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Comparative Study on the Potency of Certain Chemical and Safe Alternative Compounds Against the Small White Butterfly, *Pieris rapae* (L) (Lepidoptera: Pieridae), Infesting Cabbage Plantations in Assiut, Upper Egypt

Abdel-Galil, F.A; Safaa M.A. Amro; A.A. Abd El-Raheem and Dalya Y.A. Darwish

[1]Plant Protection Department, Faculty of Agriculture, Assiut University, Assiut, Egypt.
[2]Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.
*Corresponding Author, Email address: faagalil@hotmail.com
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Abstract:

The small white cabbage butterfly, *Pieris rapae* (L) is one of the most serious insect pests infesting cruciferous plants especially cabbage. Comparison between the potency of certain chemical and safe alternative compounds in reducing, *P. rapae* larval populations in the field was the corner stone of this investigation. Also, their potency to reduce the pest infestation levels and yield loss (unmarketable plants) has been taken in consideration. The pest larvae were recorded in very small numbers; 14 days post application (round up the economic threshold) by using most of the tested compounds. Potency of the tested compounds indicated that, Broact 5% SG (Emamectin Benzoate) showed the highest reduction percentages, (93.29% for larvae populations; 52.13% for infestation percentages and 36.04% for unmarketable plants). It followed by the newly introduced European compounds, Karate® Zeon (Lambda cyhalothrin Sc 9.4%) and Evure® (Tau-Fluvilonat). However, Melody 24% SC (Metoxyfenozide) and Biosad 22% SC (Spinosad) appeared as the least effective compounds. In general, it can be concluded that, Broact 5% SG in the rate of 8 gm. /100 Litter water, was the most effective against *P. rapae* larvae, providing an increase of marketable cabbage plants by 36.04% with one application per season. Therefore, it can be recommended to use Broact 5% SG , Karate® Zeon and Evure® in the Integrated Pest Management (IPM) programs for controlling the small white cabbage butterfly, *P. rapae* in the future

Keywords: *Pieris rapae, Chemical and safe alternative insecticides.*

Introduction:

The cruciferous or mustard family is a large natural family of major economic importance containing a diverse variety of crop plants grown for salads, vegetables, condiments, and ornamental plants. These include cabbage, cauliflower, broccoli, radish and field crops such as turnip, mustard and rape (Embaby and Lotfy, 2015). The small white cabbage butterfly, *Pieris rapae* (Linnaeus, 1758) (Lepidoptera: Pieridae), is one of the most serious cruciferous insect pests infesting cabbage. Control of this insect pest is becoming increasingly difficult due to its resistance to many conventional synthetic insecticides in many areas (Li *et al*., 1999). With the imposed quality restrictions on fresh market vegetables, management, cabbage pests have been based on either a low threshold or on scheduled weekly sprays (Cartwright *et al*.,

1987). Thus, some recent insecticides have been introduced as substitutes to control *P. rapae*. Therefore, this work has been conducted to evaluate the potency of certain chemical and safe alternative compounds in reducing the small white butterfly, *P. rapae* populations in the field. Also, their potency to reduce the infestation levels and yield loss (unmarketable plants) has been evaluated.

Materials and Methods

Experiments were carried out at a private farm in El-Fath district by using Sabeny cabbage cultivar during 2017 and 2018 cabbage growing seasons at (Ca.1/4 feddan) and divided into plots (1/400 fed. /plot). Plants were transplanted in 50cm intervals at 1st July during both seasons. Insecticides application were initiated as larvae densities exceeded the threshold level of 0.3 larvae per plant (two months post transplantation) as determined by Cartwright *et al*., (1987). To evaluate the reduction percentage of *P. rapae* larvae, 4 cabbage plants were tagged and visually examined in the field /each replicate (4 replicates) in addition to the control replicates. Mean numbers of *P. rapae* larvae were counted before spray by the selected compounds (Table 1) and consequently after 3, 7 and 14 days post application. Reduction percentage of the targeted insect pest larvae, were calculated according Henderson and Tilton (1955) equation. Reduction percentages of the infested and unmarketable plants (Figure 1) were calculated according to the same equation. Data were statistically analyzed by using F-test and means were compared according to Duncan's multiple range tests as described by Steel and Torrie (1982).

