Alexandria University
Faculty of Agriculture (Saba-Basha)

New approaches for controlling certain insect-pests of potatoes at Nobaria region

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مقدمة من

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Table (19): Economics and profits of the used compounds compared with the control against *Ph. operculella* in 2016 season.

Treatments	No.of insecticidal applications	Potato yields (metric ton/feddan)	Gross monetary return/feddan (L.E) (a)*	Insecticide costs/feddan (L.E) (b)	Constant service costs (c)	Total costs of control /feddan (L.E) (d)	Net returns/feddan(L.E) (e)	Additional return over untreated control (L.E) (f)	Profit one pound investment (L.E) (g)
Dipel DF®	2	17.06	38306	300	22000	22300	16006	7134.8	0.32
Careprotector®	2	15.6	35256	360	22000	22360	12896	4084.8	0.18
Hocky®	2	19.250	43895	175	22000	22175	21720	12723.8	0.57
Azadrachtin®	2	18.4	41272	280	22000	22280	18992	10100.8	0.45
Regurone®	2	18.4	41069.2	240	22000	22240	18829.2	9898	0.45
Radiant®	2	18.810	42187.7	230	22000	22230	19957.7	11016.5	0.50
Control	0.00	14.4	31171.2	0.00	22000	22000	9171.2	0.00	0.00

(a)Worked out at 220 dolar pound L.E (2728) for expertation at L.E (700) for the local market.
(b)Worked out at L.E 300,360, 175,280,240 and 230 for Dipel DF, Careprotector, Hocky ,Rogurone ,and Azadrachtin, respectively.
(c) Worked out at L.E 22000/fed.
(d) Total costs of control = insecticide price + constant service control/fed.
(e) Net return /feddan=Gross monetary return/feddan – Total costs of control / feddan.
(f) Additional return= treatment return-control return.
(g) Profit for one Egyptian pound= Additional return ÷ Total costs of control.

SUMMARY

Potato is ahighly nutritious food which provides us with carbohydrates, proteins, minerals, vitamins (C & B) and high quality of dietary fibers. Potato is the fifth most economically important crop in the world. Egypt produces 2.6 million metric tons of potatoes and exports 411.000 metric tons to Europe and some Arab countries. Potato crop is subjected to be attacked with many insect-pest species, in particular the potato tuber moth *Phthorimaea operculella* (Zeller), thrips, whiteflies, armyworm, cabbage looper, spotted cutworm and the wireworm. The main economic insects attacking potatoes have a long history of developing resistance to insecticides. Recently, several programs for pest control have been developed, including the use of coarse or/and fine dusts, essential oils of natural plant origin, resistant potato strains.

In the present field trials were conducted to survey the main prevailing insect-pests and /or beneficial ones on potato plants at El-Nobaria, district, El-Behiera Governorate, Egypt during the elapsing period from December 2014 up to April 2016.

Therefore, the main objectives of the present conducted study are the following:

1. Survey the main insect-pests of potato plant leaves and tubers throughout the elapsed period from December 2014 up to 2016,
2. studying the impact and effectiveness of certain chemical-and bio-pesticides against the common abundant insect- pests on potato plants.
3. Determination of the efficacy of different performed treatments on the rate of tubers infestion and potato yield,
4. Determination of the residues of applied insecticides in potato tubers.
5. Evaluation of the efficiency of Dipel DF, tested fine dusts of natural plants and talc powder on the calculated reduction percentages of infested Potato tubers by the tuber moth *(Phthrorimaea operculella*).

6. Studying the Economics and profits of the tested insecticides to control the potato tuber moth

The obtained results can be summarized as follows:

1-Survey of the prevailing insects on the growing Potato Plants *Solanum tuberosum L.* (Solanaceae)

It was found that Potato plants are mainly attacked by a large number of insect pests such as *Myzus persicae* (Sulzer), *Aphis craccivora* Koch, *Aphis gossypii* Glover, *Trichoplusia ni* (Hübner), *Liriomyza trifolii* (Burgess), *Phthrorimaea operculella* (Zeller), *Thrips tabaci* Lind, and *Empoasca lybica* Beg. Besides, numerous species of Natural Enemies particularly, *Chrysoperla Carnea* (Stephens), *Paederus alfierii* Koch, *Syrphus corolla* Fabricius and *Coccinella undecimpunctata* Linnaeus.

