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Evaluation of stevia (*Stevia rebaudiana* Bertoni.) Genotypes performance on growth and chlorophyll accumulation

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Abstract
The present investigation was carried out in 2018-19 to evaluate the performance of nine stevia genotypes viz., CIM Madhu, CIM Mithi, Kodaikanal Local, Pune Local, Zaheerabad Local, GKVK Stevia-1, Indore Local, Hyderabad Local and Bidar Local for their vegetative growth and chlorophyll content under the Northern Dry Zone of Karnataka. The experiment was laid out in Randomised Complete Block Design (RCBD) with three replications at the Main Horticultural Research and Extension Centre (MHREC), Bagalkot, Karnataka. The parameters like plant height, number of leaves per plant and chlorophyll reading were recorded at different growth stages. The maximum plant height (46.02 cm), number of branches per plant (57.60), number of leaves per plant (895.43), plant spread in East-West (31.47 cm) North-South (31.23 cm) directions and maximum chlorophyll reading (53.67) at harvest were recorded for the stevia genotype, GKVK Stevia-1.

Keywords: Stevia, genotypes, chlorophyll, evaluation

Introduction
Stevia, commonly known as sweet leaf, candy leaf or sugar leaf is a tender perennial, belongs to the family Asteraceae and native to parts of Brazil and Paraguay is an important medicinal plant used against diabetes. The dry powdered leaf is used as a sugar substitute for diabetic patients for controlling the blood glucose level. Stevia is a non-nutritive and non-caloric sweetener, which does not metabolize in the human body after consumption. The plant grows abundantly throughout India up to 1000 to 1500 meters altitude. Different classes of diterpene glycosides are present in stevia leaves (stevioside and rebaudioside) which are nontoxic, antioxidant, antifungal, antimicrobial, antihyperglycaemic high potency sweeteners and may substitute sucrose as well as other synthetic sweeteners, being 300 times sweeter than sucrose. The steviol glycoside or the stevioside present in stevia leaves activates the TRPM5, which is an important protein for the perception of sweet taste (Koenraad *et al*., 2017) [5]. Furthermore, this protein prompts the beta cells of the pancreas to release insulin after food intake, thus it helps to regulate blood sugar levels and prevents the development of diabetes.

Material and methods
The field experiment was carried out at the Main Horticultural Research and Extension Centre (MHREC), University of Horticultural Sciences, Bagalkot, which is situated in the Northern Dry Zone of Karnataka (Zone-3) located at 16° 10' North latitude, 74° 42' East longitude and at an altitude of 542.0 m above mean sea level during *rabi* 2018-19. The experiment was laid out in Randomized Complete Block Design (RCBD) in 9 treatments and 3 replications consisting of nine stevia genotypes viz., CIM Madhu, CIM Mithi, Kodaikanal Local, Pune Local, Zaheerabad Local, GKVK Stevia-1, Indore Local, Hyderabad Local and Bidar Local. The land was levelled and was divided into plots of required size (1.8 m × 2.7 m).
The stevia genotypes were collected and propagated vegetatively through stem cuttings for planting in the main field. Two month old rooted cuttings were planted at a spacing of 45 × 30 cm. The observations like plant height, number of branches, plant spread in East-West and North-South directions, number of leaves and chlorophyll reading were recorded from five randomly selected plants in each plot at 30, 60 and 90 days after transplanting and at harvest (120 DAT). The chlorophyll reading was recorded using the SPAD meter.

The recorded data was statistically analysed by using the Fischer's method of analysis of variance technique as outlined by Panse and Sukhatme (1967) [8]. The details about source of collection of stevia genotypes is furnished below:

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Name of the genotype	Source of collection
CIM Madhu	Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, U.P.
CIM Mithi	Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, U.P.
Kodaikanal Local	Horticultural Research Station (TNAU), Kodaikanal, Tamil Nadu.
Pune Local	Farmer's field collection from Maharashtra
Zaheerabad Local	Farmer's field collection from Telangana
GKVK Stevia - 1	GKVK, UAS, Bengaluru.
Indore Local	Farmer's field collection from Madhya Pradesh.
Hyderabad Local	Farmer's field collection from Telangana.
Bidar Local	Farmer's field collection from Karnataka.

