Animal and Veterinary Sciences
2025, Vol. 13, No. 3, pp. 66-70
https://doi.org/10.11648/j.avs.20251303.12

SciencePG
Science Publishing Group

Research Article

Studying the Effect of Liquid Sulfur SC 80% on Cotton Spider Mite *Tetranychus Urticae* (Koch) in Cotton Fields of Golestan Province

Mojeni Taghi Darvish*

Cotton Research Institute of Iran, Agricultural Research, Education and Extension Organization (AREEO), Gorgan, Iran

Abstract

Cotton is attacked by several harmful factors during its growth period, the importance of each of them depends on the cultivar, climate and various agricultural and biological factors. Seed rot, seedling death, cotton thrips, aphids, bollworms, mites, leafhoppers, and whitefly are the most common damaging factors in the Iran. The use of sulfur formulations is very important for the management of diseases and pests. In this project, the effect of liquid sulfur on reducing the damage caused by the spider mite, one of the important damaging factors in cotton fields, was carried out with 6 treatments in 4 replications at Hashmabad cotton research station in Gorgan in 2022-2023. The obtained results show that liquid sulfur treatment with a dose of 4 per thousand per hectare after 7 to 10 days of spraying with an average of 56-72% effect on the cotton spider mite had the greatest effect compared to common poisons. Average of the highest percentage effect of liquid sulfur and tested acaricides on the cotton spider mite on sampling dates, liquid sulfur 2 and 4 parts per thousand with an average effect of 50.8-53.25 percent and acaricide propargite 1lit/ha with average effect of 47.08%. Therefore, due to the cheapness of liquid sulfur and its availability, it can be used in the integrated cotton pest management program in Golestan province. In addition, Liquid sulfur treatment with a dose of 6 per thousand per hectare showed burn marks on cotton leaves.

Keywords

Liquid Sulfur, *Tetranychus Urticae* (Koch), Cotton and Golestan Province

1. Introduction

One of the important components of integrated management is the use of low-risk pesticides and reducing the amount of pesticide used. Sulfur is produced in abundance in Iranian refineries as a cheap by-product, and its maintenance is expensive, and its preparation and distribution are easy. One of the important components of integrated management is the use of low-risk pesticides and reducing the amount of pesticide used. On the other hand, helping to reduce the import of foreign pesticides and relying on chemicals that are produced domestically will help to achieve self-reliance and reduce production costs. It is possible to control several diseases and pests simultaneously. It has low toxicity to humans and livestock. It is compatible with other chemicals. It has acaricidal and insecticidal properties [2]. Cotton pests are one of the challenges of growing this crop in the world and in Iran. Cotton is attacked by numerous diseases during its growth

*Corresponding author: t_mojeni@yahoo.com (Mojeni Taghi Darvish)

Received: 29 January 2025; **Accepted:** 8 May 2025; **Published:** 18 June 2025

period, the importance of each of which depends on the variety planted, the climate of the planting area, and various agronomic and biological factors [1]. First season damaging factors: hilima fly, root wireworm, crown borer, cotton thrips and among the damaging factors in the middle of the cotton season: Cotton green leaf hopper and sugar beet caterpillar, cotton bollworm and caraderina, prodenia, white fly cotton, cotton spider mite (SM), cotton stem borer, and cotton leaf miner. The acaricidal and insecticidal effects of sulfur are also significant [3, 10]. The population of mites and insects on plants sprayed with sulfur is drastically reduced. Sulfur can prevent the development of wounds on the surface of plants and limit the growth of pathogenic fungi [8]. The activity of the cotton bollworm on the fruit-bearing organs (buds, flowers, especially bolls) causes these organs to fall off, and causes the destruction of several cells in the boll. The activity of the sucking pests, in addition to causing damage by weakening the plants, causes sap to appear on the aerial parts of the plant, especially the cotton fibers (opened bolls), which reduces the performance of the fibers and causes problems in the textile industry. Cotton mite activity in the stages after the peak of flowering causes a decrease in plant sap and shedding of young fruit-bearing organs [4]. Sulfur has long been a useful fungicide-acaricide-insecticide and was the only acaricide used to control mites until about 1920 [6]. Sulfur has many a vantage for use as an acaricide: low toxicity to applicators and consumers [7], low cost, availability in most areas, etc. Disadvantages include the fact that sulfur could be toxic to many plant species.

