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Effect of Saline Water Irrigation on the Growth of Canola under Field Conditions

Humaira Gul[1*], Rafiq Ahmed[2] and Muhammad Hamayun[1]

[1]Department of Botany, Abdul Wali Khan University, Mardan, Pakistan

[2]Biosaline Research Laboratory, Department of Botany, University of Karachi, Pakistan

*Corresponding Author: gulhumaira@awkum.edu.pk

ABSTRACT

Investigations were undertaken to find out the effect of saline rhizosphere on vegetative and reproductive growth of Canola var. Oscar under field conditions. It was grown on non-saline sandy loam irrigated with 0.6% (EC 6.5 $dS.m^{-1}$) sea salt dilution. Vegetative growth was recorded in terms of plant height, leaf area, fresh and dry shoot biomass per plant, while reproductive growth was noted in terms of number of flowers and siliquae per plant; siliquae weight; seed number and weight per siliquae; seed number and weight per plant. This variety produced 67gms fresh shoot biomass and 25gms dry shoot biomass per plant under non-saline control, while exhibited 16 and 20% reduction in fresh and dry shoot biomass respectively, under saline water irrigation. Reproductive yield (seed weight per plant) when irrigated with non-saline water (control) was 11.2 gm/pl. and showed 45.5% reduction when irrigated with 0.6% sea salt dilution under field conditions.

Key Words: Salinity, canola, vegetative yield, reproductive yield, saline water irrigation.

Introduction

Salinity refers to the occurrence of various salts in soil or water in concentration that may interfere with the growth of plants. It comprises of chloride, sulfates and bicarbonates of sodium, calcium, magnesium and potassium [13]. Many categories of salt tolerance in plants have been proposed [32]. The amount and quality of irrigation water available in many of the arid and semiarid regions of the world are the main limiting factors to the extension of agriculture [12, 41]. Saline-sodic irrigation water, coupled with the low annual rainfall and high evaporation and transpiration in the arid and semi-arid regions, have resulted in accumulation of soluble salts in the soil solution and of cations (especially sodium ions) on exchange sites, which can alter the structure and, consequently, affect the soil

hydraulic conductivity [45]. Several studies showed
external signs of salt toxicity due to irrigation with saline water such as sclerosis, leaf burning and poor vegetative growth [24, 19, 2].

Increase in the human population of the world demands an increase in food production where as land deterioration is causing a significant amount of decrease in yield. In the present situation the scientists should work out ways and means to compensate deficiencies. If good quality water is not available, moderately saline water could be use for growing salt tolerant plants for food, fuel and fodder. A good amount of literature is available containing a wide range of information with respect to the range of salt tolerance in forest trees, shrubs, grasses, halophytic and conventional agricultural crops [22, 27, 4, 30, 11, 22, 15, 39].

Canola is the name applied to rapeseed crops which yield grain possessing <20 g kg^{-1}erucic acid in the oil and <30 μmol of aliphatic glucosinolates g^{-1} in the defatted meal [50]. Salt tolerance is important in vegetables because of the cash value of crops [47]. Importance of the *Brassica* vegetables such as Chinese cabbage, broccoli, cabbage, cauliflower and kale in terms of their nutrient quality for human diet and processed food has, recently, been increased [33]. Significant variation was reported in seed germination between canola cultivars grown under salinity condition is widely reported by [52] and [42]. The two species of canola *B. napus* and *B. campestris* are classified as tolerant to salinity reported by [37]. [36] also reported that even though both the species exhibit high salinity thresholds, the rate of yield decline above the thresholds was much greater than most other crops in the tolerant category.

The present work was undertaken with interest to find out extent of salts in irrigation water and soil that can still give economically feasible growth for Canola cultivation.

Material and Methods

This experiment was performed during October 2000-April 2001. Vegetative and reproductive growth of Canola variety (Oscar) was studied in field while irrigated with saline water. A plot covering an area of 20 x 25 ft was used in this experiment, comprising of three furrows each of 25 ft long, 2.5 ft broad and 0.5 ft deep in dimension. One furrow was used for non-saline water irrigation (control), where as remaining two furrows were irrigated with

0.6% sea salt solution (EC 6.5 $dS.m^{-1}$). Distance apart between the control and saline water irrigation was about 5 ft in which a six ft deep asbestos sheet was vertically sunken to keep the two kinds of irrigation water separate from each other in root zone. Soil was sandy and percolation rate was about 90%. The furrows at one end (lower slant) were connected with deep drainage channel that served for removing excessive drainage water. Organic manure was added in soil at 9:1 ratio. Canola seeds (Var. Oscar) were sown 30 cms apart in each furrow and 25 seedlings were left in each row for experiments. Irrigation with good quality water (non-saline) was provided for 28 days after which, furrows undergoing irrigation once a week with water of above-mentioned salinity levels.