1.1- The first winter season, of 2014-2015:

- The mean calculated number of the counted individuals of *Myzus persicae* (Sulzer)/15 plants was gradually increased from the 8th of December (5.8) up to the 28th of December (11.8).
- The calculated mean numbers of *Aphis craccivora* Koch and *Aphis gossypii* Glover /15 plants were low or negligible all over the winter growing season.
- The number of larvae of *Trichoplusia ni* (Hübner) /15 plants was very low all over the inspection periods of winter growing season.
- The highest mean number of the inspected individuals of *Liriomyza trifolii* (Burgess)/15 plants reached (6.0±1.6) on the 27th of January.
- The main potato insect-pest *Phthrorimaea operculella* appeared in low numbers during the periods of this winter season.

- The inspected individuals of each of the prevailed predatory insects: *Chrysoperla Carnea* (Stephens), *Paederus alfierii* Koch, *Syrphus corolla* Fabricius and *Coccinella undecimpunctata* Linnaeus on potato plants were ratherly low or /and absent all over the adopted inspection periods of the winter season.
- Statistical analysis showed highly significant differences between the inspection periods and the rates of detected insects all over the 1st winter season.

1.2 - The first summer season, of 2015:

- The calculated mean number of *M. persicae* was gradually increased from 1.4 up to 2.2 on the 1st half of April. It was absent during the rest of the season.
- *A. craccivora* was absent all over the inspection periods of summer season.
- The maximum numbers of *A. gossypii* /15 plants were recorded on the 7th and 17th of April (8 and 5.8, respectively) , then disappeared until the end of the season.
- The mean number of *Trichoplusia ni* /15 plants was very low all over the inspection periods of the summer growing season.
- The maximum number of *L. trifolii*/15 plants was recorded on the 18th of March (2.4), while it was low or negligible all over the summer growing season.
- The calculated mean number of *Ph. operculella* was gradually increased from the 2nd week up to the end of April (8.6, 11.6, and 19.6 larvae /15 plants).
- The number of *Thrips tabaci* Lind was increased on the 7th and the 27th of April (6.8 and 7 /15 plants) respectively.
- The inspected individuals of *Empoasca lybica* Beg were almost absent during the summer season then appeared at the end of April and begining of May (0.4±0.24 and 0.6±0.40, respectively). Statistical analysis showed the positive relationship

between the detected jassid and temperature versus the negative one for prevailing humidity condition.

- The calculated mean numbers of inspected predators *C. carnea***,** *P. alfierii*, *S. corolla* and *C.undecimpunctata* / 15 plants were low or nill all over the period 1st summer growing season.
- Statistical analysis showed that there were significant differences between the inspection periods and the rates of detected insects all over the inspection periods of 1st summer season.

1.3- In the second winter season, of (2015-2016)

- The mean number of *M. persicae* /15plants was high in the 11th of December and the 20th of January (31& 24.8, respectively). Statistical analysis showed a positive weak relationship between the inspected individuals of *M. persicae* and temperature while it was negatively weak relationship with the relative humidity.
- The maximum number of *A. craccivora* /15 plants was noticed on the 21st and the 31st of December (12.8 and 10.8, respectively). Also, a positive weak relationship between the counted number of *A. craccivora* and the prevailing temperatures and relative humidity condition was detected.
- Infestation of *A. gossypii* increased on the 20th of January and amounted to 6.6 individual /15 plants.
- The mean number of *Trichoplusia ni* /15 plants was very low or negligible all over the inspection periods of the growing season.
- The numbers of *L.trifolii* and *Ph.operculella* /15 plants were increased on the 30th January of 2016 and comprised a mean value of 5.6 for both insect-pests .

