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Influence of Quickphose 57% (Aluminum Phosphide) Fumigation on Population and Biological Aspects of Two Spotted Spider Mite *Tetranychus urticae* (Koch)

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ABSTRACT

This investigation was conducted to study the effect of quickphose on *T. urticae* in closing area under laboratory conditions (27ºC &45-75 RH %). Obtained data showed that the reduction % of *T. urticae* population was increased with increasing dose of quickphose tablets. *T. urticae* individuals were exposed to fumigation of different quickphose doses and different periods. For this purpose, wooden boxes ($1m^3$) covered with plastic sheets and contained pots which cultivated with bean plants infested by *T. urticae* individuals were used. The influence of quickphose doses and exposure periods on populations and biological aspects of *T. urticae* were determined.

INTRODUCTION

Aluminum phosphide is used as a rodenticide , insecticide, and fumigant for stored cereal grains. It is used to kill small verminous mammals such as moles and rodents. The tablets or pellets, known as "wheat pills", typically also contain other chemicals that evolve ammonia which helps to reduce the potential for spontaneous ignition or explosion of the phosphine gas *(White and Bushey, 1944)*. Phosphine (PH3) produced from phostoxin (Aluminum phosphide) tablets was used to fumignate wheat with natural infestations of some species of mites and insects (Sinha, *et al.*, 1967). Phosphine is the most widely used chemical for controlling insects in stored grain (Wilkin, *et al*., 1982). Phosphine fumigation has been found to be effective in many countries and it is an effective method of eliminating insects in stored commodities (Bell, 2000). Aluminium phosphide is a highly toxic inorganic compound with the chemical formula used as a fumigant and reacts with water or acids to release phosphine (*Holleman and Egon; 2001)*. Aluminum phosphide, a well-known stored grain fumigant, available in solid formulation, has shown promise as wood fumigant. This chemical decomposes to phosphine when exposed to moisture. The feasibility of fumigant treatment to extend the service life of wood was evaluated in a small block test of two wood species. Hard wood (*Mangifera indica* L.) and conifer blocks (*Pinusr oxburghii* Sargent) were fumigated with different concentrations (0.05, 0.1, 0.2, 0.4, 0.8, and 1.6%) of aluminum phosphide. Fumigated blocks were exposed to *Lyctus africanus* Lesne (Coleoptera; Lyctidae) larvae. Results revealed that aluminum phosphide showed complete mortality of *Lyctus* larvae at 0.2% concentration, that is, 0.93 g/m^3 retention level. Mean mortality of 74% of *Lyctus* larvae was observed in soft wood blocks fumigated with lowest concentration, that is, 0.05% of aluminum phosphide, whereas in hard wood blocks >85% mortality was observed at this concentration (Himani and Sadhna, 2012). The toxicity of phosphine fumigation against *Bactrocera tau* (Walker) under low temperature conditions on different growth stages (eggs and instars) were investigated by exposing to 1.07 mg/liter phosphine for 1–10 d at 5°C, and compared with unfumigated flies at 5°C. (Li Li, *et al*, 2014). The efficacy of nitric oxide fumigation to control bulb mites and its effects on germination and growth of flower bulbs were studied and indicated that, the nitric oxide treatments did not significantly affect germination and growth of flower bulbs (Liu 2017). The present work aimed to evaluate the ability of quickphose fumigation to effect on *T. urticae* population and their biological aspects in closing area.

MATERIALS AND METHODS

a. Culture of bean:

One hundred pots (17 cm. height x 22 cm. diameter) were planted with bean seeds in three different dates with 15 days interval and were left for 45 days to grow and reach about 25-30 cm long and carried about 6-8 leaves with 3 leaflets / leaf. These pots consider the source of plants for these experiments.

b. Culture of *T. urticae:*

Infested castor bean leaves were collected and transferred to the lab.. Adult females were picked up from castor leaves and put on bean leaves then left to reproduce and increase to be the source of *T. urticae* individuals for these experiments.

c. Calculation of mites reduction %:

Handerson & Telton formula (Henderson, C.F. and E.W. Telton, 1955) was used for this purpose as follows:

$$\text{Corrected \%} \left(1 - \frac{\text{N in Co before treatment X N in T after treatment}}{\text{N in Co after treatment X N in T before treatment}}\right) \times 100$$

N = Number of mites

d. Quickphose effects on

1- *Tetranychus urticae* population.