Table 1. Trade name, Common name and application rate of the tested compounds against *the* small white butter fly *Pieris rapae* (L.).

Trade name	Common name	Application rate
1- Evure®	21,4% (240 g/l) Tau-fluvalinate	10 ml/100 Litter water
2- Karate® Zeon	Lambda cyhalothrin Sc 9.4%	31.2 ml/100 Litter water
3- Biosad 22% SC	Spinosad	10 ml/100 Litter water
4-Broact 5% SG	Emamectin Benzoate	8 Gm. /100 Litter water
5- Melody 24%SC	Metoxyfenozide	25 ml/100 Litter water

A **B** **C**

Figure 1. Small white butterfly damage symptoms on cabbage plants
(A: Healthy Plant, B: Infested plant, C: Unmarketable Plant)

Results and Discussion

Data presented in Table (2) expressed about the potency of the tested compounds to reduce the larval population density of *P. rapae* in the field, 3, 7 and 14 days post applica-

tion during the first season of study. Consequently, their potency to reduce the pest infestation levels and damaged (unmarketable) plants were estimated and presented in Tables 3&4. Data in Table (2) revealed that, Broact 5% SG (Emamectin Benzoate) reduced the pest larval populations by 94.23%, through 14 days post application and ranked the first. It followed by the newly introduced European compounds Karate® Zeon (Lambda cyhalothrin Sc 9.4%) and Evure® (Tau-Fluvilonat) by 87.21 and 85.78%, respectively. Melody 24% SC (Metoxyfenozide) ranked the fourth and reduced *P. rapae* larvae by 85.27%. The least reduction percentage of the pest larvae (76.85%) was recorded by using the bio-compound, Biosad 22% SC (Spinosad). Significant variations (f = 18.81*) were recorded between the tested compounds. It is important to note that, the pest larvae recorded very small numbers [(round up the economic threshold (0.3 larvae / plant)] 14 days post application by using most of the tested compounds.

Data presented in Table (3) expressed about the potency of the tested compounds to reduce percent infestation of plants attacked by *P. rapae*. The highest reduction percentage of the infested cabbage plants (50.22%) was recorded by using Broact 5% SG (Emamectin Benzoate). The rest of the tested compounds reduced the pest infestation levels by 49.68, 49.03, 45.23 and 40.53 by using Karate® Zeon, Evure®, Melody 24%SC and Biosad 22% SC , respectively. It can be note that, potency of the tested compounds to reduce infestation levels took the same trend and ranking order of their potency to reduce the population density of *P. rapae* larvae in the field as shown in Table (2). Non-significant variations ($f = 1.415^{ns}$) were recorded between the tested compounds.

Data in Table (4) showed the potency of the tested compounds to reduce the percentages of the unmarketable plants throughout the experimentation period; 3-14 days post application. It is important to note that, no compound reduces the unmarketable plants throughout the first 3 days post application. However, during the remaining period, the tested compound reduced the unmarketable plants by 21.67-36.00 %. Potency of the tested compounds to reduce the percentages of the unmarketable plants arranged in descending order as follows: Broact 5% SG by 36.00 > Karate® Zeon by 35.61> Evure® by 34.60 > Melody 24%SC by 33.24 > Biosad 22% SC by 21.67%. So, Broact 5% SG (Emamectin Benzoate) appeared as the most effective compound and presented the highest reduction percentage in the population density of the pest larvae and their infestation level which led to increase the proportion of marketable plants. Also, it can be note that, percentages of reduction in the infestation levels was generally higher than that recorded in the damaged (unmarketable plants). This finding is dependent on the fact that, not all of the infested cabbages plants could become unmarketable. With few exceptions, similar results (Tables 5-7) were obtained during the second season of study. Data presented in Table (8) and illustrated in Figure (2) expressed about the obtained results during the

