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Evaluation of cucumber germplasm for yield and its contributing attributes

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Abstract

Cucumber (*Cucumis sativus* L.) is a genetically diverse group of vegetables having various cultivars with distinct traits. The study was conducted to explore the available germplasm of cucumber for better yield. Different commercial open pollinated and hybrid varieties of cucumber were planted in the field and evaluated for morphological variability in traits such as canopy, floral and fruit traits. Higher leaf length (6.16 mm) and width (6.29 mm) was found in "CP001" whereas the highest length (2.39 m) of first 15 nodes was observed in "Local khera" accession. However, dark color leaves were observed in "4308" accession. The highest number of female flowers plant^{-1}were observed in "CP001" (3.33) and "Champion" (2.67) accession whereas the highest male flowers were observed in "Local khera" (329.33) and "Green pearl" (313.33). The highest number of fruits plant^{-1} were found in accessions "CP001" (18) and Local khera (17). Similarly, the highest fruit yield plant^{-1} was found in accession "CP001" (3.15 kg) followed by Local khera (2.98 kg). It was concluded from current studies that accession "CP001" performed better under Faisalabad climatic conditions.

Keywords: Accessions; Climate change; Fruit yield; Plant canopy; Variability.

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Introduction

Cucumber is an economically important vegetable and a salad crop. It is commonly cultivated in tropical and subtropical areas of the world (Ali, 2018) for 3000 years and is native to Asia (Siddique et al., 2017; Ammar & Arif, 2019). Cucumber is the fourth largest cultivated vegetable in the world after potato, tomato and onion. China is a leading producer, with production of 54,316 thousand tons while Pakistan stands at 52nd position with the production of 54,766 tons. In Pakistan, production of cucumber is 65597 tons under 3549 hectares of land (FAO, 2019). In Punjab, cucumber production is 43,298 tons and was cultivated over an area of 1,805 ha (FAO, 2019). Pakistan imported 615.5 tons of cucumber that costs of 63,653 thousand PKR (GOP, 2016). Average yield of cucumber was 16.78 tons ha^{-1} in world. China has a share of 62.7% of the total area and 63.59% of the global production per year. Production of cucumber in Pakistan is negligible compared to world average production. Cucumber has a cooling impact on sunburned skin. It also contains lignin for the cure of cardiovascular ailments and cucurbitacins for the regulation of metabolism system and blood sugar digestion (Jat et al., 2021). Cucumber are diuretics due to high in water content (90 %), low in fat, cholesterol, and salt. It also cleanses the body by eliminating accumulated waste and chemical pollutants. Additionally, cucumbers also contain antifungal, antibacterial, analgesic, antiulcer, laxative, antioxidant, and antibiotic effects due to the presence of bioactive chemicals (Kumaraswamy, 2016). The magnesium content in cucumbers also relax nerves, muscles and keeps the blood circulation efficient. Main objectives in cucumber breeding are to develop high yielding, quality varieties with fruits of uniform shape, good size, attractive skin and pulp color, fewer and soft seeds, resistant to wilt and mildew, long storage life, suitable for table and processing purposes. Elite germplasm contained substantial variation in economical traits such as fruit size, shape, flavor and color of the fruit skin. The current study was aimed to screen valuable cucumber accessions which may be exploited in breeding programs.

Materials and Methods

Seeds of commercial cucumber varieties (both open pollinated and hybrids) were collected from reliable progressive growers, research stations, authentic seed producing agencies and Ayub Agriculture Research Institute (AARI), Faisalabad. Evaluation of all germplasm accessions was done for their morphological characters i.e., leaf length, leaf width, leaf color and flower (time of flower development, number and male/female flower) and fruit yield as narrated in standard descriptors (IPGRI, 2006).

Leaf characters The length and width of eight leaves was measured by using digital Vernier caliper and average length as well as width was measured in centimeters (cm). The intensity of green color of leaf (light, medium and dark) was characterized by visual observation.

Floral characters Similarly, the floral characters such as the time of flower development and number of flowers node^{-1} as well as male/female flower ratio of treated plants was also recorded.

Fruit characters Five fruits from each variety were harvested at commercial maturity to measure the fruit size (fruit length and diameter). Fruit length (cm) and fruit diameter (cm) were measured with the help of digital Vernier Caliper. Fruit shape at stem-end (Necked, Acute, Obtuse) was determined by visual observations.