Result and discussion

The data from Table 1, shows a wide variation in the plant height among various stevia genotypes. At 30 DAT, the maximum plant height was recorded in GKVK Stevia-1 (31.39 cm) which was on par with CIM Madhu (28.56 cm) and the minimum was recorded in Bidar Local (19.53 cm). At 60 DAT, significantly higher plant height was recorded in GKVK Stevia-1 (37.01 cm) which was on par with CIM Madhu (35.47 cm). CIM Mithi (34.18 cm) and Indore Local (32.94 cm). At 90 DAT, significantly higher plant height was recorded in GKVK Stevia-1 (42.25 cm) which was on par with CIM Madhu (40.07 cm) and CIM Mithi (39.14 cm) and minimum was recorded in Bidar Local (28.04 cm). At harvest, maximum plant height was recorded in GKVK Stevia-1 (46.02 cm) which was on par with CIM Madhu (44.93 cm), CIM Mithi (43.98 cm), Indore Local (42.80 cm) and Kodaikanal Local (42 cm) and minimum was recorded in Bidar Local (31.38 cm). The better height of the genotype might be related to better biomass production in branches which might have helped in the utilization of biomass resulting in elongation of stem and thereby increasing the plant height. As far as the variation between the genotypes was concerned, it may be attributed to the genetic constitution of the genotype and their subsequent interaction with the prevailing external environmental conditions. Similar results were reported by Abderrahmane *et al*. (2018) [1] in Stevia and Aflatuni (2005) [2] in Mint.

Table 1 shows a wide variation for the vegetative parameters. At 30 DAT, significantly higher number of branches per plant were noted in GKVK Stevia-1 (23.30), which was on par with CIM Madhu (21.40) and minimum in Bidar Local (10.90). At 60 DAT, maximum and minimum number of branches were recorded in GKVK Stevia-1 (38.40) and Bidar Local (22.61) respectively. At 90 DAT, significantly higher number of branches were recorded in GKVK Stevia-1 (50.32) which was on par with CIM Madhu (48.53) and CIM Mithi (46.41) and minimum in Bidar Local (28.20). At harvest, maximum number of branches were recorded in GKVK Stevia-1 (57.60) which was on par with CIM Madhu (56.03), CIM Mithi (54.70) and Indore Local (52.63) and minimum in Bidar Local (31.63). As the plant height increases, the number of nodes on the main stem increases, which results in increase in the number of branches per plant. Mishra and Pandey (2017) [7] in coriander and Phom *et al*. (2014) [9] in fenugreek observed similar variation in the varietal performance.

The maximum and minimum number of leaves per plant were noted in GKVK Stevia-1 (171.50) and Bidar Local (75.90) respectively at 30 DAT. At 60 DAT, significantly higher number of leaves were recorded in GKVK Stevia-1 (535.57) and minimum in Bidar Local (189.97). At 90 DAT, significantly higher number of leaves were spotted in GKVK Stevia-1 (768.93) and minimum in Bidar Local (330.0). At harvest, maximum number of leaves were recorded in GKVK Stevia-1 (895.43) and the minimum were reported for Bidar Local (460.10). Among the genotypes, there was a wide variation in the number of leaves per plant, which may be due to the inherent genetic character of the genotype and their respective interaction with the environment. These obtained results are in close proximity with the studies of Ravi *et al*. (2013) [10] and Suganthi *et al*. (2018) [12] in makoi.

The significantly higher plant spread in EW direction (Table 1) was recorded in GKVK Stevia-1 (18.13, 25.07, 29.20 and 31.47 cm) which was on par with CIM Madhu (16.17, 22.03, 27.87 and 30.23 cm), whereas the minimum plant spread was recorded in Bidar Local (11.67, 18.20, 22.60 and 24.63 cm) at 30, 60, 90 days after transplanting and at harvest respectively. In the North-South direction (Table 2), a significantly higher plant spread was noted from GKVK Stevia-1 (15.37, 24.80, 28.57 and 31.23 cm) which was on par with CIM Madhu (14.67, 22.47, 26.90 and 30.0 cm) and CIM Mithi (13.63, 22.10, 26.40 and 29.07 cm) and minimum was noted from Bidar Local (10.23, 17.13, 21.17 and 23.03 cm) at 30, 60, 90 DAT and at harvest respectively. This comparatively higher plant spread of the genotype may be attributed to the presence of more number of branches per plant in GKVK Stevia, promoting lateral growth and thus resulting in maximum plant spread. The lower plant spread in the early stage may be mainly because of primary growth. But at later stages more plant spread might be due to combined effect of the growth of primary, secondary and tertiary branches. As far as the variation between the evaluated genotypes was concerned, it may be due to the genetic character and environmental influences. Similar findings were observed by Anil *et al*. (2015) [3] in french marigold and Manjit *et al*. (2008) [6] in Mehndi.

