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Adult monitoring improves control of the flavescence dorée leafhopper *Scaphoideus titanus* in Gironde (France) while using less pesticide!

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Abstract: The flavescence dorée is caused by a phytoplasme spread by the leafhopper *Scaphoideus titanus* and is present in the south of France. Leafhopper control is based on up to 3 obligatory insecticide sprayings (T1; T2; T3) using neurotoxic insecticide compounds over large areas (Imposed Sprayed Area = ISA). Spraying dates are defined according to the observation of the first larvae (T0) at T1= T0+4 weeks, T2 = T0+6 weeks (T1 and T2 aim the larvae) and T3 = T0+10 weeks (aiming at adults). Such schedules and area definition are very efficient but lack scientific basis on insect dynamics and migration and encounter opposition from farmers.

Over the last 5 years progress was made to reduce pesticide use while maintaining sufficient vector control. A project was launched in the Saint Emilion region after two plots were found contaminated in 2006. 13000ha of vineyards entered the ISA. Farmers and regional Plant protection service organised into a small association to test a more 'integrated' approach for vector control.

Spraying zones were limited to a buffer zone of 2 Km around the contaminated plots. Farmers between 500m and 2 Km were allowed to reduce sprayings to only 1 single application at T0 + 5, while adult trapping was used to monitor overall results. Traps were yellow delta traps (Piège Tri-Δnglué) that are highly efficient. In most of this zone a single insecticide spray reduced trap catches to almost nonexistent, considered as a proof of sufficient control of the vector. In some areas trap catches were considered too important (>3 adults on a single trap in a single week) and a second spraying (T3) was imposed. This was probably due to some farmers either not spraying at all or organic farmers that only were allowed Rotenone, that is rather inefficient. This approach was repeated in 2008.

Total cost of trapping and monitoring of larvae (traps, technicians, monitoring) is around 3 to 4 Euros per ha. These costs were largely compensated by the reduction in spraying (64 and 72 percent reduction in 2007 and 2008 compared to the traditional approach). Moreover, the combination of reduced spraying and vector monitoring seemed well accepted by the farmers.

In addition all plots were monitored for plants showing symptoms of phytoplasm, around 1200 samples were analyzed first year. Over 80% of the samples appeared to be 'Bois Noir' phytoplasm but some Flavescence Dorée samples were found in both 2007 (2 samples) and 2008 (6 samples). Scouting and analysis costs were around 25 Euro per ha.

In other areas where spraying frequency was reduced simultaneously but without vector monitoring, a strong increase in FD symptoms was observed, together with high insect populations. This probably reveals that many farmers do not apply the single imposed spraying. The trapping seems a useful tool both to show efficient vector control and to incite farmers to respect the minimal spraying frequency.

Key words: flavescence dorée, *Scaphoideus titanus*, vector, insecticide, trap, monitoring, imposed sprayings, scouting

Introduction

Flavescence dorée is a grapevine yellows caused by a phytoplasme that spread by the leafhopper *Scaphoideus titanus*. This disease is present in the south of France, and more generally in southwest and center Europe. The only way to manage it is to control the vector by using neurotoxic insecticides and to uproot the contaminated vines.

In France, when an infected plant is discovered, a large Imposed Sprayed Area (ISA) is defined, including the contaminated district and all the adjacent ones. On this ISA, the leafhopper management schedule is based on up to 3 obligatory insecticide sprayings (T1; T2; T3). Spraying dates are defined according to the observation of the first larvae (T0) at T1= T0+4 weeks, T2 = T0+6 weeks (T1 and T2 aiming at larvae) and T3 = T0+10 weeks (aiming at adults). If well respected, such insect management is very efficient. Yet the decision rules lack scientific basis on insect dynamics and migration. Moreover, this spraying schedule is not associated with scouting obligations, whereas it is necessary to proove by prospecting that there is no infected plant in the vineyard of the district. For this very few districts are allowed to go out of the ISA. Thus, the feeling of an inefficient management, the additional cost of these imposed sprayings and the reluctance of some wine-growers to use insecticides often lead to a non respect of the sprayings obligations and then to a failure of the fight.