The mechanism of action on mites remains obscure but its efficiency is enhanced by high temperatures. A minimum of 17°C is necessary to observe the acaricidal effect [9]; at lower temperatures its efficiency is reduced [11].

The acaricide effect of sulfur (micronised wettable sulfur) was studied on three developmental stages (eggs, protonymphs, females) of *Tetranychus urticae* Koch. Three parameters were tested: the temperature, the humidity and the dose of application. Whatever the conditions tested, the mortality was complete for protonymphs and high for adults. The female fecundity and the viability of the progeny decreased when temperature and/or humidity increased. The toxic effect of sulfur on eggs (which was never proved before) depended on the combined influence of temperature and humidity, from a threshold temperature of 27°C and a threshold humidity of 75%. This study allows us to confirm that sulfur is toxic to *T. urticae*. The extension of this work will allow us to know in what proportion sulfur could be involved in controlling phytophagous mites [5].

Liquid sulfur (LS): This type, which is one of the new sulfur formulations, is produced through a different process than the sulfur found in refineries and is claimed to be a very strong insecticide and fungicide, with 100% solubility in water. It increases yield, is effective in nourishing cotton, can be used in saline, alkaline soils, increases product quality, is an antiseptic, helps increase the absorption of phosphorus, iron, zinc and manganese in the soil, helps increase plant resistance to drought and cold, has high absorption capacity in plants [5]. Mach's idea in 1879 was that sulfur toxicity was physical, with sulfur crystals acting as lenses, focusing sunlight on fungal tissues. In contrast, the new theory is based on the chemical effects of sulfur, which suggests that sulfur acts as an antimetabolite of oxygen. Sulfur does not sublime at low temperatures, and its effect is significantly reduced. At temperatures above 35 degrees, it causes plant burn [10].

2. Material and Methods

2.1. Cotton Spider Mite

To implement the project, a plot of land was planted at the Hashemabad Cotton Research Station in Gorgan with the commercial variety Golestan, and the experiment was conducted during the growing season, simultaneously with uniform infestation with the spider mite population (SM). The size of each experimental plot is 5 × 10 square meters, the distance between each plot is one meter, and the distance between each repetition is 2 meters. A backpack automizer sprayer was used for spraying after calibrating it.

2.2. Statistical Analysis

This experiment was conducted with 6 treatments in 4 replications. The treatments tested were liquid sulfur SC 80% (LS) with 4 doses of 1, 2, 4, and 6 per thousand and the acaricide Propagite SC 57% with a dose of 1 liter and a check (without spray).

The sampling: The spider mite population (SM) was counted one day before spraying, 3, 5, 7, 10, 15 and 20 days after spraying. Five plants on 15 random leaves of each plot were counted in the laboratory under the binocular and recorded in special tables. The percentage of treatment effectiveness was calculated using the Tilton-Henderson formula. At the end of the growing season, statistical analysis was performed using SAS software.

3. Results

Based on the experiments conducted and data transformation, the results and analysis of variance in the experiment show that no significant difference was observed among the tested treatments, but the comparison of their average percentage of effect based on Duncan's test on the survey dates is as follows:

On the 3rd day after spraying, liquid sulfur treatment (LS) at 2 and 4 parts per thousand with 44.75 and 44.50 percent had the highest effect on mites in group **a** compared to Proparasit acaricide with 20.75 percent effect at the 5% level in group **c** (Table 1).

On the 5th day after spraying, sulfur treatment (LS) was 2

parts per thousand with an average of 59% effectiveness in group a, and propargite acaricide with 46% effectiveness in group ab, and sulfur 4 parts per thousand with an average of 25.40% effectiveness on mites was at the 5% level in group ab.
- At 7 days after spraying, sulfur 4 in per thousand with an average of 56% effectiveness in group a, sulfur 2 in per thousand with an average of 48.25% effectiveness, and propargite with an average of 47.25% effectiveness on mites were placed at the 5% level in group ab (Table 1).

