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Seasonal abundance of the cabbage aphid *Brevicoryne brassicae* (Hemiptera : Aphididae) infesting canola plants in relation with associated natural enemies and weather factors in Sohag Governorate

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Abstract:

Canola (*Brassica napus* L.) is grown in more than 120 countries around the world, including Egypt, hold the third position oil crop after palm and soybean oils . the cabbage aphid *Brevicoryne brassicae* (L.) (Hemiptera : Aphididae) is distributed in many parts of the world and is present in Egypt, especially in Upper Egypt. Its damage occurs on the plant leaves and transmit plant viruses. The present studies were carried at The Experimental Farm of Shandweel Agricultural Research Station, Sohag Governorate, Egypt during the winter seasons of 2017/2018 and 2018/2019 to investigate the population density of the cabbage aphid *B. brassicae* infesting canola in relation to some biotic and abiotic factors in Sohag Governorate. Data revealed that aphid started to take place in canola fields during the first week of December in both seasons (36 days after planting), then increased to reach its peak in at 20th and 13th February in the two seasons (Between 106 to 113 days after planting), respectively. The parasitism rate by *Diaeretiella rapae* (MacIntosh) (Hymenoptera: Braconidae) simultaneously increased as aphid populations increased in both seasons, also, the highest parasitism percentages were synchronization of the aphid numbers reduction in both seasons. *Coccinella undecimpunctata* L. (Coleoptera : Coccinellidae) , *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) and *Syrphus corollae* Fabricius (Syrphidae: Diptera) were the main predators inhabiting canola plants, started to take place in canola fields after 2-3 weeks from aphid infestation. Predators showed their highest abundance during February and simultaneously increased as aphid populations increased in both seasons. Using simple correlation and simple regression values, the effects of parasitoid and predators showed positive, highly significant and significant effects, respectively, on *B. brassica*e during the two seasons. However, none of abiotic factors (Maximum and minimum temperature and mean relative humidity) showed significant effects in the two seasons.

Introduction

Canola (*Brassica napus* L.: Cruciferae) became one of the most important oil crops all over the world. In Egypt, it is cultivated in winter and can grow in the new reclaimed lands. Therefore, canola is one of the promising oil crops which could help in reducing the gap between the local production and the consumption in Egypt (Abdrabou *et al.,* 2017). Canola crop was attacked by several insect pests, but one of the most important insects is the cabbage aphid *Brevicoryne brassicae* (L.) (Hemiptera: Aphididae) was the most serious one (Mazeed, 2006; Amer *et al*., 2009 and Syaid *et al*., 2020). The population trend of the pest is the central corner to select the best time insecticide applications against cabbage aphid in canola fields. So, several authors studied the population density of this pest (Khan and Begum, 2005 and Temerak *et al*., 2014**).** The parasitoid *Diaeretiella rapae* (MacIntosh) (Hymenoptera: Braconidae) is described as the main primary parasitoid of cabbage aphid and considered as one of the most effective factors decreased cabbage aphid population in canola fields (Sayed and Teilep, 2013 and Abdel-Galil and Mahmoud, 2019). The insect predators, *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae), *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) and *Syrphus corollae* Fabricius (Syrphidae: Diptera) was reported as the most prevalent predator species found associated with the aphid in canola fields and their role in suppressing aphid populations in canola fields was studied by many authors **(**Saljoqi *et al*., 2012 and Abbas *et al*, 2017). Weather, especially, temperature and relative humidity play a major role in the development of aphid populations **(**Abbas *et al*, 2014; Nematollahi *et al*., 2016 and Akbar *et al*., 2019). The present work was oriented to obtain better knowledge about *B. brassicae* population infesting canola in relation to some biotic and abiotic factors at Sohag Governorate.

Materials and methods

1. Experimental design:

The present studies were carried at The Experimental Farm of Shandweel Agricultural Research Station, Sohag Governorate, Egypt during the winter seasons of 2017/2018 and 2018/2019. An area of about half feddan (2100 m2) was cultivated with canola plants (Cultivar pactol) in completely randomized block design. Normal agricultural practices were performed, and no insecticidal treatments were used during the whole study period.