During the past few years, pest management adjustments have been allowed: the average number of imposed sprayings per hectare has decreased. Farmers and regional Plant protection service organised into small associations to test a more 'integrated' approach for vector control. Thanks to this alternative approach, a huge progress was made over the last 3 years to reduce pesticide use while maintaining an efficient vector control.

Material and methods

Concept of the alternative pest management of S. titanus

As a response to failures of the classical management of flavescence dorée, wine-growers decided, with Plant Protection Service agreement, to implement a new *S. titanus* management.

The main goal is to use minimum insecticide to control the vector populations in the ISA. With this alternative management, one single spraying aiming at larvae is realised (instead of 2) and a second spraying aiming at adults may be launched only if insects are observed. So a network of yellow delta traps is set up at the rate of one trap per 30ha (based on a mobility under 500m) and weekly observed during adult flight period to check the presence or absence of the insect (Catalano, 2008).

The second purpose is to scout the area in order to identify and suppress the infected plants. Such prospecting should help and speed up the decontamination of the area and eventually allow outing of the ISA.

Example of implementation on the Saint Emilion vineyard

In 2006, two plots were found infected by flavescence dorée. This led to an ISA of more than 13 000ha from 2007. The wine-growers reacted quickly and strongly, asking to implement a more integrated management of the issue than the classic one (Figure 1).

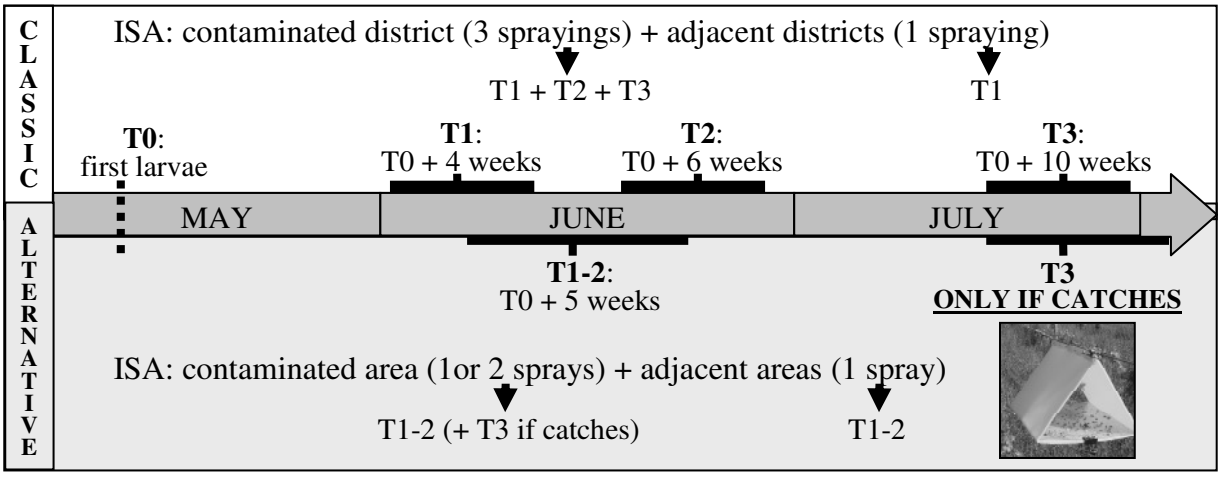

Figure 1: classic and alternative schedules for *S. titanus* management

Instead of using administrative borderline, several sprayed areas were delimited as concentric circular zones (buffer). The center of the circles was an infected plot. The number of sprayings was defined depending on the distance to the source: it was decreasing when moving away from the contaminated patch :

- plots less than 500m from the infected one (based on the hypothesis that S. *titanus* flight distance ability is under 500m and on the low number of infected plants) had to be sprayed 1 time at T0 + 5 and a second time if there are catches in the traps.
- plots between 500m and 2km from the source were allowed to be sprayed only 1 single time at T0 + 5.

A network of about 350 yellow traps was used to monitor adults populations of *S. titanus* over all the area related to the project (Figure 2).