For chlorophyll reading (Table 2), wide variation was noticed among various stevia genotypes. At 30 DAT, significantly higher chlorophyll reading was recorded in GKVK Stevia-1 (42.77) and minimum was recorded in Bidar Local (30.53). The maximum and minimum chlorophyll readings were recorded in GKVK Stevia-1 (47.53) and Bidar Local (33.17) respectively at 60 DAT. At 90 DAT, significantly higher chlorophyll reading was recorded in GKVK Stevia-1 (51.27) which was on par with CIM Madhu (47.03) and CIM Mithi (46.37) and minimum in Bidar Local (36.67). At harvest also, significantly higher chlorophyll reading was recorded in GKVK Stevia-1 (53.67) which was on par with CIM Madhu (49.17) and minimum in Bidar Local (37.0). It is evident from the numerous reports that, the amount of photosynthate is directly related to the quantum of chlorophyll. As the GKVK

Stevia-1 had significantly higher number of leaves per plant, it might have accumulated more photosynthates resulting in higher chlorophyll content. This noticeable variation in the chlorophyll content between the genotypes may be due to their genetic make-up and also due to environment. Sharanya *et al*. (2018) [11] and Gurjar *et al*. (2016) [4] in fenugreek also reported similar findings.

Table 1: Performance of different stevia genotypes on growth characters

Treatments	Plant height (cm)				Number of branches per plant				Plant spread in EW direction			
	Days After Transplanting			At harvest	Days After Transplanting			At harvest	Days After Transplanting			At harvest
	30	60	90		30	60	90		30	60	90	
T_1- CIM Madhu	28.56	35.47	40.07	44.93	21.40	36.70	48.53	56.03	16.17	22.03	27.87	30.23
T_2- CIM Mithi	26.31	34.18	39.14	43.98	20.20	34.90	46.41	54.70	15.63	21.47	26.80	29.67
T_3- Kodaikanal Local	24.49	31.21	35.10	42.00	16.73	30.40	41.15	48.57	13.17	20.13	25.73	28.73
T_4- Pune Local	24.16	30.26	34.56	38.79	14.07	29.27	37.03	44.13	12.70	19.53	25.57	28.30
T_5- Zaheerabad Local	22.35	28.25	31.33	35.31	12.43	27.70	34.57	40.93	12.33	19.03	24.80	26.90
T_6- GKVK Stevia-1	31.39	37.01	42.25	46.02	23.30	38.40	50.32	57.60	18.13	25.07	29.20	31.47
T_7- Indore Local	25.61	32.94	36.58	42.80	19.00	33.87	44.14	52.63	15.43	21.23	26.67	29.07
T_8- Hyderabad Local	21.81	26.30	29.59	32.82	11.17	24.23	30.05	35.87	12.10	18.57	24.03	25.10
T_9- Bidar Local	19.53	25.41	28.04	31.38	10.90	22.61	28.20	31.63	11.67	18.20	22.60	24.63
SEm±	1.28	1.64	1.70	1.96	0.88	1.95	1.89	2.25	0.71	1.04	1.26	1.48
CD (0.05)	3.84	4.91	5.11	5.89	2.63	5.85	5.68	6.75	2.13	3.10	3.77	4.43
CV (%)	8.91	9.08	8.38	8.55	9.17	10.93	8.19	8.31	8.71	8.71	8.41	9.07

Table 2: Performance of different stevia genotypes on growth characters and chlorophyll (SPAD) content