entire study period. Potency of the tested compounds indicated that, Broact 5% SG showed the highest reduction percentages in all of the tested measurements (93.29% for larvae populations; 52.13% for infestation percentage and 36.04% for unmarketable plants). It followed by the recent introduced European compounds, Karate® Zeon and Evure®. However, Melody 24% SC and Biosad 22% SC appeared as the least effective compounds on *P. rapae* population trends.

Successful use of Broact 5% SG (Emamectin Benzoate) against Lepidoptera was clarified by Jansson *et al*., (1997). They stated that, this epimethyl amino derivative has unprecedented potency against a broad spectrum of lepidopterous pests. Also, they described Emamectin benzoate as a novel semi-synthetic derivative of the natural product abamectin in the avermectin family of 16-membered macrocylic lactones. On the same approach, Mau *et al*.,(2001) reported that, Emamectin benzoate provided superior control of the Diamond Back Moth (DBM) *Plutella xylostella* and other lepidopteran larvae in the field. They found that, growers obtained an average increase in marketable yield of 29% and an estimated net increase in gross revenues of about $660 per hectare. They also, reported that, its rapid degradation on leaf surfaces provides a good margin of safety for parasitoids of DBM and other lepidopteran pest species. Therefore, this insecticide could be has a positive characteristics for use in IPM programs. The safe alternative compound (Spinosad) has been described by Mertz and Raymond (1990) as an insecticide based on chemical compounds found in the soil bacterium species, *Saccharopolyspora spinosa* which consider a natural substance that can be toxic to insects and can be used to control a wide variety of pests , i.e. thrips, leaf miners, spider mites, mosquitoes, ants, fruit flies and others. Also, Radiant 12% SC (Spinotoram) was previously tested in the same area of study and reduced Onion thrips, *Thrips tabaci* Lindeman by 89.75% (Amro and Abdel-Galil, 2012). However, it reduced the cotton seed bug *Oxycarenus hyalinipennis* (Costa) infesting Okra fruits by 80.99% (Abd El-Rahim and Amro, 2015). In an agreement study about the other tested compounds in this manuscript, e.g. Evure® (Tau-Fluvilonat) and Karate® Zeon (Lambda cyhalothrin Sc 9.4%), Vuković *et al*.,(2014) assess the efficacy of Tau - fluvalinate and lambda - cyhalothrin based insecticides in the control of *P. rapae* and *P. xylostella* caterpillars. They reported that, efficacy of both insecticides after four days ranged from 96.4 to 100 % and after seven days 89.8 - 97.3 %, respectively. In general, it can be concluded that, Broact 5% SG (Emamectin Benzoate) in the rate of 8 gm. /100 Litter water, was the most effective against *P. rapae* larvae, providing an increase of marketable cabbage plants by 36.04% with one application per season. Therefore, it can be recommended to use Broact 5% SG, Karate® Zeon and Evure® in the Integrated Pest Management (IPM) programs for controlling the small white cabbage butterfly, *P. rapae* in the future.

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References

Abd El-Rahim, G. H. and Amro, M. A. 2015. Population fluctuations of *Oxycarenus hyalinipennis* and effect of certain compounds on its population on okra in Assiut Governorate. Egypt J. Agric. Res. 93(1):25-35.

Amro, M. A. and Abdel-Galil, F. A. 2012. Can safe alternative compounds used as a promising tool for suppressing *Thrips tabaci* (Lind.) inhabiting onion seed plantations? The 6rd. Int. Conf. for Develop. and the Env. in the Arab world, March, 24-26:167-175.