Plant height was recorded at regular interval. Leaf area, fresh and dry biomass were recorded in harvested plants. Moisture content was calculated from fresh and dry weight and expressed as percentage of fresh weight. Shoot root ratio was calculated and expressed at dry weight basis at grand period of growth. Number of flowers and pods were recorded weekly. Pod weight, pod length, seed number and weight per pod, seed number and weight per plant were recorded at termination of experiment. A total flower shed per plant by calculating the difference between total flowers and pods per plant and expressed as the percentage of total flowers produced per plant.

Statistical analysis of the data was carried out as outlined by [34] and [23]. Data were analyze using computer program Costat 3.03. Mean separation of data was carried out using Duncan Multiple Range test [17].

Observations and Results

Plant height does not carry the idea of better growth in most of the cases. The biomass has been often found more in the plants of relatively shorter height. Plant height exhibited significant increase with the increase in time in control as well as in saline medium at $P<0.001$ level (Figure 1). Salinity exhibited significant ($P<0.001$) reduction in this parameter. Relative growth rate (RGR) calculated for height exhibited high values in control plants during 2nd and 3rd fortnight period while salinity treated plants exhibited increase during 4th growth period (Figure 1). These findings established that salinity causes stunting growth in glycophytes [44, 46]. [5, 6] have stated that since plant height is genetically controlled, different varieties can not be graded into tolerant and susceptible on this basis. This

statement further confirmed by [8] for Canola
mungbean, [7] for sorghum and [9] for

Table 1. Effect of irrigation water of different salinity level on shoot root ratio in Canola var. Oscar under field conditions.

Treatment	Shoot Dry Wt. (gms)	Root Dry Wt. (gms)	Shoot/Root
Control	17.154 a ±0.549	7.642 a ±1.647	2.504 b ±0.631
0.6%	13.540 b ±4.892 (-21.068)	2.276 b ±1.140 (-70.209)	8.404 a ±1.200 (+235.622)
$LSD_{0.05}$	6.104	4.611	2.829

Means followed by different letters in the same column differ significantly at 95% probability level according to New Duncan's Multiple Range Test.

Figures in parentheses indicate % promotion (+) and reduction (-) over control.

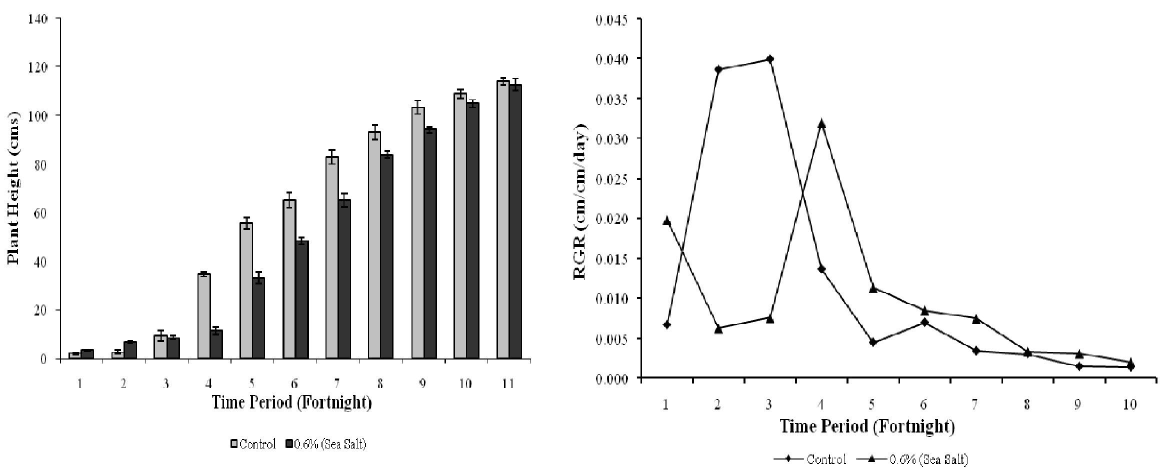


Figure 1. Effect of irrigation water of different salinity levels on plant height and RGR of Canola var. Oscar grown under field conditions.