Treatments	Number of leaves per plant				Plant spread in NS direction				Chlorophyll reading (SPAD)			
	Days After Transplanting			At harvest	Days After Transplanting			At harvest	Days After Transplanting			At harvest
	30	60	90		30	60	90		30	60	90	
T_1- CIM Madhu	118.53	398.90	618.13	782.37	14.67	22.47	26.90	30.00	37.67	42.53	47.03	49.17
T_2- CIM Mithi	110.50	378.87	561.00	732.20	13.63	22.10	26.40	29.07	36.87	40.70	46.37	47.10
T_3-Kodaikanal Local	92.57	337.23	467.13	684.93	12.67	20.37	25.00	27.53	34.43	39.37	42.03	43.53
T_4- Pune Local	95.53	304.20	429.20	636.37	12.40	19.70	24.80	27.03	32.80	36.67	40.60	42.63
T_5-Zaheerabad Local	89.39	295.80	388.80	584.63	11.73	18.77	24.30	26.63	31.63	35.17	40.00	41.90
T_6- GKVK Stevia-1	171.50	535.57	768.93	895.43	15.37	24.80	28.57	31.23	42.77	47.53	51.27	53.67
T_7- Indore Local	104.60	355.13	513.73	709.73	13.20	20.60	26.07	28.60	34.77	40.30	43.47	45.87
T_8- Hyderabad Local	84.53	220.33	349.93	549.30	10.57	18.03	23.13	26.20	31.47	34.23	37.13	38.57
T_9- Bidar Local	75.90	189.97	330.00	460.10	10.23	17.13	21.17	23.03	30.53	33.17	36.67	37.00
SEm±	6.15	16.68	25.48	36.55	0.63	0.97	1.17	1.30	1.67	2.13	2.12	2.17
CD (0.05)	18.43	50.0	76.38	109.57	1.89	2.91	3.52	3.90	5.00	6.37	6.36	6.51
CV (%)	10.16	8.62	8.97	9.44	8.57	8.22	8.09	8.14	8.31	9.48	8.60	8.48