2. Population trend of aphid:

In order to study the population density of *B. brassicae*, ten canola plants were randomly selected, and the number of aphids was counted in each replicate. Data were collected at weekly intervals from emergence to the harvesting time.

3. Population trends of natural enemies:

In order to study the population trends of insect predators associated with cabbage aphid infesting canola plants, the numbers of *C. undecimpunctata*, *C. carnea* and *S. corollae* larvae were counted on 10 randomly plants selected from each replicate. Data were collected at weekly intervals from emergence to the harvesting time.

For the main associated parasitoid, *D. rapae*, the number of mummified aphids was counted from the first inspection date and continued to the end of the two seasons. The percentage of parasitism caused by aphid parasitoid was calculated in each sampling date according to following formula:

$$\text{Parasitism percentage} = \frac{\text{Number of parasitoid aphids}}{\text{The total number of aphids}} \times 100$$

4. The effect of some biotic and abiotic factors on population trend of cabbage aphid:

The effects of plant age, maximum temperature, minimum temperature, average relative humidity, total predator number and parasitoid number were tested for population fluctuation of aphid infesting canola using simple correlation according to Gomez and Gomez (1984)**.**

Results and discussion

1. Population trend of *Brevicoryne brassicae* on canola plant:

The seasonal abundance of cabbage aphid inhabiting canola plants during 2017/2018 and 2018/2019 growing seasons at Sohag Governorate was presented in Figure (1). Data revealed that the cabbage aphid started to take place in canola fields during the first week of December in both seasons (36 days after planting). A gradual increase in aphid numbers were recorded until the appearance of its peak at 20th and 13th February in 2017/2018 and 2018/2019 seasons (Between 106 to 113 days after planting), respectively, with 591.33 and 904.33 aphids/ plant. Then the numbers of aphid decreased until the end of the two seasons. The highest aphid population was observed during February, followed by January in both seasons.

In agreement with the above results, Khan and Begum (2005) who found that the population of aphid on canola peaked in 3rd week of February**,** and Amer *et al*. (2009) who found that the highest population was recorded during the last week of February to the second week of March. Also, Temerak *et al*. (2014) showed that the highest population density of cabbage aphid was recorded during the plant age of 108-125 days old.

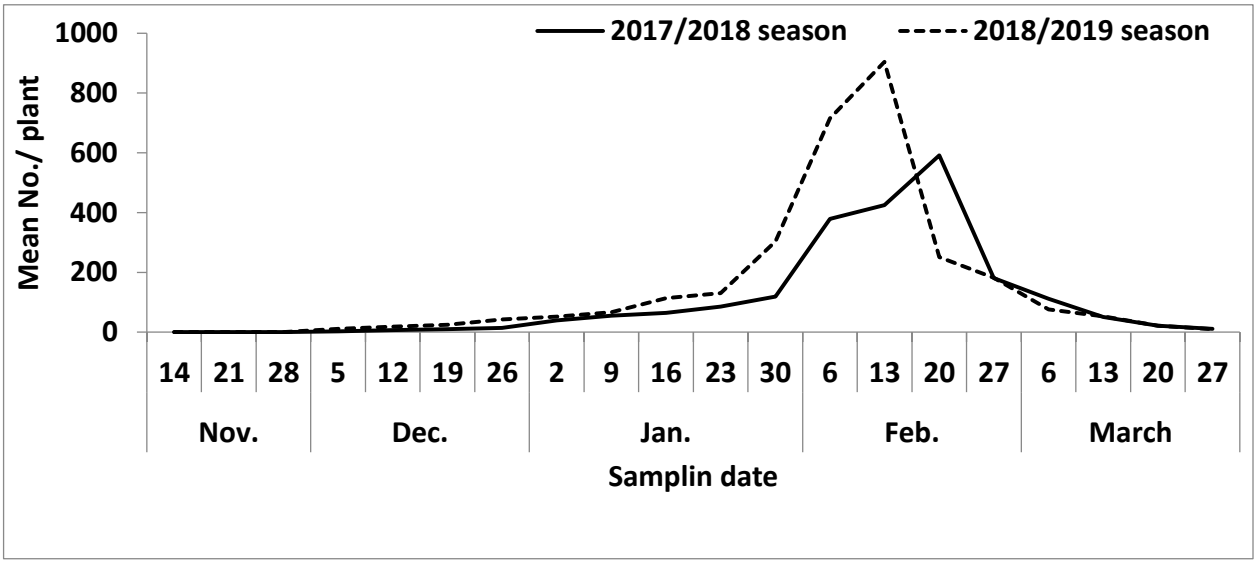

Figure (1): Population trend of *Brevicoryne brassicae* infesting canola plants during 2017/2018 and 2018/2019 seasons at Sohag Governorate.

