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Omprasad J
College of Horticulture, Anantharajupet, Dr. Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

Dr. Madhumathi C
Principal Scientist Horticulture and Head, Citrus Research Station, Petlur, Dr. Y.S.R Horticulture University, Venkataramannagudem, West Godavari, Andhra Pradesh, India

Dr. Syed Sadarunnisa
Professor, Department of Horticulture, College of Horticulture, Anantharajupeta, Dr. Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

Dr. Tanuja Priya B
Associate Professor, Department of Horticultural Research Station, Lam, Dr Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

Dr. M Jayaprada
Assistant Professor (GPBR), College of Horticulture, Anantharajupeta, Dr Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

Dr. Arunodhayam K
Assistant Professor (Pl. Path), College of Horticulture, Anantharajupeta, Dr Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

Corresponding Author:
Omprasad J
College of Horticulture, Anantharajupet, Dr. Y.S.R Horticulture University Venkataramannagudem, West Godavari, Andhra Pradesh, India

Evaluation of muskmelon (*Cucumis melo* L.) parents and hybrids for growth, yield and quality traits

Omprasad J, Dr. Madhumathi C, Dr. Syed Sadarunnisa, Dr. Tanuja Priya B, Dr. M Jayaprada and Dr. Arunodhayam K

Abstract
An experiment was conducted vegetable block, college of horticulture, Anantharajupet, Dr. YSR Horticultural University during three seasons *viz*., summer, *kharif* and *rabi* in 2019-2020 to study fifteen hybrids developed from the six parents of muskmelon (AM Sel-1, AM Sel-2, AM Sel-3, AM Sel-4, AM Sel-5, AM Sel-6 with two standard checks for twenty-six characters. Results indicated that four crosses C_{10} (AM Sel-3× AM Sel-4), C_{11} (AM Sel-3× AM Sel-5), C_{14} (AM Sel-4× AM Sel-6) and C_{15} (AM Sel-5× AM Sel-6) recorded superior mean performance regarding most characters. The cross C_{10} (AM Sel-3× AM Sel-4) recorded minimum days taken to appearance of first female flower, minimum days to taken to 50 per cent flowering, highest average fruit weight and low downy mildew incidence. The cross C_{11} (AM Sel-3× AM Sel-5) recorded highest number of fruits per plant, highest pericarp thickness, lowest acidity and highest ascorbic acid. The cross C_{14} (AM Sel-5× AM Sel-6) recorded significant differences *viz*., number of primary branches per plant, days taken to appearance of first female flower, days taken to appearance of first female flower, node at which the first female flower appearance, days taken to 50 percent flowering, days taken to first fruit harvest, number of fruits per plant, yield per plant, fruit weight and total sugars. C_{15} (AM Sel-5× AM Sel-6) recorded minimum node at which the first male and female flower appeared, highest yield per plant, highest fruit length, highest fruit diameter, highest days shelf life and low downy mildew incidence.

Keywords: Muskmelon, *Cucumis melo*, melon, growth, yield, quality

Introduction
Muskmelon (*Cucumis melo* L.) 2n = 24 is one of the most important cucurbitaceous vegetables grown as a desert crop. The centre of origin of muskmelon was earlier considered as African continent but recent studies revealed the existence of high genetic diversity of *Cucumis melo* landraces in India and China indicating the Asian origin (Sebastian *et al*., 2010) [1]. The fruits are extremely variable in size and shape. They may be ellipsoid to globose, with or without longitudinal grooves. It is used for both salad and table purpose. The fruit flesh inside varies from white to cream-yellow, orange or green. The fruits are highly relished because of their aroma, sweet taste and refreshing effect. In a tropical country like India, juicy dessert fruits like muskmelon and watermelon are considered as best thrust quenchers during the arid summer months. The area under muskmelon in India is 57,000 hectares with 1277 thousand tonnes of production (NHB, 2018-19). In Andhra Pradesh muskmelon is cultivated in an area of 9900 hectares with production of 3,14,390 tonnes (NHB, 2018-19). In India there are several muskmelon cultivars and varieties grown in different regions and dessert type muskmelon is very popular, particularly in Andhra Pradesh. It is extensively cultivated in hot and arid areas of Andhra Pradesh particularly Rayalaseema area and is being grown in cultivable land as well as in marginal land of riverbed areas. In this area cultivars exhibit enormous variability with respect to fruit traits but are poor yielders as they have been traditionally grown and selected under low input agriculture system by traditional growers who have developed their own skill and management practices to raise the crop. These varieties have very poor shelf-life and low sugar content. Muskmelon being andromonoecious is a cross pollinated crop and offers considerable variation. Generally, muskmelon requires relatively shorter growing season with a warm climate. At present, most of the commercial types have thin skin, thick orange pulp and good shelf life. However, there is a continuous demand of consumers for the varieties having orange pulp, green pulp, high sugar content and better shelf-life. Thus, the improvement in sugar content and shelf-life of muskmelon should be given prime importance.

