	6.04	7.55	6.80	8.19	20.44**
Fruit flesh thickness (cm)	3.37	4.94	4.15	3.59	-13.64**
Flesh sweetness (°Brix)	4.22	9.47	6.85	6.82	-0.41 ns
Flesh weight (g)	895	2,030	1,463	1,469	0.46 ns
Fruit weight (g)	1,029	2,119	1,574	1,663	5.69 ns
Yield (kg/4.5 m^2)	11.84	14.26	13.05	16.46	26.16 ns

ns, * and ** = not significant and significant at $P < 0.05$ and 0.01, respectively, according to a single df comparison.

Table 6: Flesh sweetness, flesh weight, fruit weight, and yield per plot of cantaloupe cultivars, Thai melon lines and their crosses.

Genotypes	Flesh sweetness (°Brix)	Flesh weight (g)	Fruit weight (g)	Yield per plot (kg/4.5 m^2)
H	9.72 a	1,273 cd	1,373 de	10.05 e
A	9.47 a	2,030 a	2,119 abc	14.26 cde
W	5.33 cd	1,375 bcd	1,597 cd	17.62 abc
S	4.63 d	1,485 bc	1,780 abcd	20.37 ab
R	4.22 d	895 d	1,029 e	11.84 de
W x H	7.67 b	2,058 a	2,287 a	21.63 a
R x H	7.98 b	1,891 ab	2,058 abc	18.43 abc
W x A	7.43 b	1,748 abc	1,948 abcd	19.89 ab
S x A	6.58 bc	2,024 a	2,245 ab	21.21 ab
R x A	6.82 b	1,469 bc	1,663 bcd	16.46 bcd
F-test	**	**	**	**
CV. (%)	13.28	20.21	19.85	18.17

** = significant at $P < 0.01$.

Means in a column followed by the same letter are not significantly different at $DMRT_{0.05}$

Note: H = Cantaloupe cultivar (Honda; F_1 hybrid)

A = Cantaloupe cultivar (Argo; F_1 hybrid)

W, S and R = Thai melon lines

Sweetness and yield of the cantaloupe cultivars, Thai melon lines and their crosses:

The cantaloupe cultivars H and A had the sweetest fruit (9.72 and 9.47 °Brix, respectively). Considering fruit weight, the crosses W x H, S x A, and the cantaloupe cultivar A had large fruits ranking from the first to the third (2,287, 2,245 and 2,119 g, respectively), whereas the R line of Thai melon had the smallest fruit (1.029 g). The W x H and S x A crosses had yield per plot of 21.63 and 21.21 kg/4.5 m^2, ranking in the first and second, where the cantaloupe cultivar H had the lowest yield (10.05 kg/ kg/4.5 m^2 (Table 6).

Considering the crosses between Thai melon and cantaloupe, it was found that the cross R x H was considered a promising cross suitable for the breeding program because it possessed more fruit weight and yield per plot. It also tended to have more flesh sweetness than others. Since great morphological variation exists in fruit characteristics of melon (*Cucumis melo*) such as size, shape, color and texture, taste and composition [1,5], and it could be cross-pollinated among groups within the species [7] such as between var. *flexuosus* (non-sweet group)

and var. *reticulates* (sweet group) [2], thus crossing between Thai melon and cantaloupe was considerable to produce more genetic variations for selection in Thai melon. Since the breeding population of Thai melon was slightly influenced by genetic effects as reported by Pramote and Pornthip [9] that variations in the studied population of Thai melon were heavily caused by environmental effects.

Conclusions:

All crosses were found heterosis in several horticultural characters. The cross R x H was considered as a promising one since it had high and significant heterosis in fruit weight and yield. This cross also had significantly more fruit weight and yield than its parents. It tended to give higher fruit sweetness than the other crosses. However, all crosses were not found heterosis in fruit sweetness.

Acknowledgements

The present study was financially supported by Rajamangala University of Technology Tawan- ok.

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