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# Assessing the biological efficacy of sulfur for control of red mite (*Tetranychus urticae*, Koch 1836) on tomatoes in (Niger)

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## ABSTRACT

Mites, mainly red mites *Tetranychus urticae*, are a limiting factor for tomato production in Niger. They are found at all production sites, where they often cause greater production losses. To minimize the losses, micronized sulfur at a rate of 800g/kg was tested at the experimental station in a Fisher block design with 4 replications. It was compared with an abamectin-based acaricide. At doses of 7.5 kg/ha, 11.25 kg/ha and 15 kg/ha, the micronized sulfur significantly reduced red mite populations. At these doses, the efficacy of the product was also reflected 80% of yield increases as compared to the absolute control (no insecticide applied). The reference acaricide, abamectin, is comparable to the dose of 7.5 kg/ha of micronized sulfur.

**Key words:** red mite, *Tetranychus urticae*, sulphur, Chemical control, Tomato, Niger

## RÉSUMÉ

**Évaluation de l'efficacité biologique du soufre pour la lutte contre l'acarien rouge (*Tetranychus urticae*, Koch 1836) sur les tomates au Niger**

Les acariens, principalement *Tetranychus urticae*, constituent un facteur limitant à la production de la tomate au Niger. Ils sont présents dans tous sites de production où ils occasionnent souvent la perte totale de la production. Pour minimiser de telles pertes, le soufre micronisé à raison de 800g/kg), a été testé en station expérimentale dans un dispositif en blocs de Fisher à 4 répétitions. Il a été comparé à un acaricide à base d'abamectine. Aux doses de 7,5kg/ha, 11,25kg/ha et 15kg/ha, il a permis de réduire significativement les populations des tétranyques. A ces doses, l'efficience du produit s'est également traduite en augmentations de rendements supérieures à 80% par rapport au témoin absolu sans insecticide. L'acaricide de référence, l'abamectine se compare au soufre micronisé à la dose de 7,5 kg/ha.

**Mots clés :** acarien rouge, *Tetranychus urticae*, soufre, lutte chimique, tomate, Niger

## INTRODUCTION

Since the 1980s, vegetables have become a major source of income for horticultural producers of Niger. They also help to improve the nutritional quality of food. They are usually grown in the dry and cold seasons under irrigation from underground streams and surface water (Rabi et al., 2022). The intensification that characterizes the horticultural production system is always accompanied by a significant increase in crop pests. It is the case with tomatoes, one of Niger's main vegetable crops. It is grown on around 10,500 ha, with an annual production of almost 280,000 tons (Republic of Niger, 2021). The crop is subject to high level of infestations of diseases and insect pests, including the red mite *Tetranychus urticae*. It is present in all tomato production areas of Niger. Yield losses of over 70% have been reported by Savana (2019). Controlling the red mites is therefore a priority for increasing production levels in farmers' fields. However, there are very few registered acaricides on the Niger market. More often, growers treat their crops attacked by mites with insecticides that are mostly of unknown origin and more often dangerous for product handlers and consumers. In order to improve the range of acaricides registered in the country and on the fact that the use of sulfur as an essential natural mineral in the agroecological management of agricultural systems (Maligros et al., 2024), the objective of this study was to assess the biological efficacy of micronized sulfur against mites of solanaceous plants such as tomatoes.

## MATERIALS AND METHODS

### Experimental sites

The trial was set up at the Tillabéri station, adjacent to a vegetable growing site where attacks by major pests on horticultural crops are regularly observed, including red mite, *Tetranychus urticae* on tomatoes.

### Plant material

The plant material is the tomato variety cv Tropimech, which is highly appreciated for its agronomic performance and organoleptic qualities. This variety is sold on the market by Saheliasem, the Niger subsidiary of the Tropicasem company.