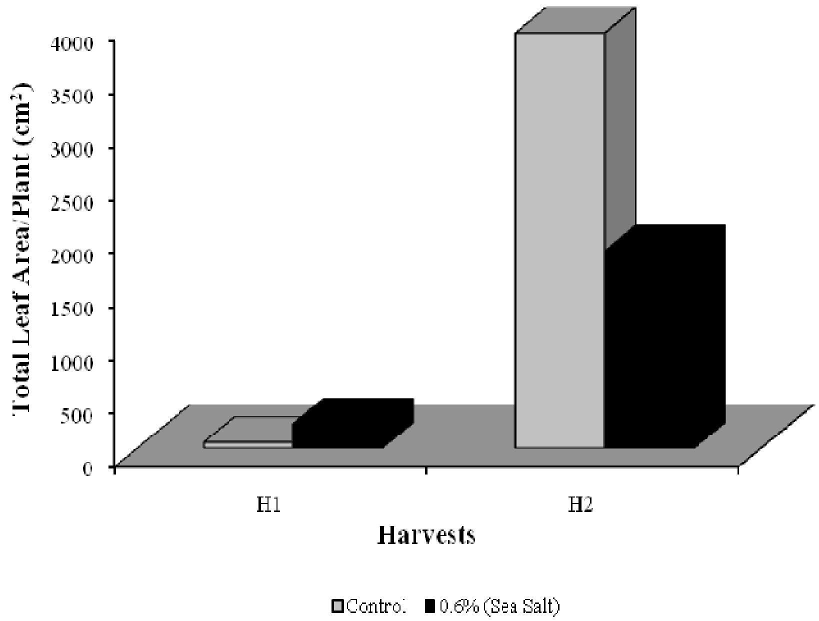


Figure 2. Effect of irrigation water of different salinity levels on total leaf area per plant of Canola var. Oscar grown under field conditions.

H1: First Harvest **H2**: Second Harvest

Salinity stress results in a clear stunting of plants [25, 16, 49]. The immediate response of salt stress is reduction in the rate of leaf surface expansion leading to cessation of expansion as salt concentration increases [51]. Leaf area presented in Figure 2 exhibited significant increase ($P<0.001$) while salinity had significant ($P<0.01$) reduction (52%) in this parameter as compare to non-saline control. The major factor of reduction in growth and yield is mainly due to limited supply of metabolic energy for maintenance of normal growth processes. Salinity increases the amount of work necessary to counteract osmotic and ionic stresses for normal cellular maintenance, as a consequence there is less energy left for growth requirements [18, 10, 31]. Shoot root ratio (Table 1) was increased in salinity as compare to control plants. This increase was significant at $P<0.001$ level. Moisture content exhibited high values in salinity treated plants as compare to non-saline control (Figure 3). The differences of moisture content with harvests was significant at $P<0.001$ level and at $P<0.01$

level with salinity. Interaction of harvests and salinity was significant at P<0.001 level. Increased NaCl levels results in a significant decrease in root, shoot, and leaf growth biomass and increase in root/shoot ratio in cotton [40].

Table 2. Effect of irrigation water of different salinity level on total flowers, pods and flowers shed per plant in Canola var. Oscar under field conditions.

Treatment	Total Flowers Per Plant	Total Pods Per Plant	Total Flowers Shed Per Plant	Flower Shedding (%)
Control	381.666 a $\pm$3.863	211.000 a $\pm$7.753	170.666 a $\pm$8.877	45 a
0.6% (S.S)	248.166 b $\pm$16.232 (-34.980)	177.000 b $\pm$13.389 (-16.110)	71.166 b $\pm$6.488 (-58.320)	29 b
$LSD_{0.05}$	19.741	39.633	43.772	11.484

Means followed by different letters in the same column differ significantly at 95% probability level according to New Duncan's Multiple Range Test.

Figures in parentheses indicate % promotion (+) and reduction (-) over control.

