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Effect of Hargal (*Solenostemma argel* (Del) Hayne) shoot powder aqueous extract on some tomato insect pests

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Abstract
A field experiment was carried out for two seasons 2013/2014 and 2014/2015, on sandy soil in Fogga village at Barra locality, North Kordofan State, Sudan to evaluate the efficacy of Hargal shoot powder aqueous extract (*Solenostermma argel (Del) Hayne*) at 10, 20, 30 and 40g/litre of water to control the whitefly (*Bemisia tabaci* Genn.) and African bollworm (*Helicoverpa armigera* Hübner) on tomato compared with the standard insecticide Permethrin 10% EC at 68 g a.i./fed and untreated control. A randomized complete block design with four replications was used. Mean number of *B. tabaci* adults/5 plants, mean percentage infested fruit by *H. armigera* and the percentage incidence of tomato yellow leaf curl virus (TYLCV) were measured. Hargal extract at 40g/litre showed comparable performance to the standard insecticide Permethrin in reducing the number of *B. tabaci* adults, which resulted in lowering infested fruit and the percentage of plants infected by TYLCV. Tomato yield obtained from plants treated with Hargal extract at 40g/litre and the standard insecticide was 25.2 and 25.3 ton/ha, respectively. The study recommended that Hargal shoot powder aqueous extract at 40 g/ L of water + 50 ml of 5% gum Arabic can be used as foliar application for the control *B. tabaci* and *H. armigera* on tomato fields.

Keywords: Tomato, *Bemisia tabaci*, *Helicoverpa armigera*, *Solenostermma argel* .

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Introduction
Tomato (*Lycopersicon esculentum* Mill.) is one of the most important vegetables in Sudan in terms of production and consumption. In the Sudan, different varieties of tomato grown in different agro ecological zones, both as a source of income as well as food (MOAF, 2015). In north Kordofan, tomato production is concentrated in some small areas in the northern (sandy soils) and southern (clay soils) (MOAAW, 2008). Tomato plants are subject to infestation by a number of insect pests including, leafminers (*Liriomyza* Spp.); cotton whitefly (*Bemisia tabaci*); African bollworm (*H. armigera*); potato tuber moth (*Phthorimaea operculella* (Zeller)) and recently tomato leafminer (*Tuta absoluta*) (Osman, *et al*., 2013). Whitefly and African bollworm are the key pests of tomato (Schumtterer, 1969). *B. tabaci* is a vector of a number of viral diseases such as Tomato Yellow Leaf Curl Virus (TYLCV), a disease that severely affects tomato crop yields in Sudan (Ahmed and Wani, 1997). In the two last decades more than 81 chemical insecticides were recommended to control *B.*

tabaci and *H. armigera* on tomato under Sudan conditions (Ahmed *et al.*, 2014). Botanicals have long been proposed as attractive alternatives to synthetic chemical insecticides for pest management because they are reputed to pose little threat to the environment or to human health (Isman, 2006). More than 1000 species of plants have been reported to have chemicals in leaves, stems, flowers, seeds and roots which have insecticidal property, but only a few of them have been used for practical insect control on a commercial scale in the past (Stoll, 2000). Hargal (*Solenostemma argel* Del. Hyne.) is an erect perennial shrub up to 60 cm feet high with numerous branches carrying opposite decussate leaves. It is a desert plant, wide spread in Central and Northern parts of Sudan and some neighbouring countries (Elkamali and Khalid, 1996). This shrub is commonly used in folk medicine in North Africa (Elkamali, 2001). An insecticidal effect of Hargal was reported by Elkamali (2001), Sidahmed *et al*. (2009) and Bakhiet and Taha (2009). The objective of this trial was to evaluate the efficacy of aqueous extract of *S. argel* shoot powder to control whitefly (*B. tabaci*) and the African bollworm (*H. armigera*) on tomato.

Materials and Methods

The study site:

The field trials were conducted in Fogga village at Barra locality, North Kordofan State, Sudan. It is located about 79 km North of ElObeid. The site is situated at latitude 13° 43′ 0″ N, 30° 19′ 0″ E and 618 m *asl*. The soil of experimental site is sandy where sandy fraction amounts to more than 85%. Tomato seeds of variety "Super Strain B" from the local market were sown in the nursery in 10 September 2013 and 21 September 2014.