It is therefore required to improve the locally preferred cultivars for high yield and adaptation or development of new hybrid combinations

Material and Methods

The experiment was carried out in the year 2018- 2020 at the college of Horticulture, Anantharajupeta, Dr YS.R Horticultural University. The experimental material comprised six inbred lines AM Sel-1, AM Sel-2, AM Sel-3, AM Sel-4, AM Sel-5, AM Sel-6 and fifteen hybrids developed in half diallel fashion and two standard checks Kundan and Papasa. These parents and hybrid evaluated in the field with two standard checks Kundan and Papasa in three seasons *viz*., summer, *kharif* and *rabi* in 2019-2020. The experiment was laid out in Randomised Block Design with three replications at spacing of 1.0 x 1.5 m. The cultural and management practices were adopted according to the package of practices recommended by Dr. Y.S.R Horticultural University. The observations were recorded from ten randomly selected plants in each genotype per replication. The data of individual plants each progeny were recorded twenty six characters *viz*., vine length (m), number of primary branches per vine, days taken to appearance of first male flower, days taken to appearance of first female flower, node at which the first male flower appeared, node at which the first female flower appeared, days taken to 50 per cent flowering, total number of male and female flower per vine (sex ratio), days taken to first fruit harvest, days taken to last fruit harvest, number of fruits per plant, fruit weight(kg), yield per plant (kg), fruit length (cm), fruit diameter (cm), fruit firmness (kg/cc), rind thickness (mm), pericarp thickness (cm), shelf life (days), total soluble solids (^{0}Brix) acidity, ascorbic acid (mg/100g), total sugars (%), reducing sugars (%), β-carotene (µg/g) downy mildew incidence. The least significant difference test at 5 per cent level of probability was used to test the differences among mean values.

Results and Discussion

The pooled analysis of variance for all characters studied furnished in table 1. Highly significant differences among the genotypes were observed for all the characters under the study except node at which first male flower appeared. For growth characters recorded the highest vine length C_5 (AM Sel-1× AM Sel-6) (3.40 m) in pooled analysis followed by C_{13} (AM Sel-4× AM Sel-5) and C_{14} (AM Sel-4× AM Sel-6) than the standard check Papasa Where As the hybrid C_3 (AM Sel-1× AM Sel-4) (3.79) recorded significantly more number of primary branches than both standard checks in pooled analysis.

Early harvest is also one of the important desirable traits for crop improvement programme. The present study also brought out certain genotypes with significant early harvest. For earliness characters the cross C_{10} (AM Sel-3× AM Sel-4) took minimum (28.33) days taken to appearance of first female flower and minimum (31.55) days to taken to 50 per cent flowering than standard check Kundan, the cross C_{15} (AM Sel-5× AM Sel-6) recorded minimum (4.93) node at which the first female flower in pooled analysis. Similar trend of earliness was reported by Rakhi and Rajamony (2005) [10] in culinary melon, Hossain *et al*. (2010) [7] in cucumber, Hanchinamani *et al*. (2011) [6] in cucumber.

For yield traits the cross C_{15} (AM Sel-5× AM Sel-6) recorded highest yield per plant (6.83 kg) followed by C_{11} (AM Sel-3× AM Sel-5), C_{14} (AM Sel-4× AM Sel-6), AM Sel-1 and C_{10} (AM Sel-3× AM Sel-4), and highest average fruit weight (1.63 kg), highest fruit length (17.57 cm), highest fruit diameter (13.65 cm), the cross C_{11} (AM Sel-3× AM Sel-5) recorded highest number of fruits per plant (4.42) in pooled analysis. The similar line of results of high fruit yield per plant obtained by the Amandeep *et al*. (2017) [2], Cheema *et al*. (2011) [4] and Pandey *et al*. (2010) [8] in muskmelon.