***T**otal length of first 15 internodes* Total length of first 15 developed internodes was measured with the help of Vernier Caliper. The length of 15 developed internodes were categorized as very short (<0.7 mm), short (0.7-1.0 mm), medium (1.1-1.4 mm), long (1.5-1.8 mm) and very long (>1.89 mm). The study was laid out according to Randomized Completely Block Design (RCBD) with three replications. Data was analyzed by using ANOVA statistical techniques and means were compared using LSD test (Steel et al., 1997).

Results and Discussions

A. Diversity in Leaf and Floral Attributes of Cucumber Cultivars:

Leaf size and nodal length: It was observed that leaf length and width showed significant variation *($P \leq 0.05$)* among various cucumber cultivars. The highest leaf length was observed in "CP 001" (6.19 cm) followed by "Champion" (5.51 cm) and "Local khera" (5.25), while the lowest leaf length was observed in "Green star" (4.99 cm) and "Green pearl" (4.94 cm) as shown in Table 1. It was noted "CP 001" (6.29 cm) gained highest leaf width followed by "Champion" (5.85cm) and "Local khera" (5.65 cm) while the lowest leaf width was recorded in "Green Star" (5.32 cm) and "Green Pearl" (5.03 cm). Similarly, significant variation *($P \leq 0.05$)* was noted among various cucumber cultivars regarding length (m) of first 15 nodes. "Local khera" (2.39 cm) followed by Cucumber 4308 (2.22 cm) gained the highest length of first 15 nodes (Table 1) while the lowest length of nodes was recorded in "CP 001" (1.85 cm) and "Green pearl" (1.71 cm).

Leaf color intensity A significant difference *($P \leq 0.05$)* was noted among various cucumber cultivars regarding dark color intensity (Fig. 1 A-C). It was observed Cucumber 4308 (2.00) gained highest score for dark leaf colour intensity followed by Green Star (1.33) and CP 001 (1.33). While minimum score for dark leaf color intensity was recorded in Champion (1.00) and Local khera (1.00) as well as Green pearl (1.00) (Table 1). Similarly, significant variation *($P \leq 0.05$)* among various cucumber cultivars regarding score for light color intensity in their leaves. It was noted that cultivars Green pearl (1.67), Green Star (1.67) and Cucumber 4308 (1.67) were at par and gained highest score for light color intensity of leaf. While minimum score for light color intensity was recorded in Local khera (1.00) followed by CP 001 (1.33) and Champion (1.33). Moreover, Cultivar Local khera (2.67) gained highest score for medium color intensity of leaves followed by Green pearl (2.33), Champion (2.33) and CP 001 (2.33). While minimum score for medium color intensity of leaves was recorded in Green Star (2.00).

Number and Type of Flowers: A significant variation *($P \leq 0.05$)* was revealed among various cucumber cultivars regarding number of male and female flowers (Fig. 1 D-I). It was noted that cultivars CP 001 (3.33) and Champion (2.67) developed highest number of female flowers per node. While minimum number of female flowers per node was recorded in Green Star (2.0) and Green Pearl (2.0) (Table 1). Regarding male flowers, Champion (7.0) and Local khera (5.33) developed maximum number of male flowers while CP 001 (1.22) developed minimum number of male flowers. Maximum number of female flowers per plant were observed in CP 001 (24.00) followed by Champion (23.67) while minimum number of female flowers were observed in Green pearl (16.00) and Cucumber 4308 (16.33) as shown in Table 1. Similarly, higher number of male flowers per plant were noted in Local khera (329.33) followed by Green Pearl (313.33), however, minimum number of male flowers per plant were observed in Champion (293.67), CP

001(306) and Green Star (306). A significant variation was revealed among various cucumber cultivars regarding days of flowering. It was noted that Local khera (30.33) took maximum days to bloom followed by Green Star (27.73) and Cucumber 4308 (27.60) while minimum days to flowering was recorded in Green Pearl (24.73) (Table 1).

