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Mite Populations and its Predators on Some Vegetables in Relation to Monthly and Site Variations in Ismailia, Egypt

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ABSTRACT

Monthly abundance of Tetranychus urticae along with its predators, Phytoseiulus persimilis, Scolothrips longicornis and Stethorus gilvifrons were studied on Cucumis sativus and Solanum melongena at different sites. This study was conducted for one year, extending from February 2014 to January 2015 at two namely: Sarabium and Wasfia regions, in Ismailia governorate, Egypt. Results showed that monthly and site variations were significantly affected the mean abundance and prevalence of the adult stages of T. urticae and its predators on both crops. The results showed that the mean abundance of T. urticae adult stages on C. sativus was the highest in February (13.96±2.93) and March (12.08±1.93) in Wasfia and Sarabium, respectively. On the other hand, results showed that the mean abundance of T. urticae adult stages on S. melongena was highest in Sarabium in most of the months as compared to Wasfia where the highest mean abundance was in April (11.04±1.54) and March (10.04±1.5) in Sarabium and Wasfia, respectively. As well, the prevalence was monthly dependent in the two sites. There was a clear effect for site and month variations on the abundance and prevalence of the predators where it didn't appear permanently on C. sativus in winter months on contrary to S. melongena. In conclusion, the present study is one of the key conditions for establishing an efficient IPM strategy and this was clearly discussed.

Keywords: *Tetranychus urticae, abundance, vegetable crops, predators, temperature*

INTRODUCTION

Cucumber, *Cucumis sativus* L. and eggplant, *Solanum melongena* L. are two of the most preferred host plants of *Tetranychus urticae* Koch (Acari: Tetranychidae) throughout the world (Bostanian *et al*., 2003; El-Lakwah *et al*., 2011; Maklad *et al*., 2012). Ismailia governorate is one of the rich agricultural governorates in Egypt. Its planted area is about 337626 acres. World total production was 74.98 and 50.19 million tons for cucumber and eggplant; approximately 2.18 and 1.87 million hectares, respectively are planted yearly. In Egypt total production was 473.78 and 1.258 million tons for cucumber and eggplant; approximately 20.88 and 49.71 million hectares, respectively are planted yearly. From 2004 till 2014, Egypt is ranked ninth in cucumber production and the third in eggplant production with an average of 612.88 and 1.197.374 tons, respectively (FAO, 2014).

T. urticae threatened fruitful cultivation of all crops (Haque *et al*., 2011; Dutta *et al*., 2012) as feeding on the underside of the leaves, removing its cell contents thus resulting in the destruction of chloroplasts and loss of leaf chlorophyll. Then leaves turn totally pale, desiccate, and fall off (Tomczyk and Kropczyńska, 1985; Park and Lee, 2002). It is expected that an adult spider mite devours about 50 percent of its mass per hour (Tehri, 2014). Consequently; it represents a biotic stress to its host plant (Abdel-Wali *et al*., 2012).

Spider mites usually produce bimodal population peaks during early summer and autumn and showed low density in mid-summer. Population density of spider mites was also affected by host plant quality and predation (Schoenig and Wilson, 1992; Gotoh and Gomi, 2000). Nevertheless, temperature was found an important regulatory factor for *T. urticae* build up for many vegetable crops with positive correlations (Gulati, 2004; Ismail *et al*., 2007; Geroh, 2011; Haque *et al*., 2011).

The present work was conducted to monitor the monthly prevalence and mean abundance of *T. urticae* and its associated predators on *C. sativus* and *S. melongena* at two different sites at Ismailia governorate, Egypt during a one year study extended from February 2014 to January 2015.

Materials and Methods

Mean monthly abundance and prevalence of *T. urticae* and its predators on *C. sativus* and *S. melongena* was studied for twelve successive months from February 2014 till January 2015 at two agricultural locations Sarabium (30°26'57"N 32°18'51"E) and Wasfia (30°34'53"N 32°9'53"E) in Suez Canal region, Ismailia governorate, Egypt. Five leaves per plant were collected each month randomly from ten plants (fifty leaves per each studied site and crop). Each plant served as a replica. After that the leaves were conveyed to the laboratory in separate polythene bags to be examined under a stereo-binocular microscope. According to Kumar *et al.* (2015), the total numbers of adult mite stages were counted in 2.5 cm^2 area of the leaf underside. While, the predatory mites were counted in the whole leaf area as reported by Poe (1980). During the study periods, field temperature was registered daily in the two sites. All records were obtained from the Central Laboratory for Agricultural Climate, Plant Protection Research Institute, Agricultural Research center, Cairo, Egypt.