Twenty wooden boxes covered with plastic for all sides were divided into four groups. Each group contains five pots, and each pot including five plants of bean infested by ten individuals of *T. urticae* and one tablet (3 gm.) of quickphose. The second and third groups have the same contents but replaced one tablet by two and three tablets, respectively. While the fourth group was a control without quickphose tablets. Numbers of *T. urticae* were recorded during pre and post treatments after periods of 12, 24, 48, 72 and 96 hours, respectively. Reduction % of *T. urticae* was calculated.

2- *Tetranychus urticae* biological aspects.

Three wooden boxes contains bean plants infested by *T. urticae* were used. Boxes were supplied with one, two and three tablets, respectively. Deutonymphal individuals were picked up after exposure periods as 12, 24, 48, 72 and 96 h. and reared separately on disk of bean plant put on piece of wetted cotton in Petri dishes. Examination was made after different periods to record the parameters of biological aspects.

RESULTS AND DISCUSSION

1- Quickphose effects on population of *T. urticae*:

Obtained data presented in Table (1) showed that the effects on population were varied according to dose of quickphose least reduction % was occurred with one tablet treatment where it is beginning with 15.7 % for exposure period 12h and reached to its maximum reduction % 98.1 after exposure period 96 h compared with that of 42.1, 52.4 and 77.8 % after exposure periods 24, 48 and 72 h, respectively. Little exposure periods and highly reduction effects were occurred upon using two and three tablets of quickphose treatments. When two tablets of quickphose used reduction % were 53.8, 76.5 and 96.3 % with exposure periods 12, 24 and 48 h, respectively, compared with that of 86.4 and 95.7 % with periods of 24 and 48 h, respectively, upon using three tablets treatments.

Table1. Effects of quickphose doses and exposure periods on *T. urticae* populatios.

Treats.	Applied period/ h.	Population of *T.urticae* (Pre and Post- applied) with different quickphose tablets treatments														
		Replicate 1			Replicate 2			Replicate 3			Replicate 4			G .mean of pesticide efficiency		
		Pre-app	Post-app.	R. %	Pre-app.	Post-app.	R. %	Pre-app.	Post-app.	R. %	Pre-app.	Post-app.	R. %	Pre-app.	Post-app.	G.R. %
One tablet /m^3	12 hr	22	20	13.4	27	26	15.3	26	22	25.9	25	24	11.4	25.0	23.0	15.7
	Cont	20	21		22	25		21	24		24	26		22.0	24	
	24 hr	20	17	35.7	26	21	38.9	30	21	41.9	18	13	55.4	23.5	18.0	42.1
	Cont	22	27		28	37		34	41		21	34		26.3	34.8	
	48 hr	27	20	39.6	24	15	53.6	21	14	56.1	19	16	61.1	22.8	16.3	52.4
	Cont	31	38		23	31		25	38		18	39		24.3	36.5	
	72 hr	28	17	54.1	23	10	69.1	18	2	95.5	24	4	89.3	23.3	08.3	77.8
	Cont	28	37		27	38		17	42		25	39		24.3	39.0	
	96 hr	31	2	95.1	27	1	99.9	15	0	100	21	0	100	23.5	0.75	98.1
	cont	29	38		28	40		20	45		28	50		25.6	43.4	
Two tablets/ m^3	12 hr	23	12	59.2	23	14	49.3	31	19	57.7	24	17	45.4	25.3	15.5	53.8
	Cont	25	32		15	18		29	42		27	35		24.0	31.8	
	24 hr	19	11	63.5	18	8	63.8	28	7	81.4	29	4	89.7	23.5	7.5	76.5
	Cont	17	27		22	27		29	39		32	43		25.0	34	
	48 hr	21	1	95.9	29	1	97.5	23	1	96.8	27	2	94.9	25.0	1.3	96.3
	Cont	29	34		28	39		31	42		30	44		29.5	39.8	
Three tablets/ m^3	12 hr	32	4	90.9	29	12	72	21	1	96.9	20	3	89.3	25.5	5	86.4
	Cont	30	41		25	37		24	37		27	38		26.5	38.3	
	24 hr	38	1	97.6	18	2	93.3	23	1	96.7	19	2	94.6	22.8	1.5	95.7
	Cont	32	44		27	45		32	42		21	41		28	43	