Preparation of Hargal shoot powder aqueous extract:

Hargal shoot parts were bought from the local market and ground by electric mill to very fine powder and kept at room temperature in a plastic container until to be use. For preparation of the extract, the fine powder was weighed to rates as follows 10, 20, 30 and 40 grams. Each one was mixed with one litre of tap water and left for 24 hours in plastic container under room conditions. Then, each mixture was filtered by muslin cloth and 10 ml of 5% gum Arabic solution was added to each treatment as sticky material.

Application:

The seedlings were sprayed weekly with Hargal shoot powder aqueous extract at 10, 20, 30 and 40 g/litre of water and Permethrin 10% EC at 68 g a.i./fed for the control of the whitefly in the nursery except one plot used as untreated control. The seedlings were transplanted to the field in 8 October 2013 and 19 October 2014 in 2x2 m plots at 1m between beds and 0.4 m between plants. The four treatments in each season were laid out in a randomized complete block design with four replications. Manual weeding was done twice, after three and six weeks of transplanting. Urea as nitrogen at 25 kg/fed was applied to all plots after one and two months of transplanting.

In the first season (2013/2014), the first spray was applied in 18 October, the second was in 27 October, the third was in 6 November and the fourth was applied in 15 November. In the second season (2014/2015), the first spray was applied in 31 October, the second was in 8 November, the third was in 17 November and the fourth was applied in 26 November. The treatments were applied using knapsack sprayer with spray volume 100 L /fed. For the control of African bollworm (*H. armigera*) in the same experiment, the trial treatment was applied at 50% flowering. The other three

applications were carried out on 10 days interval.

Data collection and statistical analysis

Five tomato plants were randomly selected and whitefly adults on five leaves in each plants were counted one day before spray (pre-spray) and at 2,4, and 9 days after spray (post- spray counts). Percentage of infected plants with TYLCV was recorded in 27 November 2013, 7 December 2013 and 22 December 2013. Tomato fruit yield was taken from each treatment (4 plots) for each season. The percentage of tomato fruits infested by *H. armigera* was also calculated. Data were transformed to $\sqrt{x+0.5}$ when needed and subjected to analysis of variance (ANOVA). Duncan's Multiple Range Test (DMRT) was used for means separation. For tomato fruit yield, analysis was done for each season and combined data. Mstat-C statistical package was used to analyze the data.

Results and Discussion

In the subsequent post spray counts, Hargal extract at 40 g/litres of water showed significant gradual reduction in the *B. tabaci* number, comparable to the standard and significantly lower than untreated control (Table 1). Same trend was observed in the post spray counts of other, three sprays (Tables 2- 4). In the second season, four sprays were applied. In the first, second and third post spray counts, Hargal extract at 40 g/ litres of water showed lowest number of *B. tabaci* with similar number as the standard insecticide (Table 5). Also, same trend was observed in the first, second and third post spray counts of three sprays (Tables 6- 8).

The data presented in Table (10) exhibited significant differences between treatments and untreated control with respect to infestation level of *H. armigera*. In the first season, Hargal extract at 30 and 40 g/ litres of water and the standard insecticide (Permethrin 10% EC) at 68 g a.i./fed gave the least percentage infestation of *H. armigera*. The highest concentrations of Hargal extract and the standard insecticide showed the least infestation level of *H. armigera* in the second season. The above findings supported many studies carried out in the Sudan to investigate the bioactive effects of different Hargl formulations against some insect pests of date palm and mango under field conditions (Sidahmed *et al*., 2009; Eldoush *et al.,* 2011 and Mardi, 2015). In the second season, results on TYLCV incidence showed that all tested concentrations of Hargal extract and the standard insecticide generally decreased the mean of infected plants as a result of controlling the vector insect. The highest concentration of aqueous of Hargal shoot powder and the standard insecticide recorded the lowest disease incidence in the season (Table 9). This result was due to control of *B. tabaci* the vector of the disease.

Yield of tomato fruits (ton/ha) was determined. Hargal extract at all tested concentrations and the standard insecticide supported higher yields than the untreated control. In first season, aqueous extract of Hargal at 40g/ litre and the standard insecticide resulted in similar non significant highest fruits yield (25.6 ton/ha for both). For the second season, the same trend was noticed as in the previous season, with similar non significant highest tomato yield (Table 11). The combined analysis of tomato yield showed that highest means yield were obtained by aqueous extract of Hargal at 40g/L of water and the standard insecticide. This was mainly attributed to their effect on the control of *B. tabaci* and *H. armigera*. Similar results were obtained by Sidahmed *et al*. (2009); Eldoush *et al.* (2011) and Mardi (2015). In conclusion, the results of this study revealed that significant control of white fly, African boll worm and tomato leaf curl virus disease on tomato fields was achieved by spraying aqueous extract of *S. argel* shoot powder at 40 g/ L of water + 50 ml of 5% gum Arabic.