- The mean numbers of the counted predatory individuals of *C. carnea P.alfierii, S. corolla* and *C.undecimpunctata* / 15 plants were low or negligible all over the inspection periods of the season.

1.4- In the second summer season, of 2016:

- The mean number of the counted individuals of *M. persicae* was very low or negligible then slightly increased at the end of April (0.6)⁄15 plants.
- *A. craccivora* and *A. gossypii* were completely absent all over the inspection periods of the 2nd summer season.
- The mean number of counted individuals of *T. ni* /15 plants was very low all over the inspection periods of the growing season. Statistical analysis showed a positive relationship between the prevailing temperature and the number of *T. ni* while it was negatively weak with R.H. % .
- The mean number of *L .trifolii*/15 plants increased from (1 /15plants) on1st of April (2.8 and 4.6) on the 11th and 21th of April.
- The number of *Ph. operculella* /15 plants gradually decreased on the 12th and 22th of March (4 and 3.4) then increased during the 1st up to the end of April (7.4, 6, and 8).
- The number of the counted individuals of *T. tabaci* /15 plants was greatly decreased on the 12th of March and the 21th of April (0.0, 0.4, respectively).
- The counted number of *E. lybica* was low or negligible all over most of inspection periods of the 2nd summer season. Alespite the maximum number of its counted individuals /15plants occurred on the 11 of April (6.2).
- The maximum mean number of the counted individuals of *C.carnea* /15 plants was detected on the 11 of April (1.4).

- Each of the inspected predators of *P. alfierii*, *S. corolla* and *C. undecimpunctata* were negligible found all over the whole inspection periods of 2nd summer season.

2-Survey of insects infesting the Potato tuber

The comparatively lower mean number of infested tubers by mole cricket *G. Grylotalba* /100 tubers in the 1st Summer season of 2015 (2.6) was increased in1st winter Season of 2015 and the 2nd Summer season of 2016 up to (4.6 and 4.6) respectively. The mean number of infested tubers of *Ph. operculella* /100 tubers was, more or less increased during the 1st Summer Season of 2015 (5.4) and 2nd Summer Season of 2016(6.2), while decreased during the 1st and 2nd winter Seasons of 2015 (4.8 & 0.4, respectively).

The higher mean number of infested tubers by White grub *Penitodon bispinosus* /100 tubers was recorded throughout the 2nd Summer Season of 2016 (5.2), followed by a lowered mean number of (3.2) in the 1st Summer Season of 2015, while was greatly decreased during the 1st and 2nd winter Seasons of 2015&2016 up to (2).

3-Effect of evaluated pesticides against the potato tuber moth *Phthrorimaea operculella* and the leafminer, *Liriomyza trifolii* on the leaves of potato plants.

The efficacy of each of the following tested insecticides: Chloropyrifos methyl(Houky®)**,***Bacillus thuringiensis* (Dipel DF®),*Beauveria bassiana*(careprotector®),Azadirachtin (Achook®), (Lufenuron (Regurone ®) and Spinetoram (Radiant ®)was evaluated on the growing potato plants under field conditions.

3.1 Efficacy of tested insecticides during summer cultivation of season 2015 against the potato tuber moth *Ph. Operculella*.

From the recorded and statistically analyzed data it could be concluded that the superior efficient toxic effect of tested chemical compounds was revealed for Houky after the 1st &2nd sprays resembled by a general mean of reduction 32.36% & 46.73%, respectively, followed by the 2nd ranked compound azadirachtin (28.21% &38.52%) respectively. Regurone indicated more efficient control against the insect after the 2nd spray with a general mean of reduction comprised (35.79%), compared to that calculated general mean of reduction after the 1st one (12.44%). Careprotector showed improved efficiency after the 2nd spray amounted to (28.44%) as a general mean of reduction, versus itscalculated negligible mean of reduction (-43.83%) after the 1st one, while, Dipel to a less extent showed more toxic efficiency against the insect after the 2nd spray (23.01%),compared to (18.60%) after the 1st one.