app. = application G. = General %R. = %Reduction G.R. = General Reduction

2- Quickphose effects on biological aspects of *T. urticae*:

a- Effects on immature stages:

Egg incubation periods were affected by exposure periods. Insignificant and gradually prolonged between different exposure periods were evident at one tablet where, these periods ranged between 2.8- 3.3 days, respectively. Also affected by quickphose doses, where these periods were increased with increasing tablets number, ranging 3-3.2 days with periods of 12 and 24h., respectively at 2 tablets compared with that of 3.1-3.3 days with 3 tablets. The same trend was evident with larval, protonymphal and deutonymphal stages. Total immature periods were significantly prolonged with increasing of exposure periods and doses. Also % mortality was affected and ranging 0.0 – 46.5 % at one tablet treatment and increased with increasing tablets to reach 40.1 % and 61.3 % at 2 and 3 tablets treatments.

b- Effects on adult female stages:

Longevity of females was affected by quickphose doses where preoviposition period was significantly prolonged with increasing dose and exposure periods compared with that of control. On the other hand, oviposition and postoviposition periods were shortened. Mortality % which occurred during adult female stage was increased with increasing doses and exposure periods where its beginning with 1% at one tablet and reaching 53% at 3 tablets .In this respect, LiLi, 2014 mentioned that, eggs incubated for 12 h at 25°C represented the most tolerant growth stage to phosphine fumigation at 5°C. The exposure time was more important than the phosphine concentration.

c- Effects on female fecundity:

The obtained resulted presented in table 4, indicated that number of eggs laid was affected by doses and exposure periods. Eggs laid by females which treated by one tablet were reduced from 131.9 to 9.9 eggs after exposure periods 12 and 96 h., respectively. While reduced from 102.2 to 17.9 and 65.4 to 13.6 eggs at two and three tablets doses, respectively. Eggs laid at different treatments and different exposure periods were significantly little compared with that at control (138.5 eggs). Also, mortality % of eggs laid was significantly increased with increasing doses and exposure periods. Wilkin 1982, indicated that mites in wheat at 16 moisture and about 10 ºC, showed that all stages of *Acarus siro* L. including eggs could be controlled by doses of 2.5 g/m^3 phosphine and exposure periods of a least 8 days. Minimum dose to give complete control in 6 days was 2 g/m^3 but there were some survivors when the dose was reduced to $1mg/m^3$ .Similar results were obtained in both wheat and oilseed rape.

Table 2. Effects of quickphose doses and exposure periods on *T. urticae* immature stages.