### Soil preparation and maintenance

Ploughing was carried out using a cattle plough. For all treatments, a fertilizer base of 25 t/ha of well-decomposed organic manure and 150 kg/ha of NPK (15-15-15) mineral fertilizer was incorporated into the soil using a hoe and rake. Transplanting was carried out at the recommended density of 80 cm x 40 cm. Thirty days (30) after transplanting, 200 kg/ha of 15- 15-15 were applied per plot as a maintenance fertilizer.

### Experimental design

The trial was conducted in a Fisher block design with 4 replications and 7 treatments, with:

T0 = no insecticide (control);

T1 = ½ recommended commercial dose (3.75 kg/ha) of the micronized sulfur;

T2 = ¾ recommended commercial dose (5.625 kg/ha) of the micronized sulfur;

T3 = recommended commercial dose (7.5 kg/ha) of the micronized sulfur;

T4 = 3/2 recommended commercial dose (11.25 kg/ha) of the micronized sulfur;

T5 = recommended double commercial dose (15 kg/ha) of the micronized sulfur;

T6 = reference acaricide Bomec 18 EC (Emulsifiable concentrate) /ha (abamectin, 18 g/l) at 1 liter /ha.

The plots were 5m x 5m, i.e. 25 $m^2$. The distance between plots was 1 m and the distance between blocks was 2 m.

### Application of the products

The products were applied twice. The first, 27 days after transplanting and the second 10 days later. The sulfur was sprayed on the plants using a backpack sprayer. To do this, the sulfur was put into the 16-litre tank, which was first filled halfway with water and then the amount of sulfur needed to obtain the correct dose was poured in. After stirring well, the remaining volume of water was topped up. As the reference product was an EC, and therefore applied by spraying, the control plots were also sprayed with plain water to ensure the same wetting conditions.

### Sampling technique

Each grower took a random sample of a representative umber of leaves: 20 tomato leaves per elementary plot, taken at random from the central rows. Mobile forms and mite nymphs were counted using a field magnifier.

### Data analysis

The raw data of mites (numbers of mobile and immobile forms) per leaf were transformed into $\sqrt{(x+0.5)}$. The percentage reduction in populations at day 10 after the first and second treatments was calculated using the following formula:

$$R(\%) = \frac{N0 - Nt}{N0} x100$$

Where N0= number of individuals under the control and Nt= number of individuals under the treatments.
The data were then processed by analysis of variance, followed by the LSD test, at the 5% threshold, using Statistix 10 software.

## RESULTS

### Effect of micronized sulfur dose on mite populations

The relationship between the dose of micronized sulfur and the mite population was exponential in which, when the value of x (sulfur dose) increases, e-x tends towards zero. The coefficient of determination R2= 0.9454 (Figure 1). So as the dose increases, the mite population decreases. These results corroborate those of Valiollah et al (2021) working on oil seed rape.

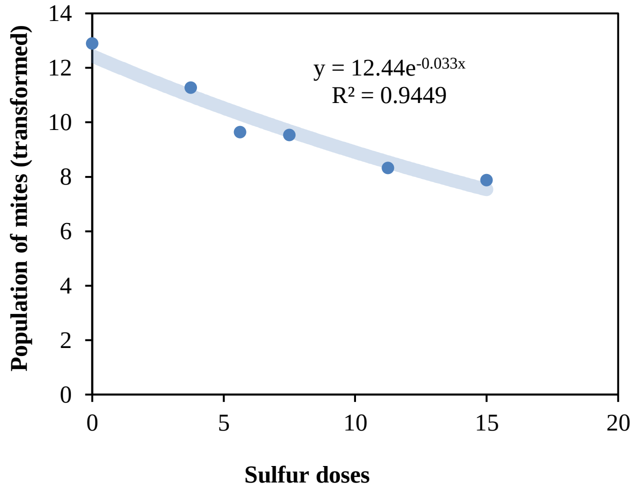


Figure 1. Relationship between the micronized sulfur dose and mite populations

### The first application

In the control, mite density was significantly higher than in the other treatments over the last three samples. All doses greater than or equal to the recommended dose reduced mite population levels. The same applies to the commercial dose of the reference product (Bomec 18 EC). Reduction rate ranged from 24.32% (1/2 recommended dose) to 82.55% (double dose). This parameter was 51.59% for the reference product (abamectin) (Table 1).