Statistical Analysis

The Mean abundance (±SE) of the individuals per leaf was calculated. The percentage of infested leaves of the collected samples was also calculated. To satisfy the assumption of the statistical analysis, all the data were normalized by log (x^{+1}) transformation. Analysis of variance followed by Post hoc was applied for studying the significant differences regarding the effects of temperature and site on the abundance of the spider mite and its predators. All the statistical tests were accomplished through the software packages SPSS 15.0.0 (USA).

Table1. *Mean monthly abundance (±SE) of T. urticae adult stages and its predators on C. sativus in Sarabium and Wasfia regions during a one year survey extending from February 2014 to January 2015.*

Months	Regions	*T. urticae* adult stages	*P. persimilis*	*S. longicornis*	*S. gilvifrons*
February (2014)	Sarabium	0.40±0.11	0	0	0
	Wasfia	13.96±2.93	0	0	0
March (2014)	Sarabium	12.08±1.93	3.04±0.60	0	0
	Wasfia	10.83±1.66	1.54±0.17	0	0
April (2014)	Sarabium	5.36±0.77	3.92±0.75	0.60±0.12	0.04±0.04
	Wasfia	7.72±1.26	6.20±1.70	0.48±0.14	1.08±0.34
May (2014)	Sarabium	2.66±0.45	1.66±0.40	0.29±0.12	0.96±0.30
	Wasfia	2.08±0.43	0.83±0.16	0	0.37±0.10
June (2014)	Sarabium	1.54±0.22	0	0	0
	Wasfia	1.44±0.36	0	0	0
July (2014)	Sarabium	-	-	-	-
	Wasfia	-	-	-	-
August (2014)	Sarabium	-	-	-	-
	Wasfia	-	-	-	-
September (2014)	Sarabium	0	0	0	0
	Wasfia	0	0	0	0
October (2014)	Sarabium	0	0	0	0
	Wasfia	0	0	0	0
November (2014)	Sarabium	4.04±1.01	0	0	0
	Wasfia	1.12±.39	0	0	0
December (2014)	Sarabium	4.88±0.82	0	0	0
	Wasfia	1.24±0.39	0	0	0
January (2015)	Sarabium	1±0.31	0	0	0
	Wasfia	7.76±1.84	0	0	0

Results

Mean abundance (±SE) and prevalence of *T. urticae* adult stages and its predators on *C. sativus* in Sarabium and Wasfia regions during a one-year survey from February 2014 to January 2015 were shown in Table (1) and Figure (1). Results showed the presence of *T. urticae* adult's stages in February, March, April, May, June, November, December and January in both Sarabium and Wasfia regions. The mean abundance of *T. urticae* adult's stages was the highest in Wasfia (13.96±2.93) and the lowest was in Sarabium (0.40±0.11), both in February (P <0.001). The prevalence of *T. urticae* adult's stages was the highest in Wasfia (8.33%) in February and March and the lowest was in February (3%) in Sarabium.

Regarding the predators, three predator species were detected on *C. sativus* in Sarabium and Wasfia regions which were *Phytoseiulus persimilis* Athias-Henriot, *Scolothrips longicornis* Priesner and *Stethorus gilvifrons* Punctillum. The results showed that *P. persimilis* was found in March, April and May while *S. longicornis* was found in April in both regions and only in May in Sarabium but *S. gilvifrons* was found only in April and May in both regions. The mean abundance of *P. persimilis* was the highest in April (6.20±1.70) and the lowest (0.83±0.16) in May, in Wasfia (P <0.001). The prevalence of *P. persimilis* was the highest (8.33%) in March and April and the lowest (5.33%) in May, in Wasfia. The mean abundance of *S. longicornis* was the highest (0.60±0.12) in April and the lowest (0.29±0.12) in May, in Sarabium (P <0.001). The prevalence of *S. longicornis* was the highest in April (4.33%) and the lowest in May (2%) in Sarabium. The mean abundance of *S. gilvifrons* was the highest (1.08±0.34) in April in Wasfia but the lowest was in April (0.04±0.04), in Sarabium (P <0.001). The prevalence of *S. gilvifrons* was the highest in Sarabium (4.33%) and was the lowest in Wasfia (3%) in May.