Table 1. *Analysis of variance table of the percentage effect of liquid sulfur on spider mites Tetranychus urticae after 3, 5, 7, 10, 15, and 20 days after spraying in the cotton fields Gorgan.*

Treat.	After spraying 3 days	After spraying 5 days	After spraying 7 days	After spraying 10 days	After spraying 15 days	After spraying 20 days	Total of Ave. percentage effect.	Ave. percentage effect.
Liquid Sulfur SC 80% (1tho/ha)	31.25ab	33.50b	26.75bc	53.75ab	59.25b	36.25bc	240.75b	40.13b
Liquid Sulfur SC 80% (2tho/ha)	44.75a	59a	48.25ab	43.50b	58.25b	46.75a	300.50ab	50.08ab
Liquid Sulfur SC 80% (4tho/ha)	44.50a	40.25ab	56a	72a	61.50ab	45.25ab	319.50a	53.25a
Liquid Sulfur SC 80% (6tho/ha)	26b	33.50b	26.75b	42.25b	63ab	47.50a	212.25c	35.38c
Propargite SC57% (1lit/ha)	20.75c	46ab	47.25ab	57.50ab	72.75a	38.25b	282.50ab	47.08ab
CV%	27.01%	11.24%	17.15%	20.85%	6.32%	34.80%		

On the 10th day after spraying, liquid sulfur treatment (LS) 4 in per thousand with an average of 72% had the highest effect in group a, proparasit poison with an average of 50.57% effect in group ab, and sulfur 2 in per thousand with an average of 50.43% effect on mites (SM) at the 5% level in group b (Table 1).

At 15th day after spraying, Propargite treatment had the highest effect of 72.75% in group a, and liquid sulfur (LS) 6 in per thousand with an average of 63% and liquid sulfur 4 in per thousand with an effect of 61.50% on mites (SM) at the 5% level in group ab (Table 1).

At 20 days after spraying, liquid sulfur (LS) treatment had the highest effect with an average effect of 47.50 percent, and sulfur 2 and 4 per thousand had the average effect of 46.75 and 45.25 percent, respectively, in group ab, and the lowest effect was sulfur 1 per thousand with an average effect of 25.36 percent on mites at the 5% level in group **bc** (Table 1).

It should be noted that according to the experiment conducted in liquid sulfur (LS) treatments with a dose of 6 per thousand per hectare, burn marks were observed on cotton leaves. Therefore, this dose of liquid sulfur (LS) is not recommended in cotton fields.

4. Conclusion

According to the results obtained from the experiment, liquid sulfur (LS) treatment at a rate of 4 parts per thousand per hectare 7-10 after spraying had a good effect on the cotton spider mite pest, with the highest average of 56-72 percentage, compared to the recommended pesticides (Table 2).

Table 2. *The highest percentage of effect of liquid sulfur on spider mites Tetranychus urticae in the days after spraying in the cotton fields Gorgan.*

Treat.	After spraying days	Ave. percentage effect.
Liquid Sulfur SC 80% (1tho/ha)	7, 10 after spraying days	26.75 – 53.75
Liquid Sulfur SC 80% (2tho/ha)	7, 10 after spraying days	43.50 – 48.25
Liquid Sulfur SC 80% (4tho/ha)	7, 10 after spraying days	56 - 72
Liquid Sulfur SC 80% (6tho/ha)	10, 15 after spraying days	42.25 - 63
Propargite SC57% (1lit/ha)	10, 15 after spraying days	57.50 – 72.57

Thus, average of the highest percentage effect of liquid sulfur (LS) and tested acaricides on the cotton spider mite (SM) on sampling dates, liquid sulfur (LS) 2 and 4 parts per thousand had the greatest effect on mites, with an average effect of 50.8-53.25 percent and acaricide propargite 1lit/ha with average effect of 47.08%. (Figure 1).

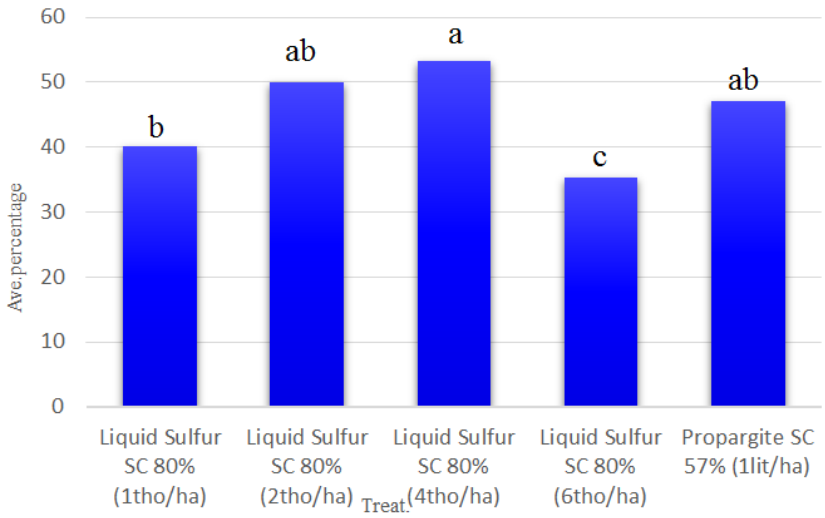

Figure 1. *Average percentage effect of liquid sulfur and miticides on Tetranychus urticae in the cotton fields of Gorgan.*