### The second treatment

The pattern was the same as for the first treatment. The density of mites increased by an average of more than 25% at 10 DAT. It was significantly greater than those obtained with doses of sulfur equal to or greater than

5.625 kg/ha and those obtained with the reference miticide **(**Bomec 18 EC**)**. Mite population reduction rates varied from 23.67% (at 1/2 dose recommended) to 77.53% (at double dose). This parameter was 44.16% with the reference acaricide. But, the difference between the effect of micronized sulfur was not significantly different from that of the reference acaricide Table 2).

Table 1. Effect of first treatment on mite population levels according to sampling dates

| **Traitements** | **0 DAT** | **3 DAT** | **7 DAT** | **10 DAT** | **% Reduction (10 DAT)** |
|---|---|---|---|---|---|
| T0 | 132,51(11,53) | 152,49(a | 151,46(12,37)a | 147,47(12,16)a | - |
| T1 | 132,51(11,53) | 112,17ab | 120,33(10,99)ab | 111,61(10,59)ab | 24,32 |
| T2 | 132,51(11,53) | 385,04bc | 81,81(9,07)bc | 73,63(8,61)bc | 50,07 |
| T3 | 132,51(11,53) | 72,32bc | 56,06(7,52)bc | 50,78(7,16)bc | 65,55 |
| T4 | 132,51(11,53) | 67,47bc | 53,23 (7,33)c | 45,57(6,79)c | 70,00 |
| T5 | 132,51(11,53) | 40,65c | 32,62(5,75)c | 25,73(51,12)c | 82,55 |
| T6 | 132,51(11,53) | 85,61bc | 76,83(8,79)bc | 71,68(8,49)bc | 51,39 |
| Cv | - | 3,56 | 4,29 | 7,28 | - |

DAT: days after treatment; the numbers in brackets are the transformation of the data into √(x+0.5). Within a column, numbers with the same letter are not significantly different ($p<0.05$).

Table 2. Effect of micronized sulfur and the reference control on tomato mites (second treatment)

| **Treatments** | **0 DAT** | **3 DAT** | **7 DAT** | **10 DAT** | **% reduction (10 DAT)** |
|---|---|---|---|---|---|
| T0 | 147,47(12,16)a | 151,71(12,34)a | 178,76(13,39)a | 165,71(12,89)a | - |
| T1 | 111,61(10,59)ab | 115,00(10,75)ab | 125,21(11,21)ab | 126,48(11,27)ab | 23,67 |
| T2 | 73,63(8,61)bc | 99,86(10,02)bc | 91,03(9,57)bc | 90,53(9,54)bc | 45,37 |
| T3 | 50,78(7,16)bc | 91,23(9,58)bc | 82,01(9,08)bc | 68,74(8,32)c | 58,52 |
| T4 | 45,57(6,79)c | 87,73(9,39)c | 80,54(9,00)bc | 61,66(7,88)c | 62,79 |
| T5 | 25,73(51,12)c | 62,19(7,91)c | 48,23(6,98)c | 37,25c | 77,53 |
| T6 | 71,68(8,49)bc | 103,48(10,20)bc | 102,04(10,13)bc | 92,53bc | 44,16 |
| Cv | 7,28 | 9,32 | 6,06 | 8,20 | |

DAT: days after treatment; the numbers in brackets are the transformation of the data into √(x+0.5). Within a column, numbers with the same letter are not significantly different ($p<0.05$).

## Tomato yield

The average yield obtained under each dose of micronized sulfur and the reference miticide (abamectin) is shown in Figure 2. The overall average yield for the trial was 11.71 t/ha. Yields ranged from 7.56 t/ha on the no acaricide control to 14.54 t/ha on the 11.25 kg/ha dose of micronized sulfur. The increase in yield obtained with the recommended dose was 70% compared with the control treatment without acaricide. The reference product (abamectin) produced a similar increase in tomato yield (68%) (figure 2).