2. Population trends of natural enemies associated with *Brevicoryne brassicae* on canola plant:

2.1. *Diaeretiella rapae* parasitoid:

The mean percentage of cabbage aphid parasitized by *D. rapae* during 2017/2018 and 2018/2019 growing seasons at Sohag Governorate was estimated as shown in Figure (2). The first mummified aphids appear was observed during the last week of December in both seasons, the seasonal mean of parasitism percentage maximized two times in both seasons. The peaks were observed in 16th January (12.03%) and 13th March (39.99%) in 2017/2018 season. While, in 2018/2019 season, the peaks recorded in 9th January (15.58%) and 27th February (43.01%). The parasitoids appear delay by about three weeks after canola infestation by aphids. However, the parasitism rate simultaneously increased as aphid populations increased in the both seasons, also, the highest parasitism percentages were synchronization of the aphid numbers reduction in both seasons.

Relations between B. brassicae and its parasitoids were clarified by Temerak *et al*. (2014)**.** The previous results support the findings of **Abdel-**Galil and Mahmoud (2019) who reported that the aphid number decrease was in simultaneous with the increase of its parasitoid.

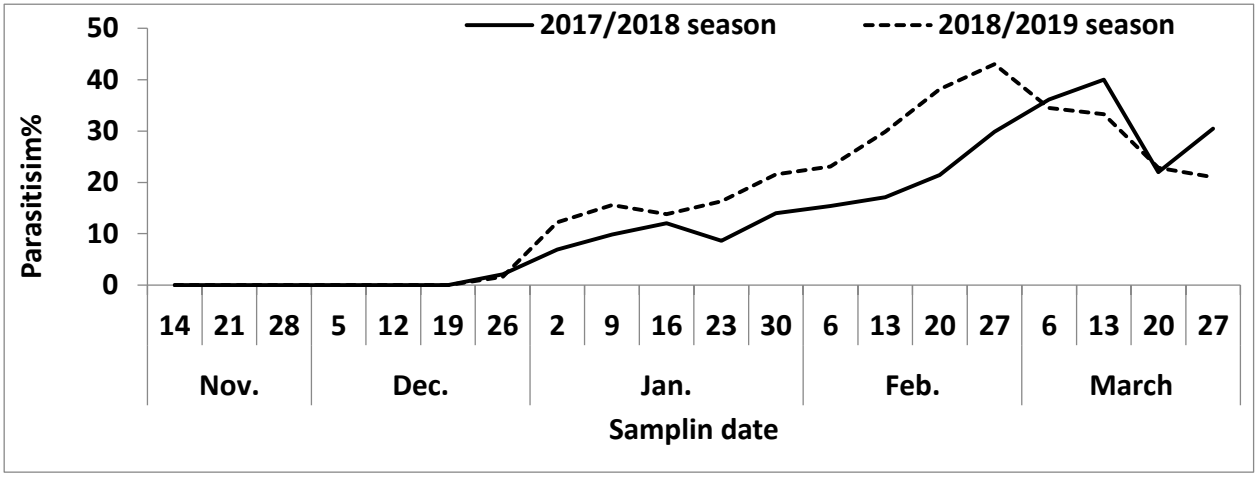

Figure (2): Mean percentage of *Diaeretiella rapae* parasitism on *Brevicoryne brassicae* infesting canola plants during 2017/2018 and 2018/2019 growing seasons at Sohag Governorate.