Table 1. Effect of Hargal shoot powder aqueous extract on whitefly adults on tomato. (first spray 18. 10. 2013, firest season 2013/ 2014).

Treatment	Conc (v/ L of water	Mean number of whitefly adults/100 leaves				
		Days after spray				
		Pre-spray count 18.10.2013	2	4	7	9
Hargal shoot powder	10	(38.5) 6.2 a	15.3 (4.0) bc	19 (2.8) c	24.3 (4.2) b	40 (4.8) b
Hargal shoot powder	20	36.5 (6.1) a	14.3 (6.1) b	16.8 (4.1) b	21.5 (4.7) b	33.5 (4.6) b
Hargal shoot powder	30	35.5 (6.0) a	3.5 (2.0) c	3.3 (1.9) cd	6.5 (2.6) c	24.5 (3.5) b
Hargal shoot powder	40	35.8 (6.0) a	1.0 (1.2) c	1.5 (1.4) d	3.3 (1.9) cd	22.3 (5.3) b
Permethrin 10% EC (standard)	68 g a.i./fed	35.3 (6.6) a	1.0 (1.1) c	1.3 (1.3) d	2.8 (1.8) d	27.5 (5.3) b
Control (untreated)	-	40.3 (6.4) a	68.8 (9.3) a	59.8 (7.8) a	60.5 (7.8) a	73.3 (8.6) a
C.V (%)	-	5.0	50.8	25.6	13.8	35.7
SE±	-	0.13	0.82	0.34	0.22	0.78

-Means with the same letter (s) in the same column are not significantly different at 5% level of significance.

- Means in parenthesis are transformed to $\sqrt{x+0.5}$.

Table 2. Effect of Hargal shoot powder aqueous extract on whitefly adults on tomato .(second spray 27. 10. 2013, first season 2013/ 2014).

Treatment	Conc (v/ L of water	Mean number of whitefly adults/100 leaves				
		Days after spray				
		Pre-spray count 27. 10. 2013	2	4	7	9
Hargal shoot powder	10	40 (4.9) b	11 (3.4) b	21 (4.6) b	25.3 (5.1) b	35.8 (6.0) b
Hargal shoot powder	20	33.5 (4.6) b	11.8 (3.5) b	20.3 (4.6) b	23 (4.8) c	32.5 (5.7) b
Hargal shoot powder	30	24.5 (3.5) b	3.3 (1.9) c	6.3 (2.6) c	12.5 (3.6) d	25.5 (5.1) c
Hargal shoot powder	40	22.3 (5.3) b	2.0 (1.6) cd	2.3 (1.7) d	2.8 (1.8) e	26 (5.1) c
Permethrin 10% EC (standard)	68 g a.i./fed	27.5 (5.3) b	1.3 (1.4) d	1.8 (1.5) d	2.3 (1.7) e	24.3 (5.0) c

Control (untreated)	-	73.3 (8.6) a	63.5 (8.0) a	59.3 (7.8) a	69 (8.3) a	60.3 (7.7) a
C.V (%)	-	35.7	9.6	3.5	2.8	4.0
SE±	-	0.78	0.13	0.05	0.05	0.09

Legend as in Table 1.

Table 3. Effect of Hargal shoot powder aqueous extract on whitefly adults on tomato. (third spray 6. 11. 2013, first season 2013/ 2014).

Treatment	Conc (v/L of water	Mean number of whitefly adults/100 leaves				
		Days after spray				
		Pre-spray count 6. 11. 2013	2	4	7	9
Hargal shoot powder	10	35.8 (6.0) b	9.3 (3.1) b	19.8 (4.5) b	26 (5.1) b	35.8 (6.695) a
Hargal shoot powder	20	32.5 (5.7) b	10.3 (3.3) b	21.5 (4.7) b	24.8 (5.0) b	28.3 (5.360) b
Hargal shoot powder	30	25.5 (5.1) c	6 (2.5) c	12 (3.5) c	13.8 (3.6) c	28 (5.335) bc
Hargal shoot powder	40	26 (5.1) c	2.3 (1.7) d	3.5 (2.0) d	3.5 (2.0) d	23.3 (4.870) cd
Permethrin 10% EC (standard)	68 g a.i./fed	24.3 (5.0) c	2 (1.6) d	3 (1.8) d	3 (1.9) d	22.8 (4.820) d
Control (untreated)	-	60.3 (7.7) a	65 (8.1) a	56.3 (7.5) a	59.8 (7.8) a	42.3 (6.535) a
C.V (%)	-	4.0	5.4	7.3	7.3	5.7
SE±	-	0.09	0.07	0.12	0.13	0.13

Legend as in Table 1.