Mean abundance (±SE) and prevalence of *T. urticae* adult stages and its predators on *S. melongena* in Sarabium and Wasfia regions during a one-year survey from February 2014 to January 2015 were shown in Table (2) and Figure (2). Results showed the presence of *T. urticae* adult's stages in February, March, April, May, June, November, December and January in both Sarabium and Wasfia regions. The mean abundance of *T. urticae* adult's stages was the highest in April in Sarabium (11.04±1.54) while the lowest was in Wasfia (0.52±0.17) in June (P <0.001). The prevalence of *T. urticae* adult's stages was the highest (8.66%) in March and was the lowest (3.33%) in December, in Wasfia.

Table2. *Mean monthly abundance (±SE) of T. urticae adult stages and its predators on S. melongena in Sarabium and Wasfia during a one year survey from February 2014 to January 2015.*

Months	Regions	*T. urticae* adult stages	*P. persimilis*	*S. longicornis*	*S. gilvifrons*
February (2014)	Sarabium	6.80±1.71	0	0	0
	Wasfia	5.08±0.64	0	0	0
March (2014)	Sarabium	9.80±1.69	1.16±0.25	0.64±0.15	0
	Wasfia	10.04±1.5	0.64±0.16	0.40±0.04	0.36±0.097
April (2014)	Sarabium	11.04±1.54	1.17±.28	0	0
	Wasfia	3.66±0.97	0.68±0.11	0	0.04±0.14
May (2014)	Sarabium	3.64±0.35	1.40±0.24	0.68±0.189	(0.68±0.19)
	Wasfia	0.52±0.17	0.68±0.10	0.96±0.24	0.16±0.94
June (2014)	Sarabium	6.64±0.96	0	0	0
	Wasfia	0.83±0.22	1.60±0.24	0	0
July (2014)	Sarabium	-	-	-	-
	Wasfia	-	-	-	-
August (2014)	Sarabium	-	-	-	-
	Wasfia	-	-	-	-
September (2014)	Sarabium	0	0	0	0
	Wasfia	0	0	0	0
October (2014)	Sarabium	0	0	0	0
	Wasfia	0	0	0	0
November (2014)	Sarabium	10.48±1.54	0	0	0
	Wasfia	1.37±0.26	0	0	0
December (2014)	Sarabium	3.36±0.62	0	0	0
	Wasfia	0.80±0.30	0.60±0.20	0.60±0.12	0.80±0.163
January (2015)	Sarabium	3.7±0.926	0	0	0
	Wasfia	4.24±0.52	0	0	0

Regarding the predators, the same predators were detected on *S. melongena* in Sarabium and Wasfia regions. Our results showed that *P. persimilis* was found in March, April and May in both regions while, it reappear in June and December only in Wasfia. While *S. longicornis* was found in March and May in both regions and only in Wasfia in December. *S. gilvifrons* was found only in March, April and December in Wasfia. Only in May it appears in both regions. The mean abundance of *T. urticae* adult's stages was the highest in Wasfia (13.96±2.93) in February while the lowest was in Sarabium (0.40±0.11) in February (P <0.001).

The mean abundance of *P. persimilis* was the highest (1.60±0.24) in June and the lowest (0.60±0.20) in December, in Wasfia (P <0.001). The prevalence of *P. persimilis* was the highest (7%) in April in Sarabium and in June in Wasfia while the lowest was (3.33%) in May, in Wasfia. The mean abundance of *S. longicornis* was the highest (0.96±0.24) in May and the lowest (0.40±0.04) in March, in Wasfia (P <0.001). The prevalence of *S. longicornis* was the highest in May (5%) and the lowest in March (0.3%) in Wasfia. The mean abundance of *S. gilvifrons* was the highest (0.80±0.16) in December and the lowest (0.40±0.14) was in April, in Wasfia (P <0.001). The prevalence of *S. gilvifrons* was the highest (7.33%) in May and the lowest (2.33%) in April in Wasfia.