A huge scouting was also realised: 13 500ha (all the vineyard related to the project) in 2007 and about 4000ha (around the infected plots) in 2008 were monitoed by walking through. In 2007, it represented 1,350 days of work at the end of the summer. The use of a service provider was needed to provide such a quantity of work in such a short periode. 50 hikers organised in teams walked about 30 km per day and per person.

Example of implementation on the Pessac-Leognan vineyard

Since 2003, a part of the Pessac-Leognan vineyard has been bound to apply 2 imposed sprayings against *S. titanus*. In 2008, a new plot was found infected by flavescence dorée out of the ISA of that moment. This led to a new larger ISA of about 1,420ha in 2009. The wine-growers decided to implement an alternative management of the issue. 50 yellow traps were set up in the vineyard.

The contaminated districts had to apply 1 single spraying on larvae, plus 1 on adults in case of trap catches. The adjacent ones only had to apply the spraying on larvae (Figure 3).

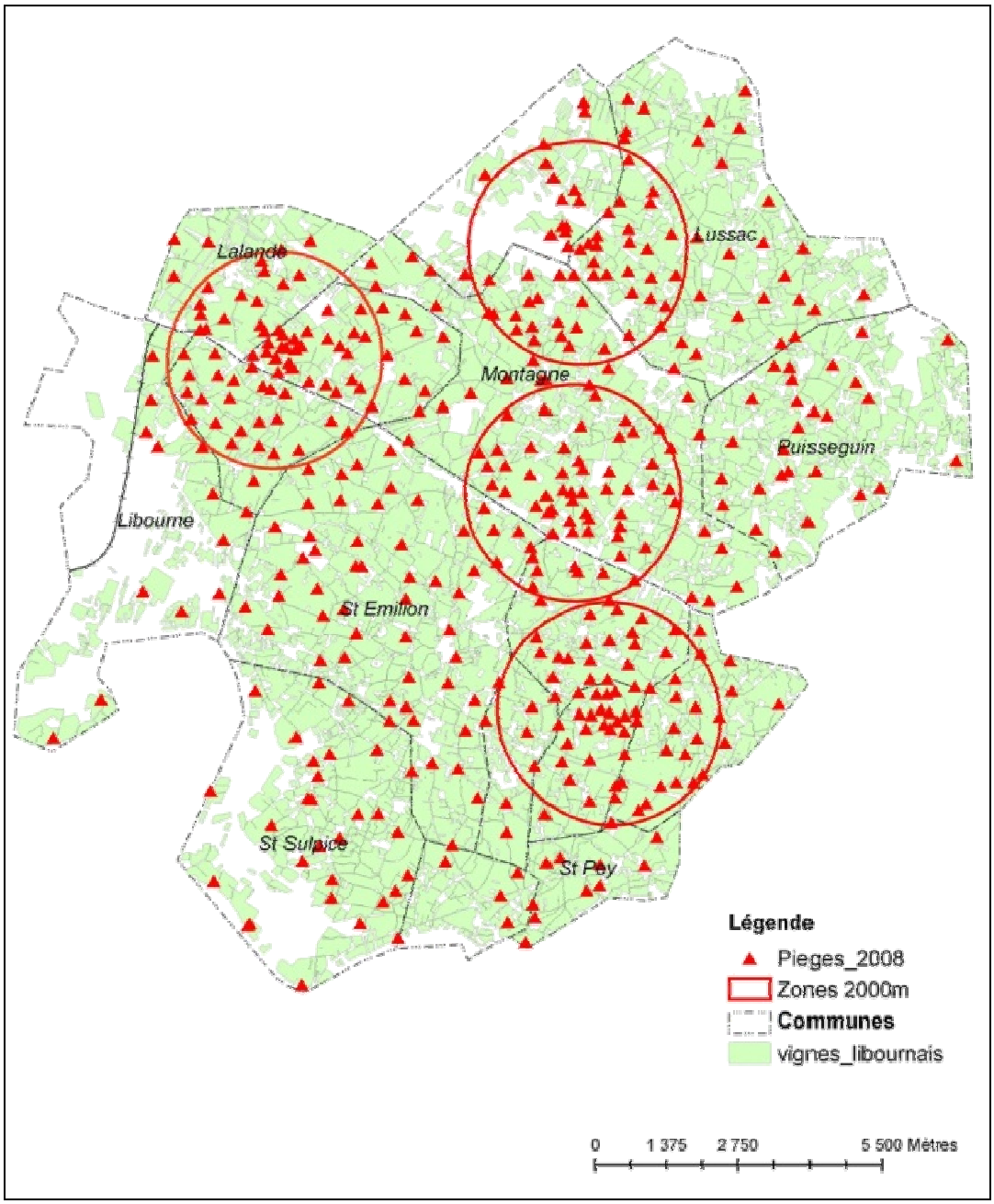