S.S: Sea salt

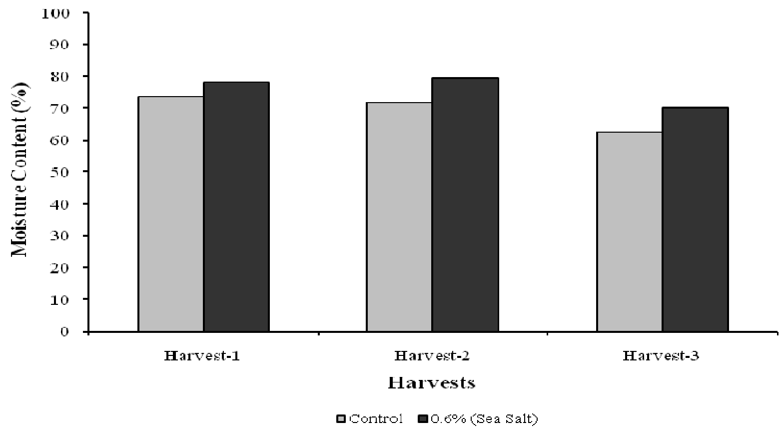


Figure 4. Effect of irrigation water of different salinity levels on moisture content of Canola var. Oscar grown under field conditions.

Salt stress also results in a considerable decrease in the fresh and dry weights of leaves, stems, and roots [25, 1, 14]. Fresh shoot biomass was higher during 2nd harvest as compare to first and third harvest irrespective of treatment while dry shoot biomass increased in 2nd and 3rd harvest (Figure 4 Changes in fresh and dry shoot biomass irrespective to harvests and salinity was significant at $P<0.001$ level. Var. Oscar grown at non-saline soil irrigated with saline water of 0.6% sea salt dilution under field conditions exhibited 19.9 and 44.7% reduction in fresh and dry shoot biomass respectively in comparison of plants irrigated with good quality water. Similar results have been reported by [26], found that total dry matter of the most salt tolerant *Brassica napus* L. decreased by 52% of its control in seawater of 12 $dS.m^{-1}$. Recently [43] reported that shoot dry weight of a Canola variety was reduced by 3% of control plants at soil salinity of 11.5 $dS.m^{-1}$ in a pot experiment under growth chamber conditions.

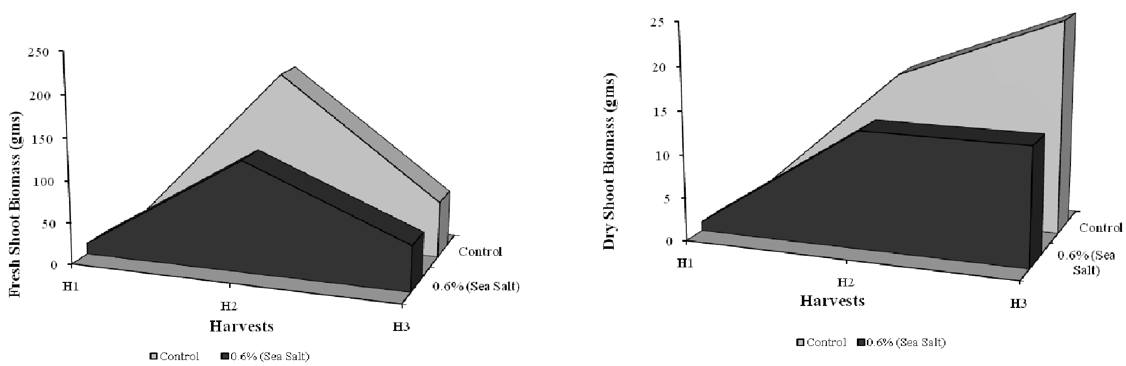


Figure 4. Effect of irrigation water of different salinity levels on shoot biomass per plant (fresh and dry) of Canola var. Oscar grown in field conditions