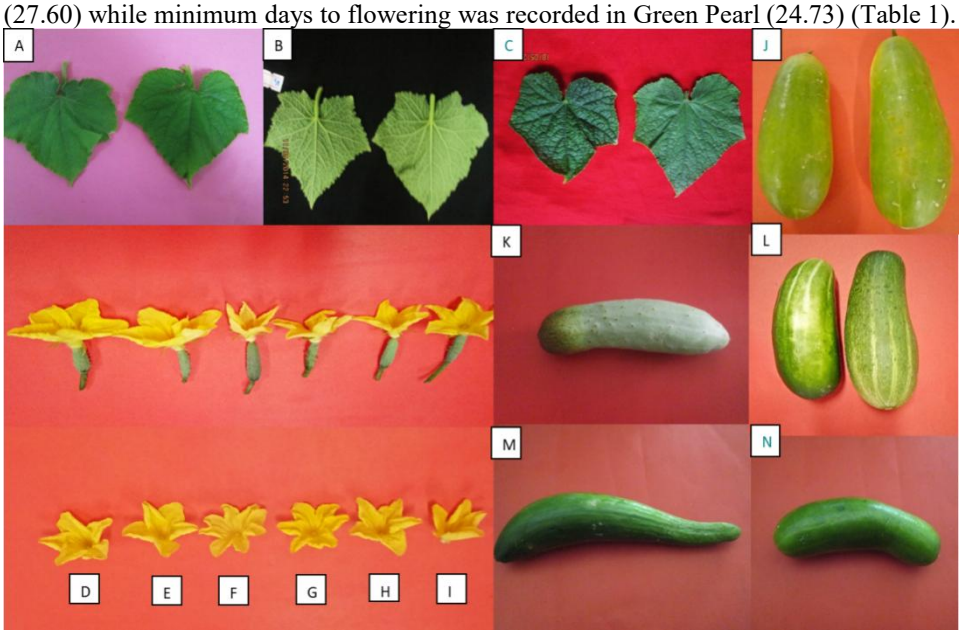

Figure 1. Phenotypic diversity in foliage, male and female flowers and fruit of cucumber germplasm. Illustration shows leaf color intensity A) light, B) medium, C) dark; female (above) and male (below) flowers D) CP 001, E) Local khera, F) Cucumber 4308 G), Green star H) Champion I) Green pearl; and fruits J) Local khera, K) Cucumber 4308, L) Green star, M) Champion and N) CP 001.

B. Diversity in Fruit Attributes of Cucumber Cultivars

Fruit Size, Quality, Seed lessness and Yield Attributes: A significant variation *($P \leq 0.05$)* was revealed among various cucumber cultivars regarding fruit size (cm), neck shape and fruit shape (Fig. 1J-N). It was noted that cv. Local khera (15.64 cm) and Green star (15.13 cm) gained maximum fruit length. While minimum fruit length was recorded in CP 001 (12.42 cm) and Cucumber 4308 (13.22 cm). Maximum fruit diameter was observed in Champion (47.29 mm) and Local khera (43.98 mm) while minimum fruit diameter was observed in CP 001 (37.27 mm) and Green Star (37.56 mm) as shown in Table (2). It was noted that cv. Local khera (1.00) gained necked shape followed by CP 001 (0.58) while minimum neck shape was recorded in Cucumber 4308 (0.17). Maximum acute shape was ranked in Cucumber 4308 (1.00) followed by Champion (0.75) and Green pearl (0.75), while minimum acute shape was observed in Local khera (0.13). Significant variation *($P \leq 0.05$)* was noted among various cucumber cultivars regarding total soluble sugars (TSS). It was noted Cucumber 4308 (3.16 °Brix) and Champion (3.09 °Brix) gained highest TSS while minimum TSS value was recorded in cv. Local khera (1.42 °Brix).