2.2. Predators:

The seasonal abundance of *C. undecimpunctata* associated with cabbage aphid inhabiting canola plants during 2017/2018 and 2018/2019 growing seasons at Sohag Governorate was presented in Figure (3). Data revealed that the coccinellid predator started to take place in canola fields the last half of December (After 2 weeks of aphid infestation) and recorded two peaks in both seasons. During first season, the peaks observed in 2nd January (3.33 larvae/ plant) and at 13th February (4.00 larvae/ plant). However, in the second season, the peaks recorded in 2nd January (2.33 larvae/ plant) and at 20th February (3.67 larvae/plant). After that, the numbers decreased to the end of the two seasons. It is clear that the highest abundance of this predator was detected during February followed by January and simultaneously increased as aphid populations increased in both seasons.

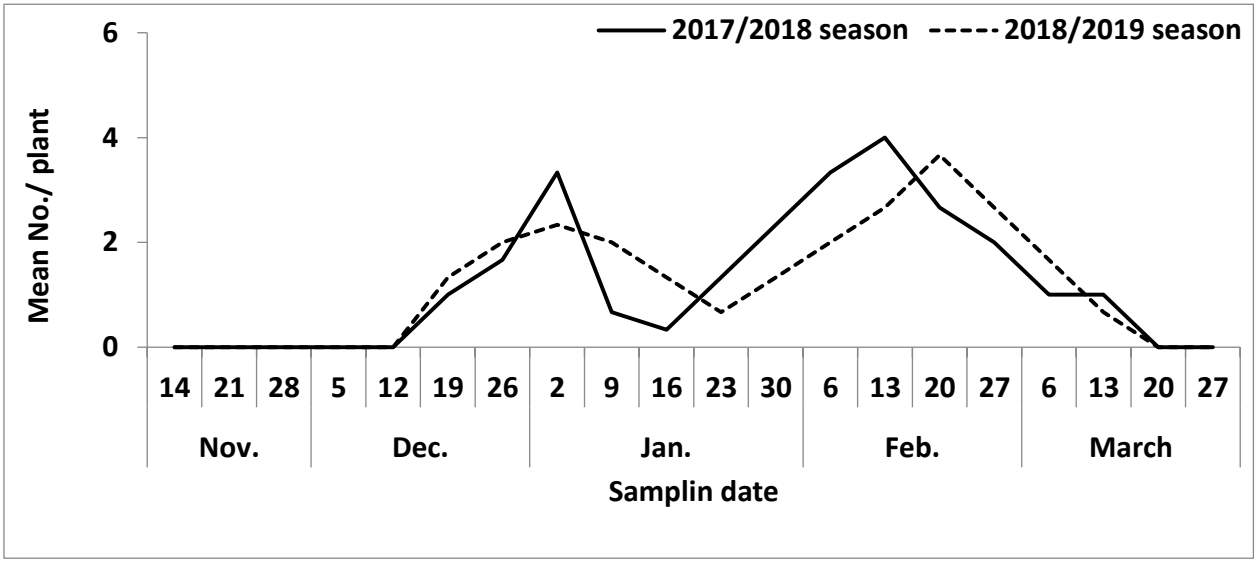

Figure (3): Population trend of *Coccinella undecimpunctata* inhabiting canola plants during 2017/2018 and 2018/2019 growing seasons at Sohag Governorate.

The seasonal abundance of *C. carnea* associated with cabbage aphid inhabiting canola plants during 2017/2018 and 2018/2019 growing seasons at Sohag Governorate was presented in Figure (4). Data revealed that the chrysopid predator started to take place in canola fields the last half of December (After 2 weeks of aphid infestation) and recorded three peaks in both seasons. During the first season, the peaks were obtained in 26th December (2.33 larvae/ plant), 23rd January (3.33 larvae/ plant) and in 27th February (2.33 larvae/ plant). However, in the second season, the peaks were recorded in 26th December (3.33 larvae/ plant), 6th February (3.67 larvae/ plant) and in 20th February (2.00 larvae/plant). After that, the numbers decreased to the end of the two seasons. The highest abundance of this predator was detected during February followed by January and simultaneously increased as aphid populations increased in both seasons.

The seasonal abundance of *S. corollae* associated with cabbage aphid inhabiting canola plants during 2017/2018 and 2018/2019 growing seasons at Sohag Governorate was presented in Figure (5). Data revealed that the syrphid predator started to take place in canola fields the last week of December (After 3 weeks of aphid infestation) and recorded one and two peaks in the two seasons, respectively. During the first season, the predator maximized at 6th March (3.33 larvae/ plant). However, in the second season, the predator maximized at 9th January (1.67 larvae/ plant) and at 27th February (2.33 larvae/plant). After that, the numbers decreased to the end of the two seasons. The highest abundance of this predator was detected during February followed by March and January in the two seasons, respectively, and simultaneously increased as aphid populations increased in both seasons.