For quality characters C_{15} (AM Sel-5× AM Sel-6) recorded highest (17.76) days shelf life, the C_{13} (AM Sel-4× AM Sel-5) recorded highest β- carotene(10.35), the parent AM Sel-6 recorded highest total soluble solids (12.08 ^{0}B) followed by AM Sel-2 (11.05 ^{0}B) AM Sel-5 (11.07 ^{0}B), C_7 (AM Sel-2× AM Sel-4) (11.02 ^{0}B), C_{12} (AM Sel-3× AM Sel-6) (10.72 ^{0}B) and C_{15} (AM Sel-5× AM Sel-6) (10.65 ^{0}B). Similar findings have also been reported by Singh and Ram (2003) [11], Glala *et al*. (2008) [5], Rad *et al*. (2010) [9] and Cheema *et al*. (2011) [4] in muskmelon.

Two crosses C_{10} (AM Sel-3× AM Sel-4) and C_{15} (AM Sel-5× AM Sel-6) (10.19%) recorded lowest downy mildew incidence in across the seasons. On the basis of average performance it can be concludes that was found best for yield per plant four hybrids C_{10} (AM Sel-3× AM Sel-4), C_{11} (AM Sel-3× AM Sel-5), C_{14} (AM Sel-4× AM Sel-6) and C_{15} (AM Sel-5× AM Sel-6) were found best for yield per plant and yield attributing traits.

On the basis of performance studies, the cross C_{10} (AM Sel-3 × AM Sel-4) portrayed earliness by recording minimum days taken to appearance of first female flower and minimum days for 50 per cent flowering, besides recording maximum fruit weight and low downy mildew incidence. The cross C_{11} (AM Sel-3 × AM Sel-5) recorded the maximum number of fruits per plant, high pericarp thickness, low acidity and high ascorbic acid. The cross C_{14} (AM Sel-5 × AM Sel-6) recorded desirable values for many traits *viz*., number of primary branches per plant, days taken to appearance of first female flower, days taken to appearance of first female flower, node at which the first female flower appeared, days taken to 50 per cent flowering, days taken to first fruit harvest, number of fruits per plant, yield per plant, fruit weight, total sugars, the node at which the first male and female flower appeared, maximum yield per plant, fruit length, fruit diameter, extended days shelf life and low downy mildew incidence. The cross C_{15} (AM Sel-5 × AM Sel-6) recorded the first male and female flower at the lowest node, highest yield per plant, highest fruit length, highest fruit diameter, extended shelf life and low downy mildew incidence.

The four hybrids C_{15} (AM Sel-5 × AM Sel-6) (6.83 kg), C_{11} (AM Sel-3 × AM Sel-5) (6.06), C_{14} (AM Sel-4 × AM Sel-6) (6.00 kg) and C_{10} (AM Sel-3 × AM Sel-4), (5.89 kg) were found to be superior in respect of yield per plant. The difference in the fruit yield was mainly due to the number of fruits per plant and fruit weight. The similar trend of result of high fruit yield was obtained by Pandey *et al*. (2010) [8] and Cheema *et al*. (2011) [4], Venkatesan *et al*. (2016) [12] in muskmelon.

Table 1: Pooled Analysis of variance (mean squares) for per se performance in respect of 26 characters in muskmelon