Discussion

T. urticae abundance is influenced by seasons where most of the mites remain in the field all over the year with low level during winter season (Chhillar *et al.*, 2007; Najafabadi, *et al.* 2011; Sharma and Pati, 2012; Kanika and Geroh, 2016). Temperature has been the most extensively studied of all-weather factors and it appears to have great effects (Riahi *et al.*, 2011; Haque *et al.*, 2011). This was in accordance with Sunita (1996), Hanafy *et al.* (2014) and Haque *et al.* (2011) who found that temperature had a positive effect on mite population on many vegetable crops such as joscpks coat, lady's finger, cucumber, tomato, eggplant, bottle gourd and bean. Also, Singh (2016) noticed that the vegetable and predatory mites were positively correlated with temperature. One of the key conditions for establishing an efficient IPM strategy is the detailed knowledge of the pest through its ecological requirements and associated natural enemies (Ochoa *et al.*, 1994). *C. sativus* and *S. melongena* were attacked by many of insect and mite pests including *T. urticae* which is considered one of the most serious pests throughout the world (Souliotis, 1990; Singh, and Mukherjee, 1991; Shirke *et al.*, 2008).

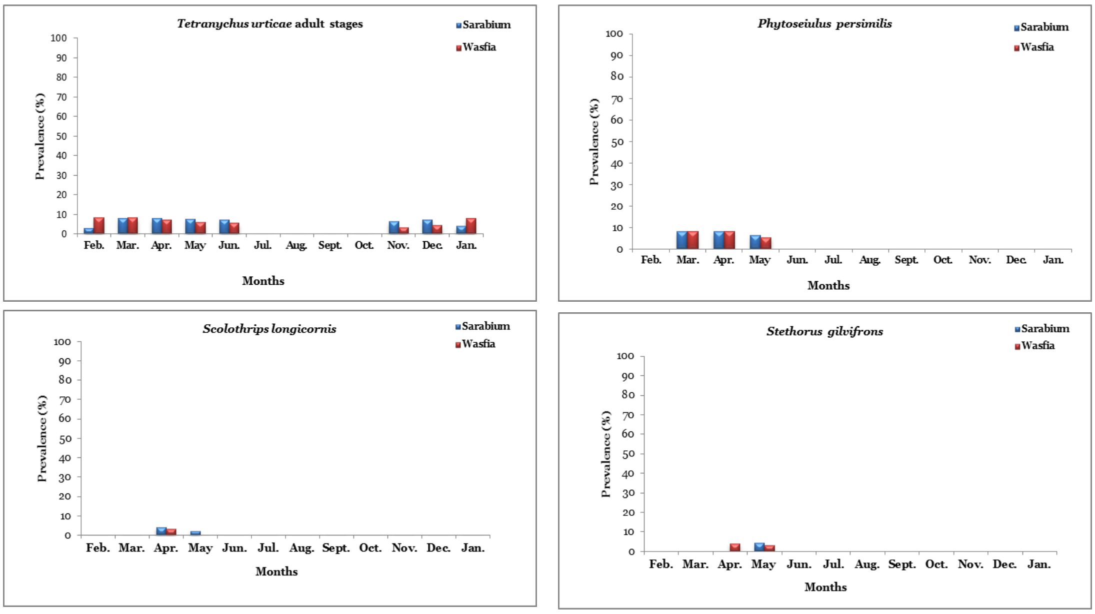

Figure1. *Prevalence of T. urticae adult stages and its predators on C. sativus in Sarabium and Wasfia regions during a one year survey extending from February 2014 to January 2015.*

The results of this study showed that monthly and site variations were significantly affected the mean abundance and prevalence of the adult stages of *T. urticae* and its predators on both crops. Regarding *C. sativus*, results showed the presence of *T. urticae* adult's stages in February, March, April, May, June, November, December and January in both Sarabium and Wasfia regions.