Cartwright, B. J.; Edelson, V. and Chambers, C. 1987. Composite action thresholds for the control of lepidopterous pests on fresh-market cabbage in the Lower Rio Grande Valley of Texas. J. Econ. Entomol., 80: 175-181.

Embaby, M. E. and Lotfy, D. E. 2015. Ecological Studies on Cabbage Pests. Int. J. Agric. Technol. 11(5):1145-1160.

Henderson, C.F. and Tilton, E.W. 1955. Tests with acaricides against the brown wheat mite. J. Econ. Entomol., 48: 157-161.

Jansson, R. K.; Brown, R.; Cartwright, B. ; Cox, D.; Dunbar, D. M.; Dybas, R. A. ; Eckel, C.; Lasota, J. A.; Mookerjee, P. K. ; Norton, J. A. ; Peterson, R. F. ; Starner, V. R. and White, S. 1997. Emamectin benzoate: a novel avermectin derivative for control of lepidopterous pests. Proceedings: The Management of Diamondback Moth and Other Crucifer Pests.171- 177.

Li, X. F.; Zhang, W. J. and Wang, C. J. 1999. The sensitivity measurement of different instars cabbageworm to different insecticides. Chinese J. Pesticide Sci., 1: 84-86.

Mau, R. F. L.; Dunbar, D. M.; Gusukuma-Minuto, L. and Shimabuku, R. S. 2001. Management of diamondback moth with emamectin benzoate and *Bacillus thuringiensis* subsp. *aizawai* insecticides. Proceedings: The Management of Diamondback Moth and Other Crucifer Pests. 26-29 Nov.178-184.

Mertz, F. and Raymond, C. Y. 1990. "*Saccharopolyspora spinosa* sp. nov. Isolated from soil collected in sugar mill rum still". Int. J. Systematic Bacteriology. 40 (1): 34–39.

Steel, R.G.D. and J.H. Torrie. 1982. Principals and Procedures of Statistics. A Biometrical Approach, McGraw-Hill Book Co.

Vuković, S.; Indic, D.; Gvozdenac, S. and Červenski, J. 2014. Efficacy of insecticides in the control of cabbage pests. Res. J. Agric. Sci., 46 (2): 421 – 425.

Table 2. Potency of the tested compounds in reducing numbers of the white butterfly *Pieris rapae* larvae infesting cabbage plants, during 2017 cabbage growing season in Assiut region.

Compound	Mean numbers of *P. rapae* larvae / 4 tagged plants / plot and reduction %							GR%	RO
	Before spraying	After 3 days		After 7 days		After 14 days			
		MN	R%	MN	R%	MN	R%		
Evure ®	21.00	8.25	65.42	1.25	95.26	1.00	96.65	85.78B	3
Karate® Zeon	19.25	6.50	69.06	1.25	95.26	0.75	97.32	87.21B	2
Biosad 22% SC	20.75	9.75	57.23	5.50	78.67	1.75	94.64	76.85D	5
Broact 5% SG	21.00	3.00	87.26	1.00	96.05	0.25	99.39	94.23A	1
Melody 24% SC	21.25	8.75	62.69	1.50	94.47	0.50	98.66	85.27BC	4
Control	21.00	23.00	------	26.75	------	31.25	------		

MN = Mean numbers, R% = Reduction %, GR% = General Reduction %, RO = Ranking order

F value between treatments= 18.81*

Table 3. Potency of the tested compounds in reducing percentage of the infested cabbage plants by the white butterfly *Pieris rapae* larvae, during 2017 cabbage growing season in Assiut region.