3.2 Efficacy of tested insecticides during summer cultivation of the season 2016 against the potato tuber moth *Ph. Operculella*.

The superior efficient toxic effect of tested chemical compounds was revealed for Radiant after both of the performed 1st &2nd sprays; resembled by general means of reduction amounted to 67.67%&73.72%, respectively. It was followed by the 2nd ranked compound (Houky 58.86% & 52.69%, respectively), then the 3rd ranked one Reguron (53.91% &34.04%, respectively). In this concern, Dipel and Careprotector indicated a more or a less efficient control against the insect after the 1st spray with a general mean of reduction comprised (49.63%) and (20.72%), compared to their negligible expressed efficiency by the calculated general means of reduction after the 2nd one (-87.77%) and (-6.99%), respectively. Also, Azadirachtin showed a more lowered efficiency after the1st &2nd sprays amounted to (25.90%) and (11.76%) as general means of reduction.

3.3 Efficacy of tested insecticides during summer cultivation of the season 2016 against the leafminer, *L. trifolii*.

The superior efficient toxic effect of tested chemical compounds was revealed for Radiant after the 1st &2nd sprays; resembled by a general means of reduction comprising 64.26% & 41.92%, respectively, followed by the 2nd ranked compound Houky (51.38% & 28.94% , respectively), then the 3rd ranked compound Regurone (50.37% &19.25%, respectively). Dipel indicated less efficient control against the insect after the 1st spray with a general mean of reduction comprised (8.06%), compared to that calculated least general mean of reduction after the 2nd one (0.095%). Azadirachtin showed a merely toxic effect in reducing the infestation of assigned insect-pest after the 1st &2nd sprays (5.21%& 6.65%, respectively), while careprotector showed improved efficiency after the 2nd spray amounted to (9.02%) as ageneral mean of reduction, versus that calculated negligible mean of reduction (-68.53%) after the 1st one .

4. Effect of different performed treatments on the rate of tubers infestation and yield of potato plants:

4.1 Season of 2015

The least determined insignificant average number of larvae/100 potato tubers was attained by Houky and/or Careprotector (2 larvae/100 tubers) compared to the untreated control (4.3 larvae/100 tubers), Also, the estimated yield of potato crop post application of these tested compounds was significantly higher (20.13 ton/fed.) for Houky, compared to (11.81 ton/fed.) for the untreated control.

4.2 Season of 2016

The insignificant estimated average No. of larvae /100 tubers was the least in case of Radiant 1.33 and /or Regurone 1.67 larvae/100 tuber, compared to that detected higher average number. Of 4.33 larvae /100 tuber in the untreated control. Also, the measured yield of potato crop after the performance of these tested compounds was significantly higher than that of the untreated control treatment in case of Houky 19.25 and Radiant 18.81 ton/fed. respectively.

5. Efficiency of evaluated Dipel DF, fine dusts of natural plants and talc powder on:

5.1. The calculated reduction percentages of inspected mines in the infested Potato tubers by larvae of *Ph. operculella*.

After periodic interval of 21 days and 28 days post treatment, the tested fine dusts of each of *Eucalyptus globulus* and *Lantana camara* ranked the 1^{st} order in reducing the infestation of potato tubers by the larvae of tuber moth, giving a reduction percentage of 100. Vice versa, Dipel DF® and Talc powder gave distinctly unefficient control of the insect represented by the negligible reduction percentages of -50 and 0.00 respectively.

After the 35^{th} day of treatment, *Eucalyptus globulus* and *Schinus terebinthifolius* ranked the 1^{st} order in reducing the tubers infestation by the larvae of these insect-pest, with reduction percentage of 66.67%. After the 42^{nd}, 49^{th} and 56^{th} day of treatment treatment with *Schinus terebinthifolius* ranked the 1^{st} order in reducing the tubers infestation, with a reduction percentage of 85.71, 92.31 and 93.33, respectively, compared to the tubers of untreated controls.