S. No.	Source of variation/character	Replication	Genotype	Error
	Degrees of freedom	2	22	44
1	Vine length (m)	0.00	0.33**	0.01
2	Number of primary branches per vine	0.01	0.18**	0.05
3	Days taken to appearance of first male flower	0.09	3.69**	0.10
4	Days taken to appearance of first female flower	0.26	2.90**	0.35
5	Node at which the first male flower appeared	0.06	0.34	0.21
6	Node at which the first female flower appeared	0.89	1.93**	0.10
7	Days taken to 50% flowering	0.32	2.85**	0.42
8	Sex ratio	0.34	15.66**	0.79
9	Days taken to first fruit harvest	3.25	14.00**	1.08
10	Days taken to last fruit harvest	6.16	29.54**	3.61
11	Number of fruits per plant	0.03	1.04**	0.06
12	Fruit weight(g)	0.00*	0.29**	0.00
13	Yield per plant (kg)	0.10	3.93**	0.16
14	Fruit length (cm)	0.01	17.18**	0.17
15	Fruit diameter (cm)	0.16	2.26**	0.32
16	Fruit firmness (kg/cc)	0.04	42.42**	0.09
17	Rind thickness (mm)	0.00	5.96**	0.01
18	Pericarp thickness (cm)	0.04	0.49**	0.01
19	Shelf life (days)	0.09	81.14**	0.29
20	Total soluble solids (^{0}Brix)	0.02	8.72**	0.06
21	Acidity (%)	0.00	0.00**	0.00
22	Ascorbic acid (mg/100g)	1.54	245.78**	1.84
23	Total sugars (%)	0.05	11.17**	0.020
24	Reducing sugars (%)	0.30	4.73**	0.16
25	β - carotene (µg/ g)	0.00	26.54**	0.00
26	Downy mildew incidence (%)	1.56	10.52*	1.05

Table 2: Mean performance of parents and hybrids for the characters in muskmelon across the seasons

	Vine length (m)	Number of primary branches per plant	Days taken to appearance of first male flower	Days taken to appearance of first female flower	Node at which the first male flower appeared	Node at which the first female flower appeared	Days taken to 50% flowering	Sex ratio	Days taken to first fruit harvest	Days taken to last fruit harvest	Number of fruits per plant	Fruit weight (kg)
Parents												
AM Sel-1	3.10	3.01	27.67	31.44	3.77	6.22	34.88	11.09	59.33	69.33	3.20	2.19
AM Sel-2	3.05	2.68	26.22	28.22	3.76	7.27	34.88	10.13	62.33	69.00	2.77	1.11
AM Sel-3	2.95	3.29	27.66	29.89	3.35	6.17	34.22	14.37	53.89	63.22	3.44	0.99
AM Sel-4	2.73	3.24	26.67	28.44	3.66	5.24	32.67	12.76	60.33	70.66	4.05	0.99
AM Sel-5	2.72	3.00	27.11	30.22	4.23	5.98	32.33	15.61	57.22	67.22	3.61	1.16