Treats	App. period/h.	Female immatures periods				Total immtures	Mortality %
		Incubation	Larva	Protonymph	Deutonymph		
One tablet/ m^3	12 h	2.8 ± 0.1 b 2-3	2.6 ± 0.1 a 2-3	4.9 ± 0.2 b 4-5	4.8 ± 0.2 b 4-5	13.8 ± 0.6 b 12-15	0.0
	24 h	2.8 ± 0.1 b 2-4	2.7 ± 0.1 a 2-3	4.8 ± 0.3 b 4-5	4.7 ± 0.3 b 4-5	15.0 ± 0.5 c 12-17	13.6
	48 h	2.9 ± 0.3 b 2-4	2.6 ± 0.3 a 2-3	4.9 ± 0.3 b 4-5	5.2 ± 0.1 b 4-6	15.6 ± 0.7 d 13-17	19.9
	72 h	3.2 ± 0.2 b 3-4	2.8 ± 0.1 a 2-3	5.1 ± 0.6 b 4-6	5.3 ± 0.1 b 5-6	16.4 ± 0.4 e 14-19	27.8
	96 h	3.3 ± 0.4 b 3-4	2.9 ± 0.2 a 2-3	5.3 ± 0.4 b 5-6	5.5 ± 0.3 b 5-6	17.0 ± 0.8 f 15-18	46.5
Two tablets/m^3	12 h	3.0 ± 0.2 b 2-4	3.1 ± 0.2 b 2-4	5.2 ± 0.3 b 5-6	5.0 ± 0.4 b 6-7	16.3 ± 0.4 b 14-19	16.7
	24 h	3.2 ± 0.2 b 3-4	3.2 ± 0.1 b 3-4	5.3 ± 0.4 b 4-6	5.3 ± 0.3 b 5-6	17.0 ± 0.5 c 15-19	26.9
	48 h	3.2 ± 0.1 b 3-4	3.7 ± 0.2 b 3-4	5.2 ± 0.4 b 4-6	5.8 ± 0.4 b 5-7	17.9 ± 0.5 d 15-19	40.1
Three tablets/m^3	12 h	3.1 ± 0.4 b 3-4	3.4 ± 0.2 b 3-4	5.4 ± 0.4 b 5-6	5.6 ± 0.1 b 5-6	17.5 ± 0.3 b 16-19	33.5
	24 h	3.3 ± 0.3 b 3-4	3.5 ± 0.1 b 3-4	5.7 ± 0.5 b 5-7	5.9 ± 0.3 b 5-7	18.4 ± 0.5 c 17-21	61.3
Control		2.3 ± 0.1 a 2-3	2.4 ± 0.1 a 2-3	3.7 ± 0.1 a 3-5	3.8 ± 0.3 a 3-4	12.2 ± 0.4 a 10-14	0.0

Means within the column followed by the same letter are not significantly at the 5% level of probability Duncan test.

Table 3. Effects of quickphose doses and exposure periods on *T. urticae* adult stages

Treats.	Applied period /h.	Female adult periods					Mortality %
		Pre-oviposition	Oviposition	Post-oviposition	Longevity	Life span	
One tablet/ m^3	12 h	3.0 ±0.7 a 2-4	16.2 ±0.9 b 15-18	5.4 ±0.9 b 4-6	24.6 ±1.2 b 22-27	38.4 ±1.1 a 31-42	1.0
	24 h	3.1 ±0.5 a 3-5	15.3 ±0.8 c 14-17	5.0 ±0.5 c 4-6	23.4 ±0.9 c 21-26	38.4 ±1.3 a 35-44	2.0
	48 h	4.0 ±0.3 b 3-5	13.4 ±1.1 d 11-15	4.3 ±0.3 d 3-5	22.2 ±1.3 d 19-24	37.8 ±1.0 b 36-41	3. 5
	72 h	4.0±0.3 b 3-5	9.6 ±0.9 e 8-12	4.0 ±0.4 e 3-5	19.8 ±1.5 e 17-21	36.2 ±1.4 c 33-40	8.0
	96 h	3.5 ±0.5 c 3-4	9.1 ±0.7 f 8-12	3.3 ±0.2 f 3-4	15.9 ±0.9 f 13-20	32.9 ±1.5 d 31-37	13.5
Two tablets /m^3	12 h	3.1 ±0.5 a 2-4	14.3 ±1.2 b 12-17	5.3 ±0.3 b 5-6	22.7 ±0.8 b 20-23	39.0 ±0.9 a 34-45	2.3
	24 h	2.3 ±0.5 b 2-4	13.8 ±1.1 c 11-15	4.9 ±0.3 c 4-6	21.0 ±0.7 c 20-24	38.0 ±1.2 a 35-45	7.2
	48 h	2.0 ±0.6 c 1-3	12.1 ±1.3 d 10-15	4.1 ±0.4 d 3-5	18.2 ±1.1d 16-20	36.1 ±1.6 b 33-41	12.0
Three tablets /m^3	12 h	2.2 ±0.2 b 2-3	11.4 ±0.6 b 9-14	4.0 ±0.2 b 5-7	17.3 ±1.3 b 15-19	34.8 ±0.8 b 32-38	26.4
	24 h	1.6 ±0.3 c 1-2	10.3 ±0.4 c 8-12	3.5 ±0.5 c 4-6	15.4 ±0.5 c 13-17	33.8 ±1.3 c 30-36	53.1
Control		2.9 ±0.1 a 2-4	17.5 ±0.9 a 16-19	6.1 ±0.3 a 5-7	26.5 ±0.5 a 23-29	38.7 ±1.4 a 36-42	0.0