Figure 2: Map of the ISA and of the network of traps in 2008 in the St Emilion vineyard

The scouting was organised on 850ha in 2009. It was realised by a team of about 10 employees provided by the chateaux during 2 weeks and formely trained to recognise the flavescence dorée symptoms. The contaminated districts were partly prospected (at 50%) whereas the adjacent ones were totally scouted, in order to allow them to leave the ISA if no infected plant was found.

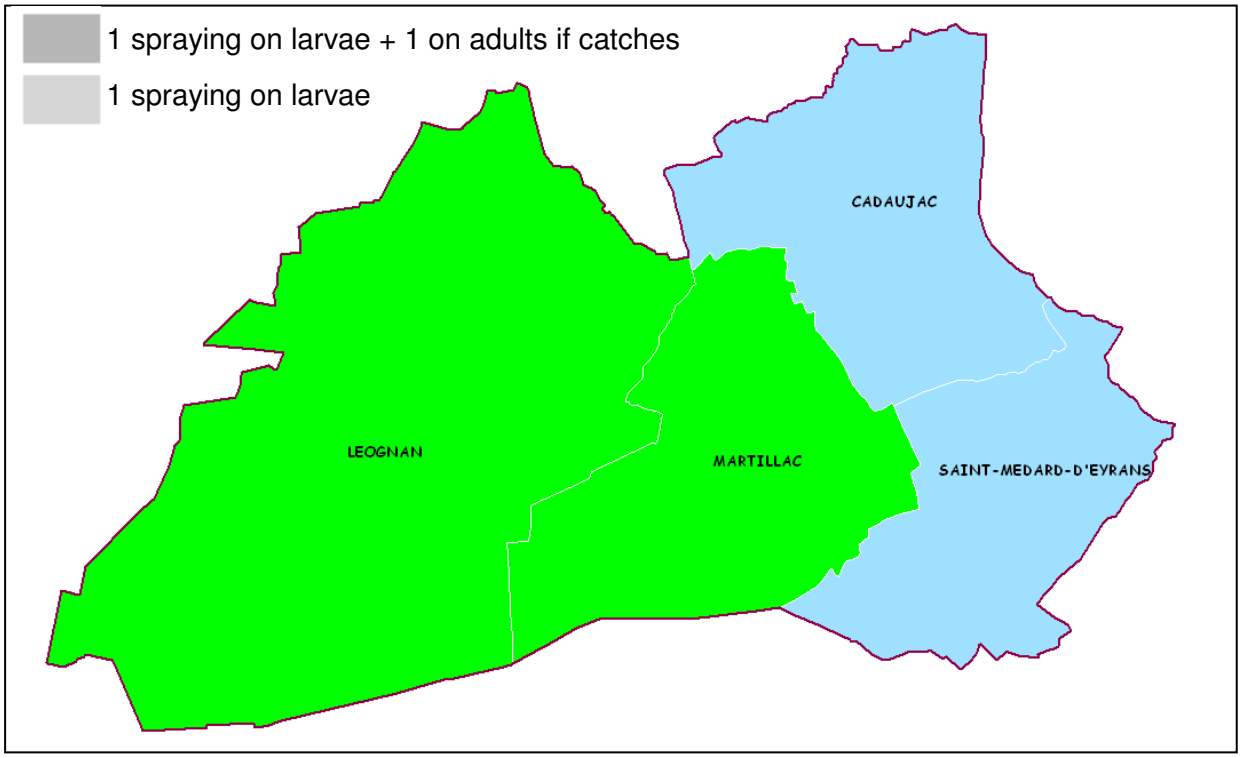

Figure 3. Imposed spraying schedules on the Pessac-Leognan vineyard in 2009

Results and discussion

Results of trapping in the Saint Emilion project

In most of the ISA, a single insecticide spraying reduced trap catches to almost nonexistent, considered as a proof of sufficient control of the vector. In only one small area (< 500m), trap catches were considered too high (>3 adults on a single trap in a single week) and a second spraying (T3) was imposed. This probably was due to some farmers either not spraying at all or organic farmers that are allowed only Rotenone, that is rather inefficient.