Table 1. Diversity in Leaf and Floral Attributes of Cucumber Cultivars

Trait	Classes	Cultivars					
		Green pearl	**Green star**	**Cucumber 4308**	**Champion**	**CP 001**	**Local khera**
Leaf Size (cm)	**LL**	4.94 b	4.99 b	5.32 b	5.51 ab	6.16 a	5.25 b
	LW	5.03 c	5.32 bc	5.58 bc	5.85 ab	6.29 a	5.65 b
Length of first 15 nodes (m)		1.71 c	1.93 bc	2.22 ab	1.86 bc	1.85 bc	2.39 a
Leaf Color	**Dark**	1.00 b	1.33 b	2.00 a	1.00 b	1.33 b	1.00 b
	Light	1.67 a	1.67 a	1.67 a	1.33 a	1.33 a	1.00 a
	Medium	2.33 a	2.00 a	2.00 a	2.33 a	2.33 a	2.67 a
Number of Flowers/node	**Female**	2.00 b	2.00 b	2.00 b	2.67 ab	3.33a	2.33ab
	Male	4.33 c	5.00 bc	4.89 bc	7.00 a	6.00 ab	5.33 bc
Number of Flowers plant^{-1}	**Female**	16.00 c	19.00 b	16.33 c	23.67 a	24.00 a	21.00 b
	Male	313.33 b	306.67 b	311.67 b	293.67 c	306.33 b	329.33 a

Means within a column followed by different letters are significantly ($P \leq 0.05$) different, while same letters within a column means non-significant difference.

Significant variation was observed regarding number of fruits and yield per plant among various cultivars of cucumber. Maximum number of fruits per plant were noted in CP 001 (18.00) and Local khera (17.00) while number of fruits were minimum in Cucumber 4308 (11.67). Regarding yield per plant, the highest value was gained by CP 001 (3.15 kg) and Local khera (2.98 kg) while minimum yield was noted in Cucumber 4308 (2.04 kg). Significant variation *($P \leq 0.05$)* was recorded for number of healthy seeds per fruit among cultivars of cucumber. Maximum number of healthy seeds were observed in cv. Local khera (144.33) followed by Green Pearl (126.54) while minimum number of seeds were recorded in Cucumber 4308 (63.29) and Champion (63.79) (Table 2). However, highest number of aborted seeds were noted in CP 001 (30.00) followed by Cucumber 4308 (29.46). While it was observed that lowest number of aborted seeds were recorded in cv. Local khera (22.25) as shown in Table 2.

Table 2. Diversity in Fruit Size and Quality Attributes of Cucumber Cultivars

Traits		Cultivars					
		Green pearl	**Green star**	**Cucumber 4308**	**Champion**	**CP 001**	**Local khera**
Fruit length (cm)		14.97 ab	15.13 ab	13.22 bc	14.29 abc	12.42 c	15.64 a
Fruit diameter (mm)		38.25 a	37.56 a	40.29 a	47.29 a	37.27 a	43.98 a
Neck Shape		0.42 b	0.42 b	0.17 b	0.46 b	0.59 ab	1.00 a
Acute shape		0.75 ab	0.58 bc	1.00 a	0.75 ab	0.42 c	0.13 d
TSS (Brix)		2.65 b	2.89 ab	3.16 a	3.09 a	2.66 b	1.42 c
No. of fruits plant^{-1}		12.33 b	12.33 b	11.67 b	16.00 a	18.00 a	17.00 a
Yield per plant (kg)		2.16 b	2.16 b	2.04 b	2.80 a	3.15 a	2.98 a
Number of seeds/fruit	Healthy seeds	126.54 b	79.17 c	82.88 c	63.29 d	63.79 d	144.33 a
	Aborted seed	24.92 ab	24.87 ab	29.46 a	26.08 ab	30.00 a	22.25 b

Discussion

Genetic diversity of cucumber has been subject of numerous studies which showed the presence of variability among morpho-economical traits in cucumber (Staub et al., 2005, 2006). Characterization and evaluation of the available germplasm of cucumber cultivars (Green Pearl, Green Star, Cucumber 4308, Champion, CP 001, Local khera) was done based on morphological and growth characteristics regarding leaf characters (leaf length, leaf width, intensity of green color), floral characters (time of flower development, number of flowers per node, male/ female flower plant, fruit characters, fruit length, fruit diameter, number of seeds per fruit, fruit shape at stem end, total length of first 15 internodes) of various cucumber cultivars (Green Pearl, Green Star, Cucumber 4308, Champion, CP 001, Local khera) revealed variation for these traits specifically in leaf length, leaf width and length of nodes in studied cultivars (Green Pearl, Green Star, Cucumber 4308, Champion, CP 001, Local khera). The above-mentioned parameters provided information to determine the magnitude of genetic diversity in morphological which may also affect yield. For instance, leaf size and a greater number of leaves have direct relation with photosynthesis leading to high yield. Local khera showed the highest length of first 15 nodes which may associated with good yield as it may provide more flowering or fruiting points in cucumber cultivar. Cucumber cultivars were evaluated on

several morphological including mentioned above by earlier studies (Ali, 2019). High magnitude of phenotypic variations was also observed in elite accessions of cumber (Colemana et al., 1994).