Compound	Mean percentage of the infested cabbage plants / plot and reduction %							GR%	RO
	Before spraying	After 3 days		After 7 days		After 14 days			
		MP	R%	MP	R%	MP	R%		
Evure ®	**5.00**	5.00	35.00	6.00	49.60	7.50	62.50	49.03A	3
Karate® Zeon	**6.00**	6.00	35.00	6.75	52.54	9.25	61.50	49.68A	2
Biosad 22% SC	**5.00**	5.00	35.00	7.25	39.10	10.50	47.50	40.53C	5
Broact 5% SG	**5.75**	6.00	32.40	7.00	48.76	7.00	69.50	50.22A	1
Melody 24% SC	**7.00**	7.00	35.00	10.00	39.94	11.00	60.75	45.23B	4
Control	**5.50**	8.50	------	13.00	------	22.00	------	------	

MP = Mean percentage, R% = Reduction %, GR% = General Reduction %, RO = Ranking order

F value between treatments= 1.415 ^{ns}

Table 4. Potency of the tested compounds in reducing percentage of the unmarketable cabbage plants attacked by *Pieris rapae*, during 2017 cabbage growing season in Assiut region.

Compound	Mean percentage of the unmarketable cabbage plants / Plot and reduction %							GR%	RO
	Before spraying	After 3 days		After 7 days		After 14 days			
		MP	R%	MP	R%	MP	R%		
Evure ®	13.00	13.00	0.00	17.00	49.30	17.00	54.50	34.60A	3
Karate® Zeon	13.00	13.00	0.00	15.00	55.15	18.00	51.70	35.61A	2
Biosad 22% SC	13.00	13.00	0.00	19.00	43.06	29.00	21.95	21.67C	5
Broact 5% SG	14.00	14.00	0.00	17.00	52.81	18.00	55.20	36.00A	1
Melody 24%SC	11.00	11.00	0.00	14.00	50.47	16.00	49.25	33.24B	4
Control	13.00	13.00	----	33.00	----	37.00	----		

MP = Mean percentage, R% = Reduction %, GR% = General Reduction %, RO = Ranking order F value between treatments= 7.08*

Table 5. Potency of the tested compounds in reducing numbers of the white butterfly *Pieris rapae* larvae infesting cabbage plants, during 2018 cabbage growing season in Assiut region.

Compound	Mean numbers of *P. rapae* larvae / 4 tagged plants / plot and reduction %							GR%	RO
	Before spraying	After 3 days		After 7 days		After 14 days			
		MN	R%	MN	R%	MN	R%		
Evure ®	20.50	8.25	64.40	2.25	91.53	1.00	96.60	84.18B	3
Karate® Zeon	20.00	7.25	67.96	2.25	91.53	0.75	97.28	85.59B	2
Biosad 22% SC	21.50	9.50	60.84	6.25	77.67	1.75	94.56	77.69D	5
Broact 5% SG	22.00	4.25	83.09	1.25	95.38	0.50	98.64	92.37A	1
Melody 24% SC	22.50	9.25	63.51	3.50	87.68	1.25	95.92	82.37C	4
Control	22.00	24.50	-----	28.75	-----	32.50	-----		

MN = Mean numbers, R% = Reduction %, GR% = General Reduction %, RO = Ranking order

F value between treatments= 18.11*

Table 6. Potency of the tested compounds in reducing percentage of the infested cabbage plants by the white butterfly *Pieris rapae* larvae, during 2018 cabbage growing season in Assiut region.

Compound	Mean percentage of the infested cabbage plants / plot and reduction %							GR%	RO
	Before spraying	After 3 days		After 7 days		After 14 days			
		MP	R%	MP	R%	MP	R%		
Evure ®	7.50	7.75	35.11	8.00	56.13	8.50	70.62	53.95A	2
Karate® Zeon	6.50	6.75	34.48	7.00	55.72	8.50	65.94	53.74A	3
Biosad 22% SC	7.00	7.50	32.59	8.25	51.62	8.25	69.32	51.18B	5
Broact 5% SG	6.00	6.25	34.48	6.50	55.72	6.50	71.92	54.04A	1
Melody 24% SC	7.00	7.25	34.48	7.75	54.49	7.75	71.14	53.37A	4
Control	6.00	9.50	-----	14.50	-----	23.00	------		

MP = Mean percentage, R% = Reduction %, GR% = General Reduction %, RO = Ranking order F value between treatments= 0.989^{ns}

Table 7. Potency of the tested compounds in reducing percentage of the unmarketable cabbage plants attacked by *Pieris rapae*, during 2018 cabbage growing season in Assiut region.