In harmony with the previous results, Saljoqi *et al*. (2012) found that at the time when the aphid population started to increase the population peaks of *C. septempunctata* and *C. carnea* was recorded. Also, Abbas *et al*. (2017) reported that among the various natural enemies, the dominions were coccinellid followed by green lacewings and syrphid flies.

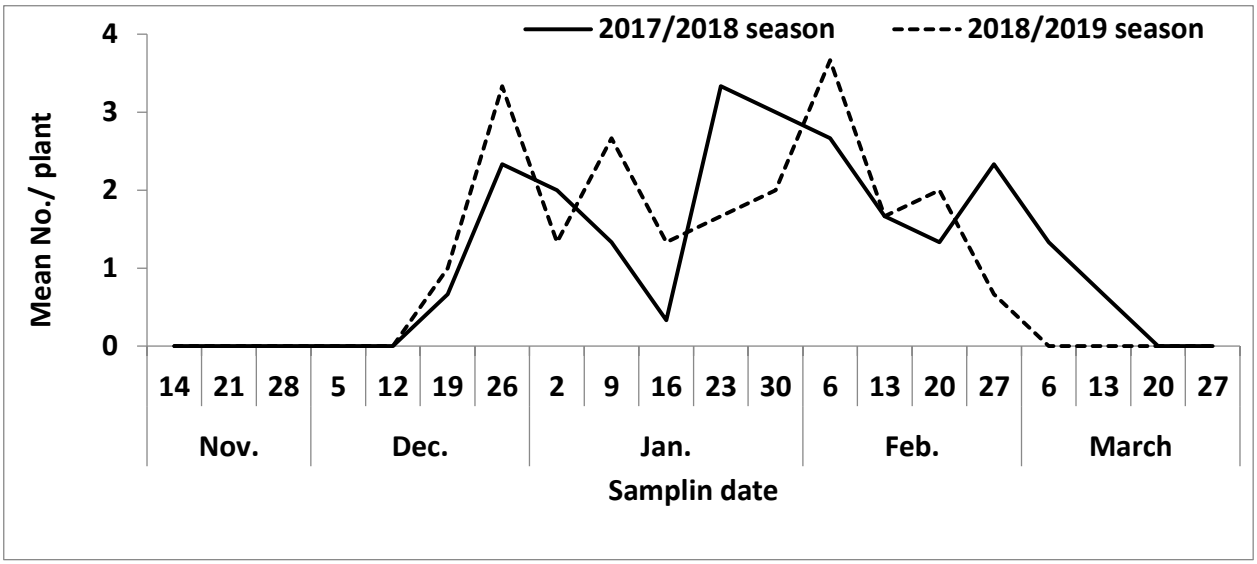

Figure (4): Population trend of *Chrysoperla carnea* inhabiting canola plants during 2017/2018 and 2018/2019 Growing seasons at Sohag Governorate.