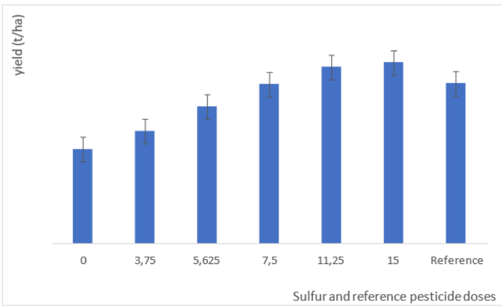


Figure 2. Yield of tomatoes treated with sulfur and reference acaricide

## Other pests and diseases

Population densities of tomato leafminer (*Tua absoulta*) and tomato moth (*Helicorverpa armigera*) were very low. Whitefly was most prevalent during the nursery stage and the attack was contained by spraying with Titan 25 EC, an Acetamiprid based insecticide.

## DISCUSSIONS

Population densities of tomato leafminer (*Tua absoluta*) and tomato moth (*Helicorverpa armigera*) were very low. Whitefly was most prevalent during the nursery phase and the attack was contained by spraying with Titan 25 EC, an insecticide based on Acetamiprid. The results of the study of assessing the biological effectiveness of micronized sulfur on the major tomato pests, mites (*Tetranychus urticae*) in Niger show that this product significantly reduces the populations of these pests. These pests can cause yield losses of almost 100%, as was the case in Tablak on several plots (Reca, 2016). These results corroborate those reported by Tixier et al (1999) in a laboratory study. They showed that the higher the temperature, the more effective micronized sulfur is against *Tetranychus urticae*. Growth temperatures of the mite range from 12°C to 40°C but the development is rapid in hot weather (optimum at 30-32°C) and low humidity (20-40%) (Tousignant, 2023). This is the case in Niger where the temperature is always high in field conditions. Similar observations were reported by Guichou (2003) and Guichou et al (2007). Prischmann et al (2005) showed that micronized sulfur effectively controls mites of the genus *Tetranychus* sp. and is more effective than chlorpyrifos under the same conditions. In our trial, we noticed that mite populations were lower than in the off-season (Savana, 2019). This is partly due to the very high relative humidity. In the cold dry season, mite populations begin to increase as temperatures rise. Sulfur efficiency has also been reported on psyllids, mealybugs and thrips (Liu, 2024). In a greenhouse study, Mazollier et al (2006) demonstrated the efficacy of micronized sulfur against *Tetranychus urticae* when used as a fogging agent. According to Guichou (2002), the toxic action of micronized sulfur is exerted on eggs, larvae and pupae, especially during periods of high temperature and relative humidity. Sulfur has also been shown to be effective against other mite species such as *Tetranychus pacificus* and *Galendromus occidentalis* on tomatoes (Costello, ND). The same is true of the results of the study conducted by Belachew (2012) which demonstrated its efficacy against the mite, *Phytoseiulus persimilis*, on strawberries. Allam et al (2022) showed that micronized sulfur reduced infestation of tomatoes by *Tetranychus urticae* by almost 70%. In our case, the effectiveness of micronized sulfur resulted in an increase in tomato yield compared with the untreated plot. Burkett-Cadena et al (2008) have recommended its use in the biocontrol of crop pests and to protect the environment. Even though research has shown that repeated applications of micronized sulfur led to an increase in red mite populations. It has also been noted that under such conditions, populations of predatory mites of the Phytoseiidae family fall (Hossain, 2006).

## CONCLUSION

The micronized sulfur applied at doses of 7.5, 11.25 and 15 kg/ha were effective in reducing tomato mite (*Tetranychus urticae*) populations, with a significant increase in yield. At the recommended dose of 7.5 kg/ha, it proved as effective as the reference acaricide (abamectin). To reduce environmental risks, we recommend the use of micronized sulfur, a natural product, at a dose of 7.5 kg/ha to control mites and other fungal diseases of tomatoes.

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