Table 4. Effect of Hargal shoot powder aqueous extract on whitefly adults on tomato . (fourth spray 15. 11. 2013, first season 2013/ 2014).

Treatment	Conc (v/ L of water	Mean number of whitefly adults/100 leaves				
		Days after spray				
		Pre-spray count 15. 11. 2013	2	4	7	9
Hargal shoot powder	10	35.8 (6.7) a	30 (5.5) b	23.3 (4.9) b	15.8 (4.0) b	18 (4.3) b
Hargal shoot powder	20	28.3 (5.3) b	20.3 (4.5) c	19.5 (4.5) c	13 (3.7) c	17.5 (4.2) b
Hargal shoot powder	30	28 (5.3) bc	12.3 (3.7) d	11.5 (3.5) d	4.3 (2.2) d	18.3 (4.3) b
Hargal shoot powder	40	23.3 (4.9) cd	6.3 (2.6) e	3.5 (2.0) e	2.3 (1.) e	19 (4.4) b
Permethrin 10% EC (standard)	68 g a.i./fed	22.8 (4.8) d	6.5 (2.6) e	4 (2.1) e	2.8 (1.8) e	18.5 (4.4) b
Control (untreated)	-	42.3 (6.5) a	56.3 (7.5) a	52.5 (7.3) a	45.8 (6.8) a	35.8 2(5.8) a
C.V (%)	-	5.7	6.9	5.7	5.1	6.8
SE±	-	0.13	0.12	0.09	0.07	0.13

Legend as in Table 1.

Table 5. Effect of Hargal shoot powder aqueous extract on whitefly adults on tomato. (first spray 31. 10. 2014, second season 2014/ 2015).

Treatment	Conc (v/ L of water	Mean number of whitefly adults/100 leaves				
		Days after spray				
		Pre-spray count 31. 10. 2014	2	4	7	9
Hargal shoot powder	10	37.8 (6.2) b	12.5 (3.6) b	20 (4.5) b	28.3 (5.4) b	40.8 (6.4) b
Hargal shoot powder	20	37.8 (6.2) b	9.8 (3.2) c	19.8 (4.5) b	26.5 (5.2) c	34.5 (5.9) c
Hargal shoot powder	30	36.8 (6.1) b	6 (2.4) d	8 (2.9) c	12.3 (3.7) d	27.8 (5.3) d
Hargal shoot powder	40	37.8 (6.2) b	0.0 (0.7) e	1.8 (1.5) d	2.8 (1.8) e	27.8 (5.3) d
Permethrin 10% EC (standard)	68 g a.i./fed	36.8 (6.1) b	0.0 (0.7) e	1.8 (1.5) d	2.8 (1.8) e	28.5 (5.4) d
Control (untreated)	-	40.5 (6.4) a	52.8 (7.3) a	54.5 (7.4) a	50.8 (7.2) a	64.3 (8.0) a
C.V (%)	-	2.0	5.03	5.7	3.0	2.9
SE±	-	0.05	0.06	0.09	0.05	0.07

Legend as in Table 1.

Table 6. Effect of Hargal shoot powder aqueous extract on whitefly adults on tomato. (second spray 8. 11. 2014, second season 2013/ 2014).

Treatment	Conc (v/ L of water	Mean number of whitefly adults/100 leaves				
		Days after spray				
		Pre-spray count 8. 11. 2014	2	4	7	9
Hargal shoot powder	10	40.8 (6.4) b	13.3 (3.7) b	19.3 (4.4) b	26.3 (5.2) b	37.8 (6.2) b
Hargal shoot powder	20	34.5 (5.9) c	11.3 (3.4) b	17.8 (4.3) b	23.5 (4.9) b	35.5 (6.0) b
Hargal shoot powder	30	27.8 (5.3) d	8.0 (2.8) c	10.5 (3.3) c	14.8 (3.9) c	34.8 (5.9) b
Hargal shoot powder	40	27.8 (5.3) d	0.5 (1.0) d	1.3 (1.3) d	2.0 (1.6) d	28.5 (5.4) c
Permethrin 10% EC (standard)	68 g a.i./fed	28.5 (5.4) d	0.8 (1.1) d	1.8 (1.4) d	1.8 (1.5) d	26.8 (5.2) c
Control (untreated)	-	64.3 (8.0) a	51.0 (7.2) a	53.3 (7.3) a	46 (6.8) a	44.8 (6.7) a
C.V (%)	-	2.9	7.4	8.9	6.5	3.45
SE±	-	0.07	0.10	0.13	0.11	0.08

Legend as in Table 1.