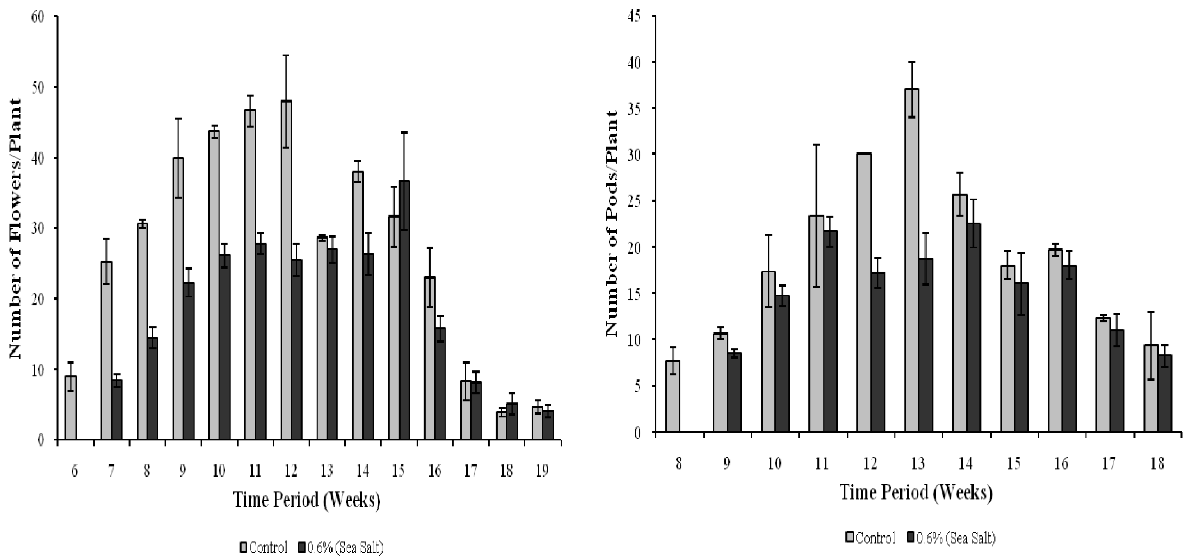
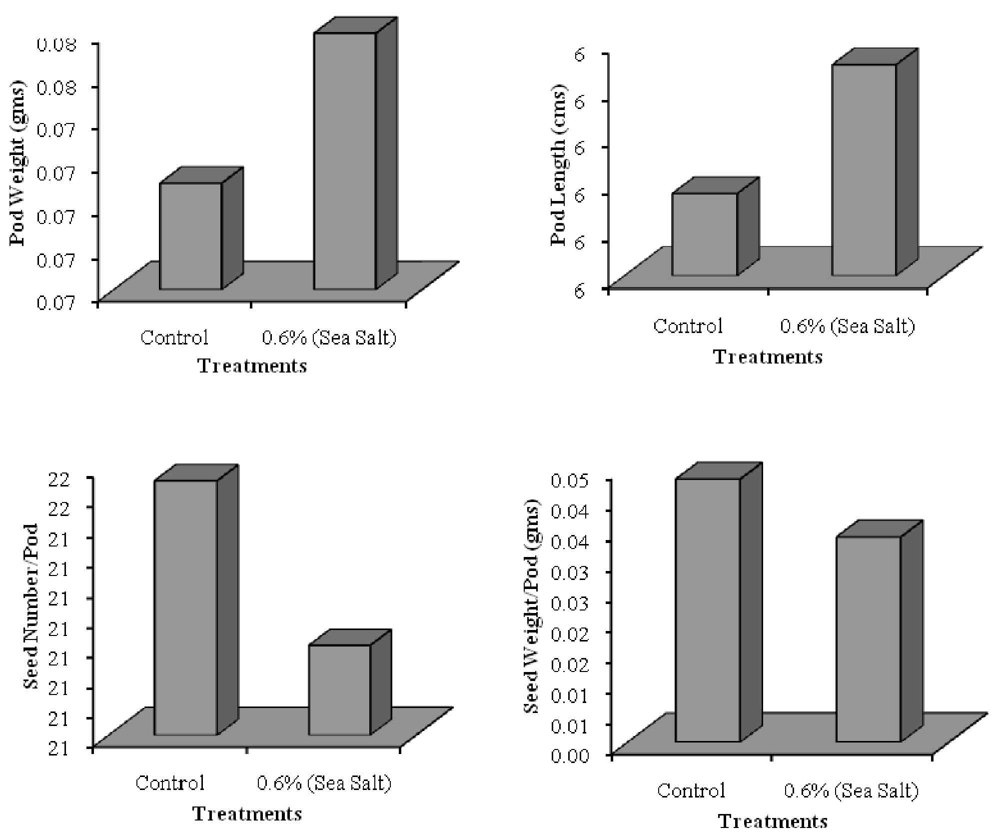


Figure 5. Effect of irrigation water of different salinity levels on number of flowers per plant and number of pods per plant of Canola var. Oscar grown under field conditions.