It was noted that cultivars Champion, CP 001 and Local khera gained highest number of female flowers node^{-1} and female flower plant^{-1} (Table 1). The lowest flower related attributes were recorded in Green Star followed by Green Pearl and Cucumber 4308. It was estimated that highest number of female flowers plant^{-1} were observed in CP 001 followed by Champion and Local khera. The lowest number of flowers plant^{-1} were observed in Green Star followed by Cucumber 4308. A significant variation was revealed among various cucumber cultivars regarding days to flowering which was also determined in accessions of cucumber evaluated phonological traits (Wehner & Gune, 2004) and Ali (2019). Accession "Local khera" took the highest days to flowering followed by Green Star and Cucumber 4308. Green Pearl followed by Champion had the lowest days for flowering. Reproductive attributes such as number of female flowers node^{-1}, number of male flowers per node and average number of flowers are directly related to yield (Vimala et al., 1999). The variation found in these cultivars (Green Pearl, Green Star, Cucumber 4308, Champion, CP 001, Local khera ARRI) indicated variation in yield, for instance it was noted that CP 001 and Champion gained the highest number of female flowers node^{-1} leading to higher fruit set percentage. Accessions such as Green Pearl followed by Champion started early bearing and was characterized as early maturing cultivars. Previous finding of Nwofia et al. (2015) also showed that three cucumber cultivars differed for number of male and female flowers and male to female flower ratio.

Fruit related attributes (fruit length, fruit diameter, necked shape, acute shape, TSS) of cucumber cultivars also revealed variations among all cultivars. Some cultivars of had larger fruits than other cultivars. The cultivars (Green Star, Local khera, Green Pearl, Cucumber 4308, Champion and CP 001) had higher fruit length which may be a positive contributor of good yield. Fruit necked shape, acute shape, TSS contribute as quality attributes. The cultivar (Cucumber 4308) having high TSS could increase antioxidants due to maintenance of high total soluble sugars levels (Nwofia et al. 2015).

Cosumer preference of cucumber fruit also dictated by color intensity (dark green, light green, medium green) of cucumber cultivars (Green Pearl, Green Star, Cucumber 4308, Champion, CP 001, Local khera). The coloring pigments (chromoplasts) and chlorophyll are specifically intensified by gene product. The dark green cultivars (Cucumber 4308) may be caused by accumulation of high-density chlorophyll. The light green cultivars (Green Pearl and Green Star) may have less chlorophyll density. The medium green cultivars (Local khera) may have sufficient chlorophyll density. Cucumber color show high preference for buyers and consumers (Cramer & Wehner, 2000).

Present study revealed that overall, there were significant variation regarding number of seeds fruit^{-1} and number of fruits plant^{-1} among various studied cultivars of cucumber. The highest number of seeds fruit^{-1} was noted in local khera while minimum healthy seeds in CP 001 and Champion as shown in (Table 2). It was also seen that highest value of number of fruits plant^{-1} was gained by CP 001, Local khera and Champion were at par with each other. It was observed that lowest values were gained by Green Pearl, Green Star, Cucumber 4308 regarding number of fruits plant^{-1}. There was significant variation regarding yield plant^{-1} among various cultivars of cucumber studied (Green Pearl, Green

Star, Cucumber 4308, Champion, CP 001, Local khera). It was seen that highest value was gained by CP 001, Local khera, Champion and were at par with each other, while it was observed that lowest values were gained by Green Pearl, Green Star, Cucumber 4308 regarding yield per plant. Based on these findings the higher yielding cultivars (CP 001, Local khera and Champion) of cucumber were selected for further investigation. It might be due to difference in photosynthetic rate depending on leaf size and enzymatic activity. Our results are in line with the outcomes of Nwofia et al. (2015) where different cultivars revealed different yield in cucumber.