Besides, there were very few catches in zones that formerly belonged to an ISA (before 2007). This seems to show that the effect of insecticides use on population levels can last several years. This can be an argument in favor of the implementation of only one imposed spraying every two years on the zones of the ISA that are far away from infected plots.

In 2008, the reduction of insecticide sprayings aiming *S. titanus* reached 72% thanks to the alternative approach (Figure 4).

Results of trapping in the Pessac-Leognan project

On the contaminated districts, almost no insect was caught in the traps and the second spraying was not launched in 2009. On the contrary, some catches were observed on the adjacent districts, but there was no second imposed spraying on this zone. This was probably due to wine-growers not spraying at all in the ISA and to the proximity of untreated zones.

In 2009, the reduction of insecticide sprayings aiming *S. titanus* reached 54 % thanks to the alternative approach (Table 1).

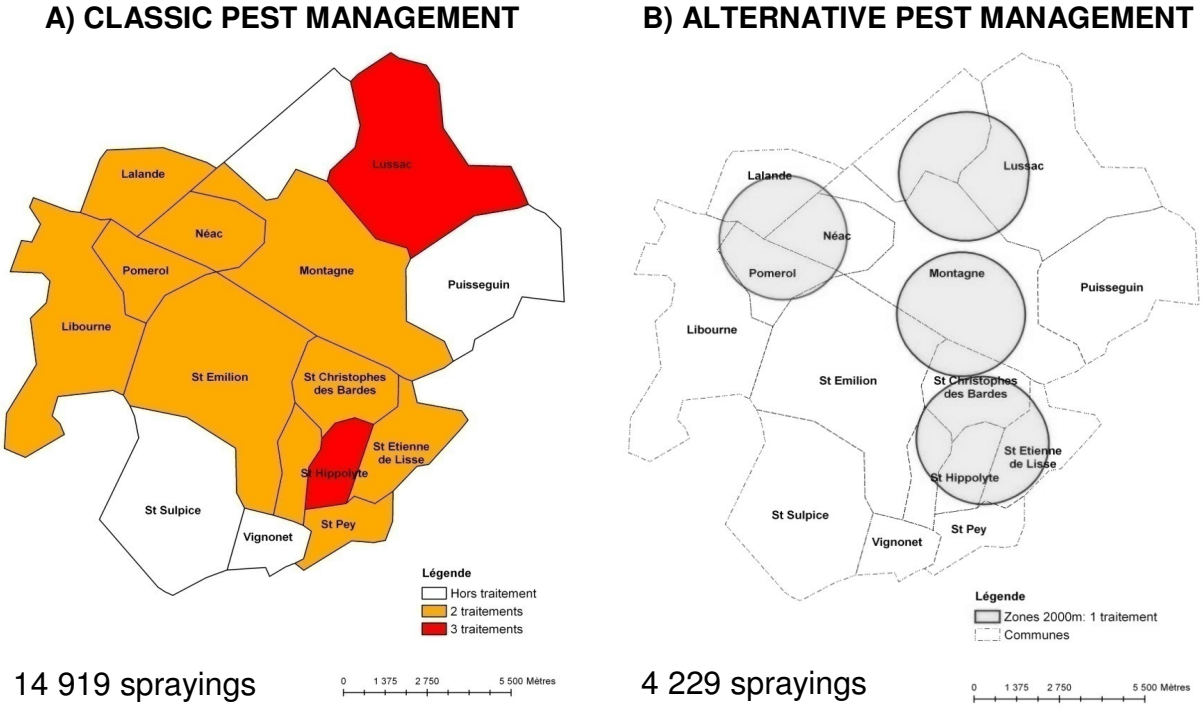

Figure 4. ISA and associated number of sprayings on the St Emilion vineyard in 2008 with a) the classic approach and b) the alternative one.