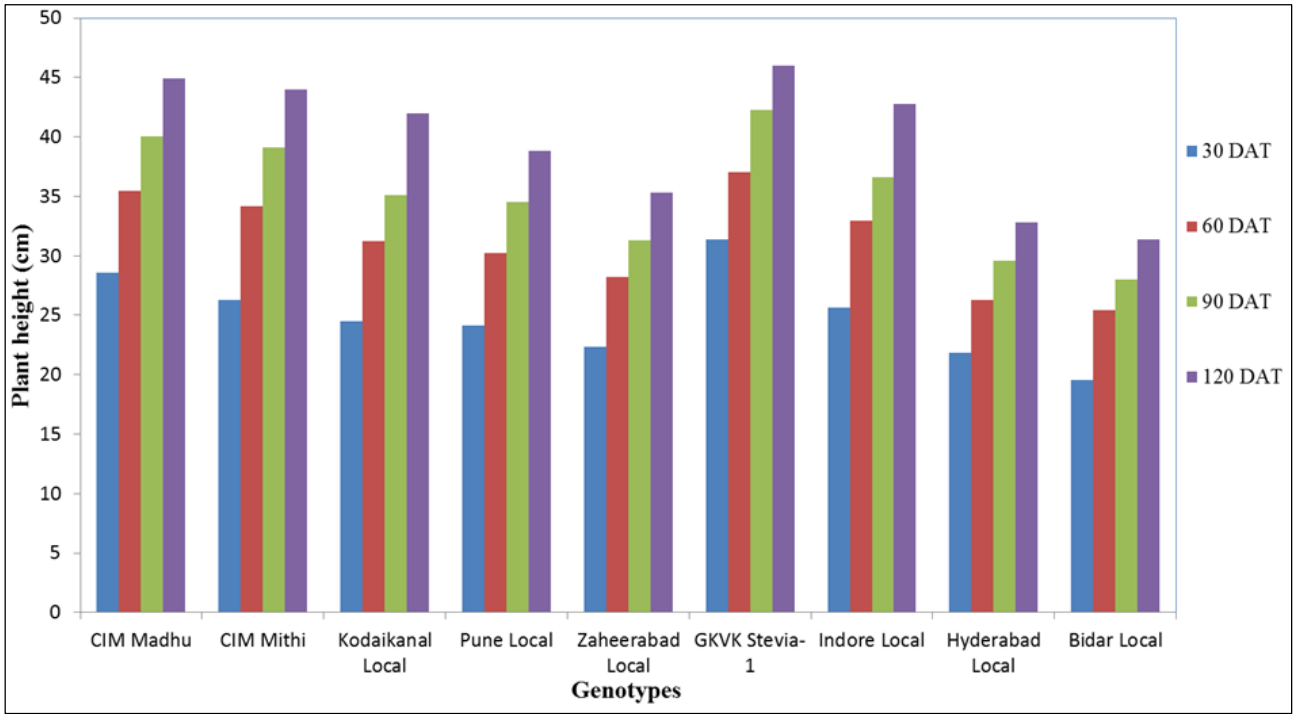

Fig 1: Performance of stevia genotypes for their plant height (cm) at different growth stages

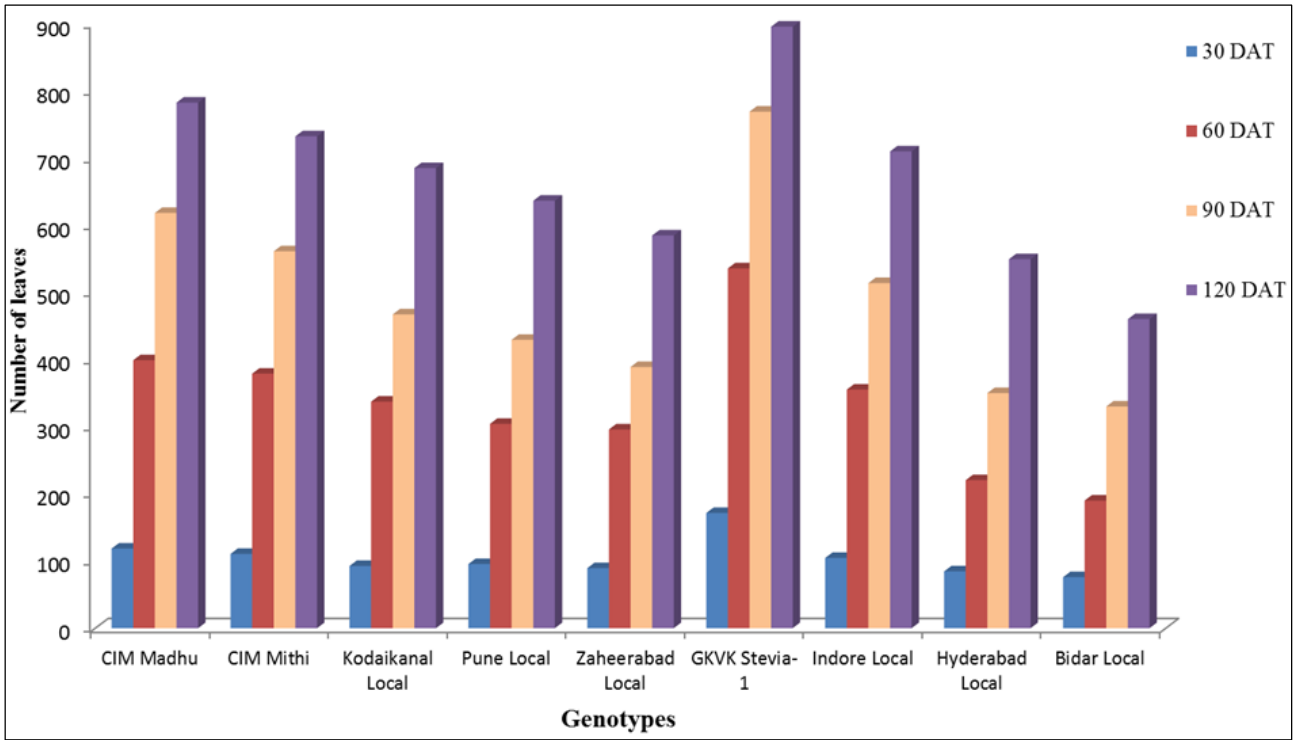

Fig 2: Performance of stevia genotypes for their number of leaves at different growth stages