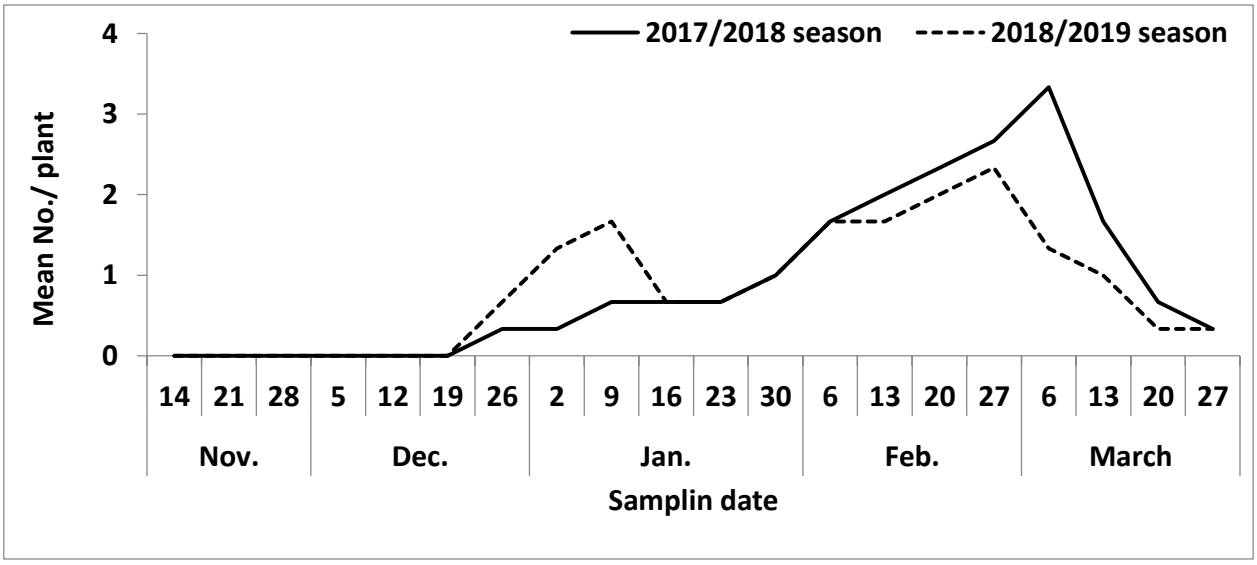

Figure (5): Population trend of *Syrphus corollae* inhabiting canola plants during 2017/2018 and 2018/2019 growing seasons at Sohag governorate.

3. Effect of biotic and abiotic factors on population of *Brevicoryne brassicae* infesting canola plants:

The effect of biotic factors (Plant age, parasitoid and total predators) and abiotic factors (Maximum and minimum temperatures and mean relative humidity) on the population of *B. brassicae* infesting canola plants was worked by processing the data of simple correlation and simple regression analysis (Table 1).

The parasitoid gave highly positive and significant effects of simple correlation and simple regression values on the population of *B. brassica*e during the two seasons. Also, total predators gave positive and significant effects of simple correlation and simple regression values on the population of *B. brassica*e during the

two seasons, no effects were observed for plant age in both seasons. in contrast with these results, Sayed and Teilep (2013) found that the effects of predators and percent parasitism showed insignificant effects of simple correlation values on the population of canola aphid. While, Abdel-Rahman *et al*. (2020) suggested that the differences in levels of infesting between the seasons might be attributed to the differences in weather factors and / or the effect of natural enemies in each season.

However, it is evident from the results that the effects of abiotic factors (Maximum and minimum temperatures and mean relative humidity) showed insignificant effects of simple correlation and simple regression values on the population of cabbage aphid. In agreement with these results, Abbas *et al*. (2014) found that none of abiotic factors were significantly correlated with *B. brassicae* population except minimum temperature in the second season. Akbar *et al*. (2019) found that the aphid abundance showed non-significant association with mean temperature, humidity and sunshine.

From the values of R-Squared (R^2) in the simple regression analysis, the most effective factor in the population of *B. brassica*e during the two seasons was the parasitism followed by the total predator number. The high R-Squared (R^2) value has been considered as evidence of the responsibility of parasitoids and predators to serve as a good biological control agent against *B. brassicae* populations.

Table (1): Simple correlation (r), simple regression (b) and R-Squared (R^2) between *Brevicoryne brassicae* and certain abiotic and biotic factors on canola at Sohag Governorate during 2017/2018 and 2018/2019 seasons.

Tested factors	2017/2018 season			2018/2019 season		
	Simple correlation (r)	Simple regression		Simple correlation (r)	Simple regression	
		b	R^2		b	R^2
Plant age	0.294	1.434	0.086	0.174	1.258	0.030
Parasitoid	0.962**	4.735**	0.925	0.976**	3.415**	0.953
Total predators	0.689**	42.458**	0.474	0.572*	55.877*	0.327
Maximum temperature	-0.027	-1.030	0.001	0.001	0.069	0.000
Minimum temperature	0.062	3.214	0.004	-0.194	-28.794	0.038
Mean relative humidity	-0.105	-1.656	0.011	-0.149	-5.068	0.022

***: Significant (p < 0.05%) **: Highly significant (p < 0.01%)**

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