Table 7. Effect of Hargal shoot powder aqueous extract on whitefly adults on tomato.(third spray 17. 11. 2014, second season 2013/ 2014).

Treatment	Conc (v/L of water	Mean number of whitefly adults/100 leaves				
		Days after spray				
		Pre-spray count 17. 11. 2014	2	4	7	9
Hargal shoot powder	10	37.8 (6.2) b	14 (3.8) b	21 (4.6) b	30.5 (5.563) b	36.3 (6.1) b
Hargal shoot powder	20	35.5 (6.0) b	10.5 (3.3) b	18 (4.3) b	26.5 (5.188) b	36 (6.0) b
Hargal shoot powder	30	34.8 (5.932) b	10 (3.2) b	10.8 (3.3) c	14.3 (3.838) c	26 (5.1) c
Hargal shoot powder	40	28.5 (5.380) c	2.3 (1.6) c	5.5 (2.4) d	4 (2.100) d	26.3 (5.2) c
Permethrin 10% EC (standard)	68 g a.i./fed	26.8 (5.217) c	2 (1.5) c	5.5 (2.4) d	3.5 (1.985) d	24.5 (5.0) c
Control (untreated)	-	44.8 (6.722) a	62.5 (7.9) a	62.5 (7.9) a	65.5 (8.122) a	57 (7.4) d
C.V (%)	-	3.5	11.4	5.4	6.3	4.1
SE±	-	0.08	0.16	0.09	0.11	0.10

Legend as in Table 1.

Table 8. Effect of Hargal shoot powder aqueous extract on whitefly adults on tomato. (fourth spray 26. 11. 2014, second season 2013/ 2014).

Treatment	Conc (v/10 L of water	Mean number of whitefly adults/100 leaves				
		Days after spray				
		Pre-spray count 26. 11. 2014	2	4	7	9
Hargal shoot powder	10	36.3 (6.1) b	13.3 (3.7) b	25 (5.0) b	38.3 (6.2) b	33.3 (5.7) b
Hargal shoot powder	20	36 (6.0) b	14.8 (3.5) b	18 (4.3) c	29.5 (5.5) c	32.5 (5.7) b
Hargal shoot powder	30	26 (5.1) c	6 (2.5) c	10.8 (3.3) d	20.8 (4.6) d	26.3 (5.2) c
Hargal shoot powder	40	26.3 (5.2) c	1.0 (1.2) d	2.0 (1.7) e	12.5 (3.6) e	17.3 (4.2) d
Permethrin 10% EC (standard)	68 g a.i./fed	24.5 (5.0) c	0.8 (1.1) d	2.3 (1.6) e	15.5 (3.9) e	20.3 (4.5) d
Control (untreated)	-	57 (7.4) d	62.3 (7.9) a	71.8 (8.5) a	90 (9.5) a	96.8 (9.8) a
C.V (%)	-	4.1	10.3	5.9	5.4	4.8
SE±	-	0.10	0.16	0.08	0.10	0.09

-Means with the same letter (s) in the same column are not significantly different at 5% level of significance.

- Means in the parenthesis are transformed to √x+0.5.

Table 9. Effect of Hargal shoot powder aqueous extract on percentage infestation of Tomato Leaf Curl Virus (TLCV) (second season, 2013/2014).

Treatment	Conc (v/ L of water	Tomato Leaf Curl Virus (%)		
		Counts		
		1st	2nd	3rd
Hargal shoot powder	10	15.8 (4.0) b	26.8 (5.2) b	46 (2.2) b
Hargal shoot powder	20	13 (3.7) b	23.5 (4.9) b	47 (3.9) b
Hargal shoot powder	30	6.5 (2.6) c	13.8 (3.8) c	22.2 (3.8) c
Hargal shoot powder	40	6.3 (2.6) c	11.3 (3.4) c	19.8 (5.1) d
Permethrin 10% EC (standard)	68 g a.i./fed	7.5 (5.3) c	12.8 (3.7) c	21 (5.2) d
Control (untreated)	-	36.5 (6.1) a	61 (7.9) a	90.5 (1.9) a
C.V (%)	-	10.3	11.4	4.8
SE±	-	0.16	0.16	0.09

Legend as in Table 1.