AM Sel-6	1.90	3.47	28.66	29.88	3.77	4.14	33.44	9.61	58.55	69.22	4.72	1.14
Mean	2.74	3.11	27.33	29.68	3.76	5.84	33.74	12.26	58.61	68.11	3.63	1.26
Crosses												
C_1 (AM Sel-1× AM Sel-2)	2.81	3.43	26.33	29.44	3.69	5.73	32.77	13.71	59.55	72.33	3.14	1.29
C_2(AM Sel-1× AM Sel-3)	2.33	3.21	27.22	29.66	3.50	5.11	31.89	11.63	60.11	70.11	2.51	1.16
C_3(AM Sel-1× AM Sel-4)	3.04	3.79	28.44	30.11	3.70	5.16	31.89	8.54	54.22	58.55	3.10	1.35
C_4(AM Sel-1× AM Sel-5)	2.97	3.36	29.33	31.44	3.31	5.48	33.44	7.78	58.88	70.22	3.81	1.41
C_5(AM Sel-1× AM Sel-6)	3.40	3.56	27.11	30.11	3.95	6.48	31.66	8.75	56.89	66.55	3.56	1.06
C_6(AM Sel-2× AM Sel-3)	2.92	3.29	28.22	30.00	3.51	5.46	32.22	8.30	59.11	71.11	3.43	1.09
C_7(AM Sel-2× AM Sel-4)	2.70	3.55	29.55	31.66	4.46	7.10	32.66	11.25	62.44	71.77	2.54	1.18
C_8(AM Sel-2× AM Sel-5)	2.85	3.53	28.00	29.89	4.43	6.45	33.11	12.19	57.22	68.55	3.56	1.40
C_9(AM Sel-2× AM Sel-6)	2.96	3.33	29.66	31.55	3.51	6.50	34.00	13.56	60.55	73.22	3.53	1.44
C_{10}(AM Sel-3× AM Sel-4)	3.17	3.14	26.11	28.44	3.66	6.15	31.55	11.08	57.67	70.00	3.53	1.71
C_{11}(AM Sel-3× AM Sel-5)	2.85	3.45	27.67	29.33	3.62	5.15	33.33	14.05	61.44	70.77	4.42	1.37
C_{12}(AM Sel-3× AM Sel-6)	2.44	3.34	27.89	29.11	3.34	5.46	33.00	10.08	60.00	71.00	4.10	1.50
C_{13}(AM Sel-4× AM Sel-5)	3.32	2.93	26.22	29.22	3.65	5.48	32.89	15.13	57.33	69.66	3.39	1.37
C_{14}(AM Sel-4× AM Sel-6)	3.31	3.06	25.67	29.22	3.39	5.33	34.22	10.57	57.89	68.33	3.93	1.52
C_{15}(AM Sel-5× AM Sel-6)	2.73	3.05	27.22	30.66	3.04	4.93	32.55	14.07	57.55	68.88	4.06	1.63
Crosses Mean	2.92	3.33	27.64	29.99	3.65	5.73	32.74	11.38	58.72	69.40	3.51	1.36
Checks												
Kundan	2.88	3.33	28.11	30.66	3.63	4.06	32.77	12.91	58.44	68.44	4.10	1.03
Papasa	3.06	3.25	28.11	29.55	3.51	5.55	34.22	13.10	57.66	66.00	2.58	2.03
Population Mean	2.88	3.27	27.60	29.92	3.67	5.68	33.07	11.75	58.63	68.87	3.52	1.35
C.V.	4.37	7.43	1.16	1.97	12.68	5.60	1.96	7.59	1.78	2.75	6.96	3.99
SE(m) ±	0.07	0.14	0.18	0.34	0.26	0.18	0.37	0.51	0.60	1.09	0.14	0.03
C.D. 5%	0.20	0.40	0.52	0.97	-	0.52	1.06	1.46	1.71	3.12	0.40	0.08
Range Lowest	1.90	2.68	25.67	28.22	3.04	4.06	31.55	7.78	53.89	58.55	2.51	0.99
Range Highest	3.40	3.79	29.66	31.66	4.46	7.27	34.88	15.61	62.44	73.22	4.72	2.19