The mean abundance of *T. urticae* adult stages was the highest in February (13.96±2.93) and

March (12.08±1.93) in Wasfia and Sarabium, respectively whereas the prevalence reaches its peak in March and April in Wasfia. This finding was in line with Nahar (2005) and Dhooria (2003) who found that the peak population of *T. urticae* was reported from May to June on cucumber. Also, Mohamed (2004) and Shalaby *et al*. (2004) found that spider mites in greenhouses were low during September, October and November, and then disappear until reappeared in April. Similarly, El-Khayat *et al.* (2010) found that *T. urticae* infested cucumber in greenhouses reaching its peak in the autumn and spring seasons. This was in accordance with Geroh *et al*. (2010) who reported *T. urticae* attacked okra plants in April to June. In contrast to our findings, highest number of mites was recorded in August on *C. sativus* where *T. urticae* increased with the rise of temperature (Haque *et al*., 2011). Similar findings were reported by Kanika *et al.* (2013) and Shaalan (2016) who found that *T. urticae* peak population was in August on cucumber. The findings of Abd El-Gawad (2004) also showed that *T. urticae* appeared on cucumber during the period from October until February. This was in agreement with Baiomy and Fatina (2008) who found the highest infestation of spider mites was in November. Also, Barma and Shantanujha (2013) observed that *T. urticae* occurred from March to September on pointed gourd.

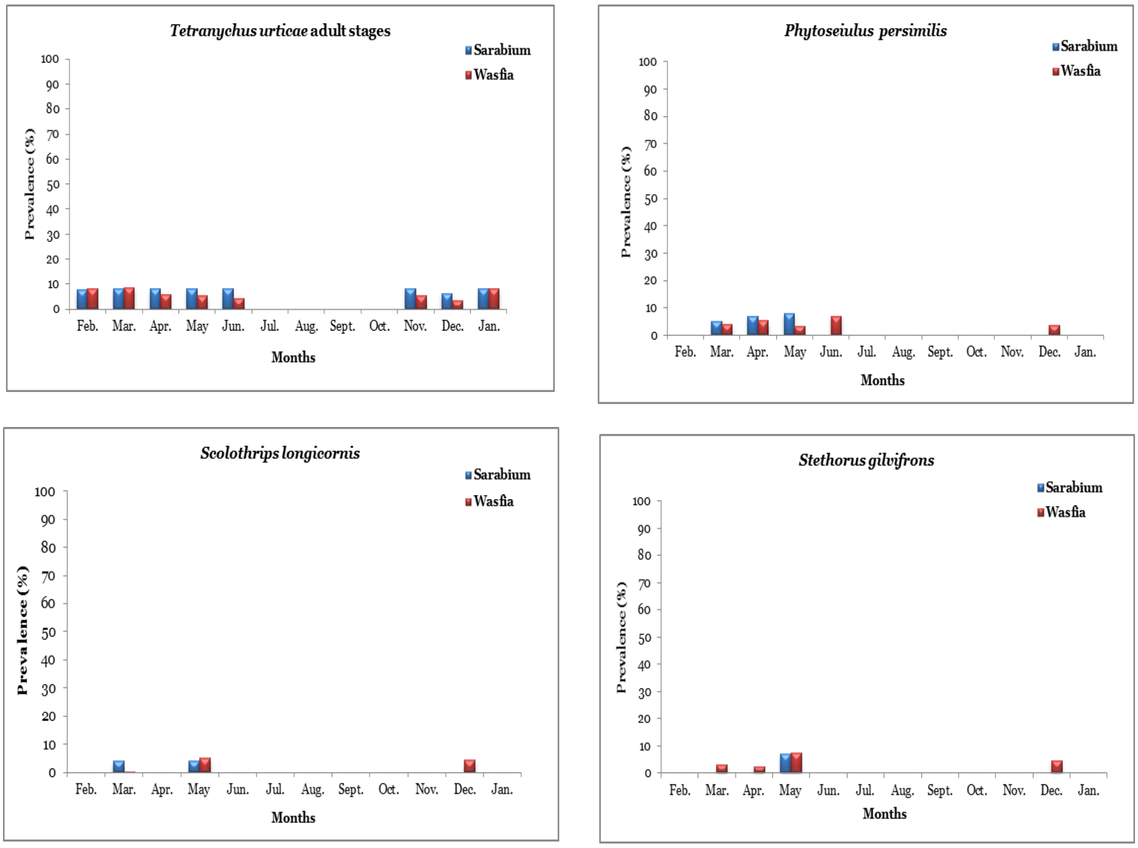

Figure2. *Prevalence of T. urticae adult stages and its predators on S. melongena in Sarabium and Wasfia regions during a one year survey extending from February 2014 to January 2015.*