Means within the column followed by the same letter are not significantly at the 5% level of probability Duncan test

Table 4. Effects of quickphose doses and their exposure periods on fecundity of *T. urticae* females.

Treats.	Applied period / h.	Female fecundity			
		Eggs / Female	Range	Daily rate	Mortality %
One tablet/m^3	12 h	131.9 ±3.4 a	120-139	8.1	4.4
	24 h	54.8 ±1.5 b	50-60	3.6	30.5
	48 h	30.6 ±2.3 c	26-37	2.3	45.9
	72 h	19.8 ±1.4 d	17-28	2.1	64.3
	96 h	9.9 ±0.9 e	7-12	1.1	81.7
Two tablets/m^3	12 h	102.2 ±3.7 b	91-111	7.1	26.9
	24 h	43.1 ± 1.2 c	36-54	3.1	63.6
	48 h	17.9 ±0.9 d	12-21	1.5	84.8
Three tablets / m^3	12 h	65.4 ±0.7 b	54-73	5.7	40.2
	24 h	13.6 ±0.6 c	10-17	1.3	89.5
Control		138.5 ±5.1 a 130-145		13.4	2.3

Means within the column followed by the same letter are not significantly at the 5% level of probability Duncan test

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تأثير التبخير بالكويكفوس ٥٧% (فوسفيد الألومنيوم) على التعداد والمظاهر البيولوجية للعنكبوت الأحمر ذو البقعتين *Tetranychus urticae* (Koch)

ماهر فؤاد رمضان محمود

قسم وقاية النبات - كلية الزراعة - جامعة الفيوم- مصر

تم اجراء هذا البحث تحت ظروف المعمل بمتوسط درجة حرارة ٢٧ °م ورطوبة نسبية تراوحت مابين ٤٥-٧٥ % وذلك لمعرفة مدى تأثير التبخير بهذا المبيد على تعداد و بعض المظاهر البيولوجية للعنكبوت الأحمر فى الأماكن المغلقة ولذلك تم استخدام أقفاص (١م^{٣}) مغلفة بالبلاستيك ووضع بها أقراص المبيد والآفة على نباتات الفاصوليا . وتم تعريض هذه الأفة لجرعات مختلفة من المبيد ولمدد مختلفة. وقد أوضحت النتائج أن نسبة الخفض فى تعداد الأفة تتزايد مع زيادة الجرعة المستخدمة وكذلك مع زيادة فترة التعرض لأبخرة المبيد . وتأثرت أيضا بعض المظاهر البيولوجية لهذه الآفة مثل مدة الأطوار غير الكاملة ومدة الطور الكامل وفترة وضع البيض وعدد البيض الموضوع ونسبة الموت.