The results of this study are consistent with the use of sulfur against plant pests that has been used since 1975. Sulfur has long been a useful fungicide-acaricide-insecticide and was the only acaricide used to control mites until about 1920 [6]. Sulfur has many a vantage for use as an acaricide: low toxicity to applicators and consumers [7], low cost, availability in most areas, etc. Disadvantages include the fact that sulfur could be toxic to many plant species. In this study the results are consistent the effect of liquid sulfur at the conditional temperatures of 27-35°C and relative humidity of 70-75% during the growing season in cotton fields has the highest mortality rate on the life stages of mites.

The results of this study are consistent with acaricide effect of sulfur (micronised wettable sulfur) was studied on three developmental stages (eggs, protonymphs, females) of *Tetranychus urticae* Koch. Three parameters were tested: the temperature, the humidity and the dose of application. Whatever the conditions tested, the mortality was complete for protonymphs and high for adults. The female fecundity and the viability of the progeny decreased when temperature and/or humidity increased. The toxic effect of sulfur on eggs (which was never proved before) depended on the combined influence of temperature and humidity, from a threshold temperature of 27°C and a threshold humidity of 75%. This study allows us to confirm that sulfur is toxic to *T. urticate* [5].

Therefore, it is necessary to replace the common acaricides in the region, which have been used for many years, in order to prevent possible resistance in the pest in the future.

It is suggested that, given the cheapness of liquid sulfur (LS), its effect on the bollworm, a key cotton pest, be investigated and, if it has a suitable effect on the bollworm, it be used in integrated management programs for important cotton pests.

Abbreviations

LS	Liquid Sulfur
SM	Spider Mite

Author Contributions

Mojeni Taghi Darvish is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

References

[1] Arabsalmani, M., Bniani, E., Azaddisfani, F. and Nemati. N. 2004. Effect of both application fungicides Carboxin- Thiram and Carbendazim with insecticide Larvin and Gauchu on germination and stand stablishment. 3rd National Conference on the Development in the Aplication of Biological Product & Optimum Utilization of Chemical Fertilizers & Pesticides in Agriculture, Tehran, Iran. 21-23Feb.

[2] Bayat-Asadi, H. and Arabsalmani, M. 2005. Cotton Pestes, Diseases and Weeds in Iran and Their Integrated Management. Agriculture Research, Education&Extension Organization, Ministry of Agriculture, 240pp.

[3] Darvish, Mojeni, T. 2014. Cotton pests and methods of controlling them. Gorgan Norouzi Publications. 74 pages.

[4] Darvish, Mojeni, T. 2014. Integrated control management of cotton bollworm. Gorgan Norouzi Publications. 56 pages.

[5] Guichou, S.; Auger, Ph. and Kreiter, S. 2015. The acaricidal effect of sulfur on *Tetranychus urticae* (Acari: Tetranychidae) under laboratory conditions. 11. International Congress of Acarology. P: 535-545.

[6] Jeppson, L. R., H. H. Keifer and E. W. Baker. 1975. History of chemical control and mite resistance to acaricides. pp. 47-61. In Jeppson L R, Keifer H H and Baker E W (Eds.). Mites injurious to economic plants. University of California Press, Berkley.

[7] Hoy, M. A. 1987. Sulfur as control agent for pest mites in agriculture. pp 51-61. In Proceedings of International Symposium - Elemental sulfur in Agriculture, Volume 1. Nice.

[8] Maude, R. B. 1998. Seebborne Diseases and Their Control. CAB Press 478pp.

[9] Klett, M. 1965. Uber die einwirkung von schwefelpräparaten auf einige Tetranychiden (Acari: Tetranychidae). Zeitschrift Angewandte Zoologie, 52: 59-130.

[10] Rakhshani, A. and Taheri, A. 2006. Principles of Agricultural Toxicology, Volume 2. Farhang Jameh Publications. 446 pages.

[11] Wilcox J. and A. F. Howland. 1956. Experiments on control of tomato russet mites in southern California. Journal of Economic Entomology, 49: 768-771.