Table 3: Mean performance of parents and hybrids for the characters in muskmelon across the seasons

	Yield per plant (kg)	Fruit length (cm)	Fruit diameter (cm)	Fruit firmness (kg/cc)	Rind thickness (mm)	Pericarp thickness (cm)	Shelf life (Days)	Total soluble solids (^{0}Brix)	Acidity (%)	Ascorbic acid (mg/100g)	Total sugars (%)	Reducing sugars (%)	β-carotene (µg/g)	Downy mildew incidence (%)
Parents														
AM Sel-1	6.04	20.04	13.72	3.08	1.83	3.14	4.66	7.71	0.13	21.62	8.27	5.57	9.21	34.26
AM Sel-2	3.13	10.82	13.93	5.72	1.77	2.62	13.78	11.05	0.17	11.95	9.15	6.07	2.30	15.74
AM Sel-3	3.08	12.85	12.19	3.30	2.67	2.40	2.89	7.24	0.14	12.42	7.91	5.15	2.41	36.11
AM Sel-4	3.46	12.60	11.97	7.35	4.16	2.66	7.66	8.12	0.17	10.32	11.13	7.60	8.63	19.44
AM Sel-5	4.08	12.38	12.39	10.41	6.29	3.12	19.11	11.07	0.16	15.49	12.09	8.06	9.71	15.74
AM Sel-6	5.42	13.02	13.38	11.74	4.88	2.65	13.55	12.08	0.20	13.54	11.79	8.10	9.53	25.93
Mean	4.20	13.62	12.93	6.93	3.60	2.76	10.27	9.54	0.16	14.22	10.05	6.76	6.96	24.54
Crosses														
C_1 (AM Sel-1× AM Sel-2)	4.08	15.91	12.64	2.81	2.29	2.41	4.77	7.91	0.16	19.07	9.57	6.15	5.55	28.70
C_2(AM Sel-1× AM Sel-3)	2.98	15.11	12.42	2.23	3.39	2.71	3.55	7.42	0.12	36.81	10.84	7.78	2.53	23.15
C_3(AM Sel-1× AM Sel-4)	4.15	13.91	11.82	2.66	3.12	3.16	5.11	8.91	0.12	26.65	8.53	4.81	10.31	31.48
C_4(AM Sel-1× AM Sel-5)	5.39	14.10	11.91	3.26	2.20	3.21	3.55	7.37	0.11	20.66	6.59	5.61	5.27	25.00
C_5(AM Sel-1× AM Sel-6)	3.80	13.08	11.90	2.26	1.18	2.16	4.33	5.86	0.13	28.11	7.07	4.83	4.69	21.30
C_6(AM Sel-2× AM Sel-3)	3.76	12.94	11.07	3.30	2.20	2.28	7.66	9.97	0.13	34.54	7.40	4.87	3.42	12.04
C_7(AM Sel-2× AM Sel-4)	2.98	11.20	12.34	8.10	1.94	2.47	5.00	11.02	0.15	35.90	9.78	7.13	2.62	14.81
C_8(AM Sel-2× AM Sel-5)	5.04	14.99	13.38	4.30	1.65	3.25	5.00	10.33	0.15	29.37	8.39	4.06	5.44	22.22
C_9(AM Sel-2× AM Sel-6)	5.04	14.84	11.46	13.01	5.39	2.79	7.44	9.88	0.28	19.29	9.13	6.25	8.54	21.30
C_{10}(AM Sel-3× AM Sel-4)	5.89	16.67	12.00	3.22	2.49	3.43	4.77	7.05	0.14	27.44	7.35	4.30	8.44	10.19
C_{11}(AM Sel-3× AM Sel-5)	6.06	14.96	12.74	3.55	5.34	3.58	6.11	7.51	0.09	40.70	6.51	4.59	3.35	16.67
C_{12}(AM Sel-3× AM Sel-6)	5.61	16.80	11.99	12.97	3.01	3.36	4.77	10.72	0.12	24.80	11.79	6.75	2.41	24.07
C_{13}(AM Sel-4× AM Sel-5)	4.39	17.30	10.84	3.02	3.05	3.00	4.11	8.94	0.23	14.77	8.32	5.62	10.35	19.44
C_{14}(AM Sel-4× AM Sel-6)	6.00	15.64	13.64	2.52	1.86	3.10	6.11	8.84	0.13	15.54	5.37	4.32	5.47	16.67
C_{15}(AM Sel-5× AM Sel-6)	6.83	17.57	13.65	5.25	4.48	3.37	17.76	10.65	0.18	15.99	10.71	6.48	8.64	10.19
Crosses Mean	4.80	15.00	12.25	4.83	2.91	2.95	6.06	8.84	0.15	25.97	8.49	5.60	5.80	19.81
Checks														
Kundan	4.19	13.40	13.40	11.82	3.61	3.13	19.55	10.98	0.19	13.98	11.52	7.72	8.41	12.96
Papasa	4.77	19.15	12.78	3.63	1.73	3.21	4.77	8.32	0.15	13.21	10.41	6.61	9.51	30.56
Population Mean	4.61	14.75	12.50	5.63	3.07	2.92	7.65	9.09	0.15	21.83	9.11	6.04	6.38	21.00
C.V.	8.91	2.85	4.57	5.41	4.52	3.47	7.11	2.85	9.75	6.22	1.57	6.67	1.29	43.01
SE(m) ±	0.23	0.24	0.33	0.17	0.08	0.05	0.31	0.14	0.01	0.78	0.08	0.23	0.04	5.26
C.D. 5%	0.67	0.69	0.94	0.50	0.22	0.16	0.89	0.42	0.02	2.23	0.23	0.66	0.13	15.06
Range Lowest	2.98	10.82	10.84	2.23	1.18	2.16	2.89	5.86	0.09	10.32	5.37	4.30	2.30	10.18
Range Highest	6.83	20.04	13.93	13.01	6.29	3.58	19.55	12.08	0.28	40.70	12.09	8.10	10.35	36.11

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