Regarding *S. melongena*, results showed the presence of *T. urticae* adult's stages in February, March, April, May, June, November, December and January in both Sarabium and Wasfia regions. The mean abundance was the highest in April (11.04±1.54) and March (10.04±1.5) in Sarabium and Wasfia, respectively. The prevalence of *T. urticae* adult's stages was the highest in April in Sarabium and the lowest in December in Wasfia. Similar to our findings, Monica (2013) found that *T. urticae* appeared on *S. melongena* from April and increased during May and June reaching its peak in June then the population gradually declined from July and became untraceable in August with positive correlations with temperature. This was in partial agreement with Rachana *et al.* (2009) who found that *T. neocaledonicus* population was the highest in March and April then decreased gradually starting from May till June and July with low density recorded from June to February. Furthermore, Hoque *et al*. (2010) recorded the highest number of *T. urticae* in May but the lowest in December with positive correlations with temperature. This observation was in line with earlier reports by Misra (1990), Kapoor *et al*. (1997) and Siddiqui and Singh (2006).

In contrast to our findings, Sunita (1996) and Chinniah *et al*. (2009) found that minimum population of *T. urticae* was recorded in November while the maximum population was found in September. This was in accordance with Khanna (1991) and Tripathi *et al.* (2013) recorded maximum population of red spider mitein June and Julyand low to negligible mite population was encountered during December, January and February months as stated by Natarajan (1989). Similarly, Paik *et al*. (2009) found that *T. urticae* was abundant from July to September during the growing season of eggplant. Although, Abou-Zaid *et al.* (2012) noticed the presence of *T. urticae* almost all the season reaching its maximum at the end of June or the beginning of July. Likewise, Kumral and Kovanci (2005) noticed that the *T. urticae* populations peaked twice a year from late June to late August and the second was observed from late September to late October whereas, Ho and Chen (1992) found two peaks May- July and September-October for *T. cinnabrinus*. No difference in mite's infestation between winter and summer season on *S. melongena* as observed by large number of farmers just a small number of farmers noticed that spider mites high infestation was recorded in autumn season (Yosif, 2017) although Eswarareddy (2000) reported that *T. macfarlanei* was abundant during summer seasons on Eggplant.

Concerning predators, no significant correlations were determined between *T. urticae* adult stages population and its natural enemy's population. On *C. sativus*, the three predators were highly existed during spring and the beginnings of summer seasons in the two sites. This was in contrast to Hoque *et al.* (2010) who found that *P. persimilis* minimum number (1.2±0.40) was recorded in March but the maximum (4.8±0.95) population was recorded in January. On the other hand on *S. melongena*, the three predators were highly existed in spring season in both sites but with exception in reappearing in December only in Wasfia region. This was in contradiction with Hoque *et al*. (2010) who found that the highest number of *P. persimilis* was observed on eggplant (14.5) in January whereas the lowest numbers (4.8) were recorded in April. But this was in accordance with Rachana *et al*. (2009) who recorded the presence of *Stethorus pauperculus* from April to August while *Amblyseius longispinosus* and *P. persimilis* were observed from July to November.

The management practices and use of fertilizers can greatly affect the density of mites between different sites. Different studies demonstrates that the ability of a crop to tolerate insect pests was tied to optimum physical, chemical and mainly biological properties of soils as well plant nutrition (Knapp *et al*., 2006). Generally, soils with high organic matter exhibit good soil fertility therefore any crops grown there revealed lower abundance of several insect herbivores may be ascribed to lower nitrogen contained in the crops (Altieri and Nicholls, 2003). On the other hand, farming practices, such as excessive use of inorganic fertilizers, can affect pest resistance. Understanding the underlying effects of farming practices, cultural methods and fertilization may lead us to new and better integrated pest management and integrated soil fertility management designs.

At this point, we have not reached the reason for the variations of the predator's appearance all the year in the different locations. It is doubtful whether *P. persimilis*, *S. longicornis* or *S. gilvifrons* will be capable of maintaining the prey under lower densities than those observed until now. In conclusion, the result of the present study support the IPM programs and as there was a clear variation for site and temperature on the *T. urticae* and its predators further studied are needed to investigate for this variation found between sites.

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