Compound	Mean percentage of the unmarketable cabbage plants / plot and reduction %							GR%	RO
	Before spraying	After 3 days		After 7 days		After 14 days			
		MP	R%	MP	R%	MP	R%		
Evure ®	14.00	14.00	7.00	15.00	44.08	16.50	52.80	34.63B	3
Karate® Zeon	14.00	14.00	7.00	15.00	44.08	16.00	54.40	35.16A	2
Biosad 22% SC	15.00	15.00	7.00	18.00	32.80	20.00	46.80	28.87C	5
Broact 5% SG	14.00	14.00	7.00	14.00	44.08	15.00	57.20	36.09A	1
Melody 24%SC	14.00	14.00	7.00	15.00	40.00	16.00	54.40	33.83B	4
Control	14.00	15.00	----	25.00	-----	35.00	-----		

MP = Mean percentage, R% = Reduction %, GR% = General Reduction %, RO = Ranking order F value between treatments= 0.224^{ns}

Table 8. Potency of the tested compounds in reducing *Pieris rapae* populations, percent infestation and unmarketable cabbage plants during 2017 and 2018 cabbage growing seasons in Assiut region.

Compound	General reduction percentage during 2017 and 2018 cabbage growing seasons						
	Plant age	*Pieris rapae* larvae populations		Infestation %		Unmarketable plants %	
		R%	RO	R%	RO	R%	RO
Evure ®	60-74 days old	84.98	3	51.49	3	34.62	3
Karate® Zeon		86.40	2	51.69	2	35.39	2
Biosad 22% SC		81.22	5	45.86	5	25.27	5
Broact 5% SG		93.29	1	52.13	1	36.04	1
Melody 24% SC		83.77	4	49.30	4	33.54	4