5.2. The calculated reduction percentages of infested Potato tubers by the larvae of tuber moth *(Phthrorimaea operculella*).

The obtained results proved that the tested fine dust of *Schinus terebinthifolius* was the utmost superior one in preventing the incidence of potato tubers infestation

by the tuber moth *Ph. operculella* , followed by the secondly ranked fine dusts of *Eucalyptus globulus* and *Lantana camara*, while each of tested fine dusts of Dipel DF® and/or Talc powder, were comparatively the least efficient in protecting the potato tubers from the infestation of potato tuber moth *Ph. operculella*.

6. Determination of the insecticides residues in potato tubers

The harvested potato tubers that have been treated with **Radiant** didn't show any detected residues. However, the treatment with **Houky** resulted in residue values of 0.01 ppm, which was in the margin of its MRL_s (0.01 mg/Kg)

7. Economics and profits of the tested insecticides in controlling the potato tuber moth during the following seasons of 2015& 2016.

7.1. In the first season of 2015

The net returns, values were 15299.6, 13760.8, 12638.8, 14575.8, 13692.4 and 1391.1 L.E/fed for the treatmental application of chloropyrifos methyl, Dipel DF, Careprotector, azadirachtin, Regurone and control, successively.

The profits for one Egyptian pound (L.E) investment were .0.72, 0.64, 0.57, 0.68 and 0.64 for the treatments of chloropyrifos methyl, Dipel DF, Careprotector, azadirachtin and Regurone, respectively.

In the light of the profits data, it could be concluded that the higher value is considered to be the utmost profitable treatment. However, depending upon the investment profits, the used chemicals could be arranged in a descending order as follows: chloropyrifos methyl > azadirachtin > Regurone >. Dipel DF > Careprotector.

7.2. In the second season of 2016

The net returns, values were in 21720, 16006, 12896, 18992, 18829.2, 19957.7 and 9171.2 L. E/fed for the treatments of chloropyrifos methyl, Dipel DF, Careprotector, azadirachtin, Regurone, Radiant and control, successively.

The profits for one Egyptian pound (L.E) investment were 0.57, 0.32, 0.18, 0.45, 0.45 and 0.50 for chloropyrifos methyl, Dipel DF, Careprotector, azadirachtin, Regurone and Radiant.

Although, chloropyrifos methyl achieved the greatest production of potatoes, the author is under the impression of using other Radiant insecticide as the desirable

compound, which characterized by high efficacy without detectable residue levels in potato tubers, with no significant statistical differences in production as compared with the use of chloropyrifos methyl.

Recommendation

Potato crop is one of the utmost nutritious vegetable crops in numerous countries of our world. It is attacked by plenty of insect -pests that reduce its productivity and marketing value. Therefore, in the lights of our performed field study, it could be recommend the following technical agricultural practices for the integrated crop management of potato plants: -

1- Choose the healthy tubers from a reliable source
2- Conduct adequate practices and follow appropriate rates and times of fertilization and irrigation.
3- Determine the suitable planting time in summer season to avoid the probable severe and injurious infestation of the fragile sucking insect-pests and utmostly dangerous potato tuber moth *(Phthrorimaea operculella)* which severely infest & damage the foliage and tubers of potato plants.
4- Good follow-up of the growing plants of the crop and removal of fewer separately infested plants. If the infection reaches the economic threshold, it is recommended to use high efficient active biocides, in particular Radiant®. Radiant® insecticide as the desirable compound, which characterized by high efficacy without detectable residue levels in potato tubers.
5- As for the tubers storage; it is advised to operate dusting with Brazilian pepper *(Schinus terebinthifolius*) fine powder to avoid and prevent probable occurrence of potato tuber moth *Ph. Operculella* infestation throughout this period prior the consequent seasonal cultivation of the plants.

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