Table 10. Effect of Hargal shoot powder aqueous extract on the percentage infestation of tomato fruit by *H. armigera*.

Treatment	Conc (v/ L of water	Infested tomato fruits (%)		Combined
		1st season	2nd season	
Hargal shoot powder	10	17.0 a	11.0 b	14.0 a
Hargal shoot powder	20	13.5 b	10.0 b	11.8 b
Hargal shoot powder	30	6.0 c	7.50 c	6.8 c
Hargal shoot powder	40	5.6 c	4.50 d	5.1 d
Permethrin 10% EC (standard)	68 g a.i./fed	5.8 c	4.3 d	5.0 d
Control (untreated)	-	15.8 a	13.0 a	14.4 a
C.V (%)	-	12.3	8.9	11.8
SE±	-	0.53	0.30	0.32

-Means with the same letter (s) in the same column are not significantly different at 5% level of significance.

Table 11. Effects of Hargal shoot powder aqueous extract on tomato fruit yield.

Treatment	Conc (v/ L of water	Tomato fruit yield (ton/hec)		Combined
		1st season	2nd season	
Hargal shoot powder	10	5.1 (2.3) c	4.7 (2.0) c	4.9 (2.2) c
Hargal shoot powder	20	15.1 (3.9) b	14.7 (3.9) b	14.8 (3.9) b
Hargal shoot powder	30	16.8 (3.7) b	15.5 (4.0) b	16.2 (3.8) b
Hargal shoot powder	40	25.6 (5.1) a	24.9 (5.0) a	25.2 (5.1) a
Permethrin 10% EC (standard)	68 g a.i./fed	25.6 (5.3) a	25.0 (5.1) a	25.3(5.2) a
Control (untreated)	-	3.2 (1.9) c	3.0 (1.9) d	3.1(1.9) d
C.V (%)	-	10.8	2.9	8.11
SE±	-	0.16	0.04	0.09

Legend as in Table 1.

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أثرالمستخلص المائى لمسحوق المجموع الخضرى لنبات الحرجل فى مكافحة بعض الآفات الحشرية فى محصول الطماطم

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المستخلص:

أُجريت تجربة حقلية لموسميين (013! /2014 و 014! /015!) فى التربة الرملية فى قرية فوجا، محلية بارا، ولاية شمال كردفان، السودان لتقييم فعالية المستخلص المائى لمسحوق المجموع الخضرى لنبات الحرجل بمعدلات 0 ، 0! ، 30 و 40 جرام/لتر الماء لمكافحة حشرتى الذبابة البيضاء (*Bemisia tabaci* Genn.) ، ديدان اللوز الأفريقية (*Ηelicoverpa armigera* Hübner)، و فيروس تجعد أوراق الطماطم (YLCV) على محصول الطماطم مقارنة مع المبيد الكيميائى القياسى بيرمثرين 0 % مستحلب بجرعة 8ا جرام مادة فعالة للفدان و الشاهد غير المعامل. أُستخدم تصميم القطاعات العشوائية الكاملة مع اربعة مكررات. تم حساب متوسط أعداد الأطوار البالغة من الذبابة البيضاء/ نباتات، ثمار الطماطم المصابة بديدان اللوز الأفريقية و النسبة المئوية لظهور فيروس تجعد أوراق الطماطم. أظهر المستخلص المائى لنبات الحرجل بمعدل 40 جرام/لتر الماء أداء مساوياً للمبيد الكيميائى قياسى فى تقليل أعداد الأطوار البالغة من الذبابة البيضاء، ثمار الطماطم المصابة بديدان اللوز الأفريقية و النسبة المئوية لظهور مرض تجعد الأوراق الفيروسى الأصفر. الإنتاجية من ثمار الطماطم المتحصلة من المستخلص المائى لنبات الحرجل بمعدل 40 جرام/لتر الماء والمبيد الكيميائى القياسى كانت 25.3 و 25.2 طن/هكتار على التوالى. أوصت الدراسة بإستخدام المستخلص المائى لمسحوق المجموع الخضرى لنبات الحرجل بمعدل 40 جرام/لتر الماء+0 مل (%)من الصمغ العربى رشاً لمكافحة الذبابة البيضاء و ديدان اللوز الأفريقية فى حقول الطماطم.