Table 1. Reduction of the number of sprayings tanks to the alternative schedule compared with the classic one on the Pessac-Leognan vineyard in 2009.

	Classic schedule	**Alternative schedule**
Léognan (650 ha, previously infected)	2 sprayings	1 spraying
Martillac (500 ha, newly infected)	3 sprayings	1 spraying
Cadaujac / St Médard (270 ha, adjacent districts)	1 spraying	1 spraying
Total sprayed surface in 2009	**3070 ha**	**1420 ha**

Results of scouting in both projects

Scouting allowed in both cases to find infected plants but in different proportions: very few contaminated vines were found in St Emilion, whereas more significant infestations were discovered in Pessac-Leognan. On the contrary, Bois Noir seemed more present in St Emilion (Table 2).

In both examples, some uncontaminated or decontaminated zones were highlighted and could go out of the ISA. According to us, a monitoring should be maintained on these areas to check if there is no recontamination. But the high cost of scouting may make it hard to accept by the wine-growers. Indeed, whereas trapping is quite cheap to implement (around 3€/ha), prospecting is much more expensive if realised using a service provider (20 €/ha) (Table 3).

Table 2. Results of prospecting in the St Emilion and Pessac-Leognan vineyards

	St Emilion in 2007	Pessac-Léognan in 2009
Prospected area	13500 ha	850 ha
Number of sampled plants	1135	119
- Positive to FD	2	49
- Positive to Bois Noir	818	47
- Negative	315	27
Outing of the ISA	2 districts in 2008	1 district from 2010

Table 3. Annual costs and savings of the St Emilion and Pessac-Leognan projects

	ANNUAL COST	ANNUAL SAVINGS	
	Total budget	In sprayings (hectares)	In money *
Saint Emilion 2007	320 000 € (26 €/ha)	14267	356 675 € (28 €/ha)
Saint Emilion 2008	240 000 € (17 €/ha)	10690	267 250 € (19 €/ha)
Pessac-Léognan 2009	14 000 € (10 €/ha)	1650	41 250 € (29 €/ha)

* Cost of 1 insecticide evaluated around 25 €/ha

Profitability, interests and limits of the approach

If scouting out of ISA raises funding issues, trapping and prospecting in ISA are profitable, even from the first year of implementation: the savings made thanks to the reduction of sprayings are higher than the costs of the approach.

The profitability of the alternative approach is of course an important argument to convince wine-growers to implement it, but other gains can also be promoted, such as the benefits for environment and human health.

Besides the insecticide reduction and the savings, this method presents a lot of interests:

- consciousness raising of the issue of flavescence dorée by the farmers
- improvement of their knowledge about it and about some other diseases,
- a better communication with the wine-growers about flavescence dorée management,
- a better acceptance and respect of the imposed sprayings,
- improvement of scientific knowledge on some questions (incubation period of the phytoplasme in plants, grape variety sensitivity…) by analysing the results of trapping or scouting.

Nevertheless, this approach is difficult to implement, especially because the expenses are paid collectively by a union, whereas the savings are made at the individual level. The money is often very hard to collect, because it is collected in advance at the beginning of the year with no guarantee that savings will be done later in the year. Moreover, the savings may be different between people depending on the possible reduction of insecticide use in their zone (especially if a second spraying is launched because of trap catches).

The discovery of new infected vines in plots that formerly were in ISA highlighted some limits of this management. Without maintaining insects monitoring and scouting on areas after

outing the ISA, recontaminations are possible and might not be identified. This underlined the lack of scientific knowledge concerning the incubation period of the phytoplasme in plants, the grape variety sensitivity… Some new contaminations or spreading are just unexplained at the moment.

Finally, if this approach can stop the spreading of the disease in infected areas and help decontaminating them, it doesn't solve the problem of introduction of infected plants from nurseries. The "hot water treatment" is an efficient way to prevent this problem and could be imposed to the nurseries for any plant sold in this zone.

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