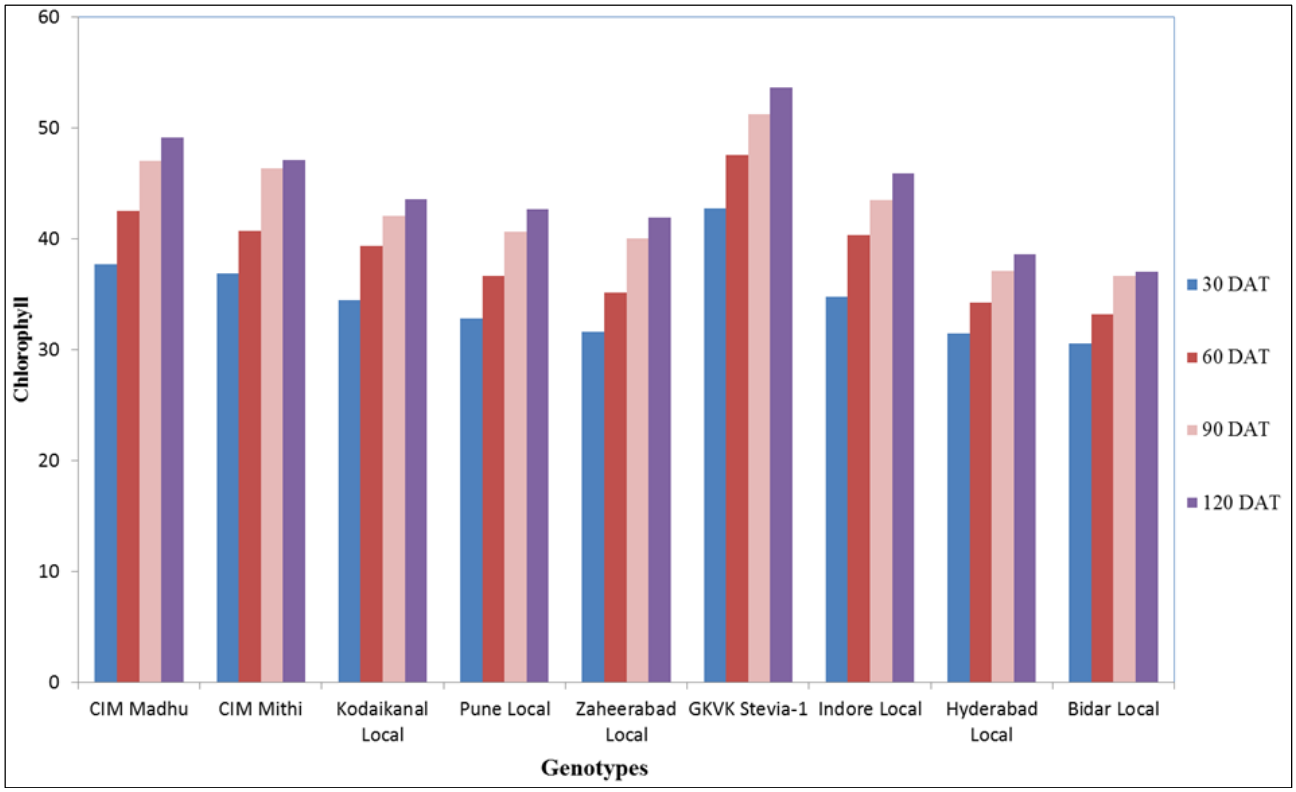

Fig 3: Performance of stevia genotypes for their chlorophyll content at different growth stages

Conclusion

The maximum plant height (31.39, 37.01, 42.25 and 46.02 cm), number of branches per plant (23.30, 38.40, 50.32 and 57.60), plant spread in EW (18.13, 25.07, 29.20 and 31.47 cm) and NS (15.37, 24.80, 28.57 and 31.23 cm) directions, number of leaves per plant (171.50, 535.57, 768.93 and 895.43) and chlorophyll reading (42.77, 47.53, 51.27 and 53.67) were recorded in GKVK Stevia-1 at 30, 60, 90 DAT and at harvest respectively. Considering the performance of various stevia genotypes for vegetative growth and chlorophyll content, the genotypes, GKVK Stevia-1, CIM Madhu and CIM Mithi showed better acclimatization to the Northern dry zone of Karnataka.

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