R% = Reduction %, RO = Ranking Order

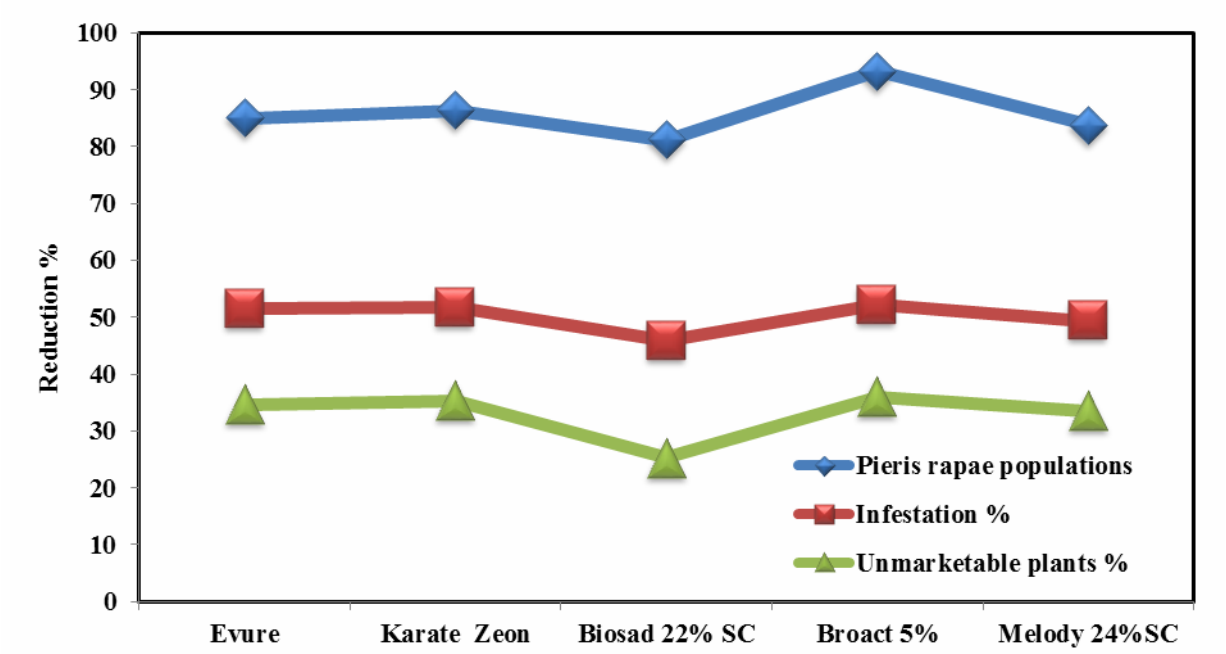

Figure 2. Potency of the tested compounds in reducing *Pieris rapae* populations, percent infestation and unmarketable cabbage plants during 2017 and 2018 cabbage growing seasons in Assiut region.

دراسة مقارنة عن فعالية بعض المركبات الكيميائية و البدائل الأمنة للمبيدات علي أبي دقيق الكرنب الذي يهاجم زراعات الكرنب بأسيوط ، بصعيد مصر

فاروق عبد القوى عبد الجليل، صفاء محمد عبدالرحمن عمرو،عبد الرحيم أحمد عبد الرحيم و داليا يوسف عوض درويش

[١] قسم وقاية النبات – كلية الزراعة – جامعة أسيوط.
[٢] معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقى – الجيزة – مصر.

الملخص

يعتبر أبي دقيق الكرنب (L) *Pieris rapae* من اهم الأفات الحشرية التي تهاجم العائلة الصليبية خاصة الكرنب. الهدف الأساسي من هذا البحث هو مقارنة قدرة بعض المركبات الكيميائية والبدائل الأمنة للمبيدات علي خفض مجاميع هذة الأفة في الحقل. أخذ في الأعتبار أيضا قياس قدرة هذه المركبات علي خفض نسبة الأصابة بالأفة و خفض نسبة النباتات التالفة أو غير الصالحة للبيع. سجلت يرقات الأفة أقل تعداد لها بعد ١٤ يوم من الرش (حول قيمة الحد الأقتصادي الحرج) بعد تطبيق جميع المركبات المختبرة. أظهرت النتائج أن مركب الأيمامكتين بنزوات سجل أعلي نسب في خفض القياسات التي سبق ذكرها علي مدار عامي الدراسة (٩٣,٢٩% في أعداد الأفة و ٥٢,١٣% في نسبة الأصابة بالأفة و ٣٦,٠٤% في نسبة النباتات غير الصالحة للبيع). تلاه المركبات حديثة الأستخدام (كارات زيون و أيفيور). أما المركبين ميلودي و سبينوساد فقد ظهرت كأقل المركبات مقدرة علي خفض أتجاه مجاميع أبي دقيق الكرنب. بصفة عامة فان أستخدام مركب الأيمامكتين بنزوات بمعدل ٨ جم/١٠٠لتر ماء كان الأكثر تاثيرا علي أعداد يرقات أبي دقيق الكرنب و ترتب علي ذلك الحصول علي زيادة النباتات السليمة و الصالحة للبيع بنسبة ٣٦,٠٤ % عند تطبيقة بمعدل رشة واحدة في الموسم. و بذلك يمكن التوصية بأستخدام مركبات أيمامكتين بنزوات و كارات زيون و أيفيور في برامج المكافحة المتكاملة لمكافحة أبي دقيق الكرنب.

الكلمات الدالة: *أبي دقيق الكرنب، المركبات الكيميائية و البدائل الأمنة للمبيدات*