References

Ali, A. H., Abdelrahman, M., Radwan, U., El-Zayat, S., & El-Sayed, M. A. (2018). Effect of Thermomyces fungal endophyte isolated from extreme hot desert-adapted plant on heat stress tolerance of cucumber. *Applied Soil Ecology*, *124*, 155–162.

Ali, M. 2019. Heat stress studies in cucumber and its alleviation through chitosan. Ph.D. Diss., Inst. Hort. Sci. Uni. Agri., Faisalabad, Pakistan.

Ammar, A.T & Arif, A. M. (2019). Phytochemical screening and in vitro antibacterial and anticancer activities of the aqueous extract of Cucumis sativus. *Biologial Sciences*, 26(3), 600-604.

Coleman, J. S., McConnaughay, K. D., & Ackerly, D. D. (1994). Interpreting phenotypic variation in plants. *Trends in Ecology & Evolution*, *9*(5), 187–191.

Cramer, C. and T. Wehner. 2000. Path Analysis of the correlation between fruit number and plant traits of cucumber populations. *Hortscience*, 35(4), 708–711.

FAOSTAT, 2019. Food and agriculture data. Cucumber production. http://faostat.fao.org.

GOP (Government of Pakistan). 2015-16. Agricultural Statistics Yearbook 2015-16. Ministry of National Food Security and Research, Islamabad, Pakistan.

IPGRI. 2006. Descriptors for cucumber (Cucumis sativus L.). International Plant Genetic Resources Institute, Rome, Italy.

Jat, G. S., Behera, T. K., Lata, S. & Kumar, S. (2021). Classical Genetics and Traditional Breeding in Cucumber (*Cucumis sativus* L.). *Cucumber Economic Values and Its Cultivation and Breeding*. (pp. 201).

Khater, E. S. G. (2017). Effect of acclimatization temperature and light intensity on the graft-take of cucumber seedlings. *J. Environ. Anal. Toxico*, *7*, 1–14.

Kumaraswamy, L. A. T. H. A. (2016). Cucumber-A Natural Medicine and its Therapeutic Potential. *Recent Progress in Medicinal Plants*, *43*, 1-8.

Nwofia, G. E., Amajuoyi, A. N., & Mbah, E. U. (2015). Response of three cucumber varieties (Cucumis sativus L.) to planting season and NPK fertilizer rates in lowland humid tropics: sex expression, yield and inter-relationships between yield and associated traits. *International Journal of Agriculture and Forestry*, *5*(1), 30–37.

Siddique, S., Ayub, G., Nawaz, Z., Zeb, S., Khan, F. S., Ahmad, N., ... & Rauf, K. (2017). Enhancement of growth and productivity of cucumber (Cucumis sativus) through foliar application of calcium and magnesium. *Pure and Applied Biology (PAB)*, *6*(2), 402–411.

Staub, J. E., Chung, S. M., & Fazio, G. (2005). Conformity and genetic relatedness estimation in crop species having a narrow genetic base: the case of cucumber (*Cucumis sativus* L.). *Plant Breeding*, *124*(1), 44–53.

Staub, J. E., Robbins, M. D., Chung, S. M., & Sun, Z. (2006). History and application of molecular markers for cucumber improvement. *Cucurbitaceae 2006, Asheville, North Carolina, USA, 17-21 September 2006*, 197–205.

Steel, R.G.D., J.H. Torrie & D.A. Dicky. 1997. Principles and procedures of statistics: A biological approach. 3rd (Eds), McGraw Hill Book Co. Inc., New York, USA.

Tuama, A. A., & Mohammed, A. A. (2019). Phytochemical screening and in vitro antibacterial and anticancer activities of the aqueous extract of *Cucumis sativus*. *Saudi Journal of Biological Sciences*, *26*(3), 600–604.

Vimala, P., Ting, C. C., Salbiah, H., Ibrahim, B., & Ismail, L. (1999). Biomass production and nutrient yields of four green manures and their effect on the yield of cucumber. *Journal of Tropical Agriculture and Food Science*, *27*, 47–56.

Wehner, T. C., & Guner, N. (2002). Growth stage, flowering pattern, yield, and harvest date prediction of four types of cucumber tested at 10 planting dates. In *XXVI International Horticultural Congress: Advances in Vegetable Breeding 637* (pp. 223–230).

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