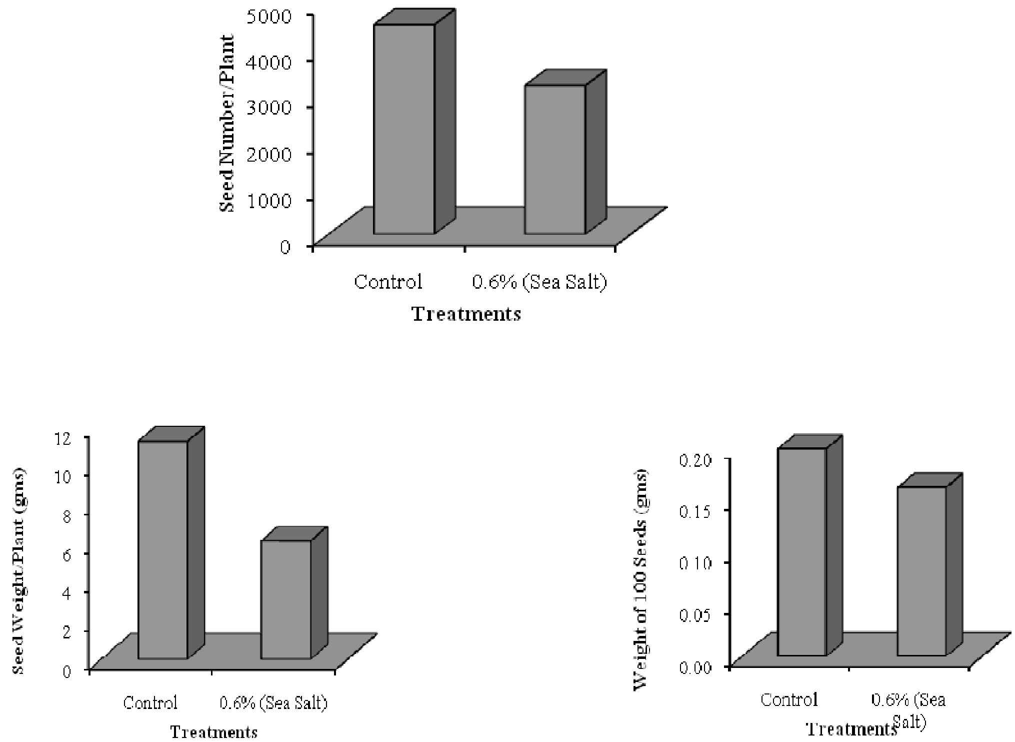


Figure 7. Effect of irrigation water of different salinity levels on reproductive parameters of Canola var. Oscar grown in field conditions.

Figure 5 showed slight delay in flowers initiation in saline medium (in 7^{th} week) and significant ($P<0.001$) reduction in number of flowers per plant as compare to control plants. Salinity had significant reduction effect ($P<0.001$) and delayed pods production as compare to control. It showed significant differences ($P<0.001$) with time while interaction of time and salinity was significant at $P<0.001$ level. Number of flower shed and their percentage was lower in plants grown in saline medium (Table 2). Number of flower shed was significantly ($P<0.001$) reduced in salinity treated plants as compare to non-saline control. Pod weight (Figure 9) and pod length (Figure 6) exhibited increase and seed number per pod (Figure 6) showed decrease in salinity treated plants as compare to non-saline control. However, these changes were non-significant when analyze statistically. Seed weight per pod (Figure 6), seed number and weight per plant (Figure 6) and weight of 100 seeds (Figure 6) were significantly ($P<0.001$) decreased in salinity treated plants as compare to control. [3] found that in barley, grains per spike and spikes per unit area were quite insensitive to field-applied salinity, while 1000-seed weight was most strongly affected, accounting for most of the decrease in grain yield. Root-zone salinity decreases the grain yield of spring wheat primarily by reducing the number of fertile tillers per plant [35, 29, 48].

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