GREEN SCALE, *COCCUS VIRIDIS* (GREEN)

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Since green scale was introduced to Taiwan it has done considerable damage to coffee, citrus, Gardenia, etc. It not only weakens the hosts but also induces sooty mould owing to its secretion of honeydew, It also interrupts the photosynthesis of infested plants as well as attracts ants to refuce the parasitic wasp population of both green scale and other citrus insects.

Resin soda wash was fully recognized of its effectiveness control this scale by citrus growers before introducing new insecticides such as summer oil and malathion. The present paper deals with the morphology, life history, natural enemies and chemical control, The writers wish to express their sincere thanks to Dr. T. W. Liu, Head of Plant Industry Division of Joint Commission on Rural Reconstruction and Dr. S. C. Hsu, Director of Taiwan Agricultural Research Institute whose encouragement was made this study possible.

Common name: Green Scale, Green coffee scale, Soft green scale, Green bug.

Synonyms: *Lecanium viridis* Green, *Lecanium colemani* Kuwana, *Trechocoris hesperidum africanum* Newst.

Distribution: Original home of this species may be South America, It was brought to other tropical regions through its hosts. According to the present record, it has distributed between the North and South 25° of latitude, with the exception of Florida and Sicilia. The recorded places are as follows.

Southeastern Asia: Bougainville Is., Burma, India, Indo-China, Java, Malaya, New Guenia, Philippines, Sumatra, Taiwan and Thailand.

Indian Ocean: Ceylan, Madagasca Is., Mauritius Is., Reunion Is. and Seychelles Is.。

Pacific Ocean: Hawaii, Mariana Is., Palau Is. and Samoa Is.。

Africa: Belgian Congo, Eritrea, Kenya, Northern Rhodesa, Tanganyika and Uganda.

Europe: Sicilia.

South America: Bolivia, Brazil, Colombia, Guiana and Venezuela.

Central America and West Indies: Antigua, Bahama Isls., Barbados, Costa Rica, Cuba, Grenada Is., Guana Is., Guatemala, Guiana, Haiti, Jamaica, Mexico, Montserrat, Nevis, Puerto Rico Is., Salvador, St Vincent, Trininad and Virgin Isls.,

North America: Florida.

Hosts: Apocynaceae: *Carissa carandas*, *Plumiera acutifolia*; Caprifoliaceae: *Viburnum* sp; Myrtaceae: *Eugenia* sp., *Psidium guajava*; Rubiaceae: *Coffea arabica*, *Gardenia florida*, *Gardenia grandiflora*, *Genipa americana*, *Ixora chineneis*; Rutaceae: *Aegle marmelos*, *Citrus* spp., *Clausena lunulata*: Sapotaceae; *Achras zapota*, *Sideroxylon ferrugineum*; Sterculiaceae: *Heritiera littoralis*.

Morphology

Egg: Polished, pale-green, oval, about 0.25 mm. X 0.15 mm.

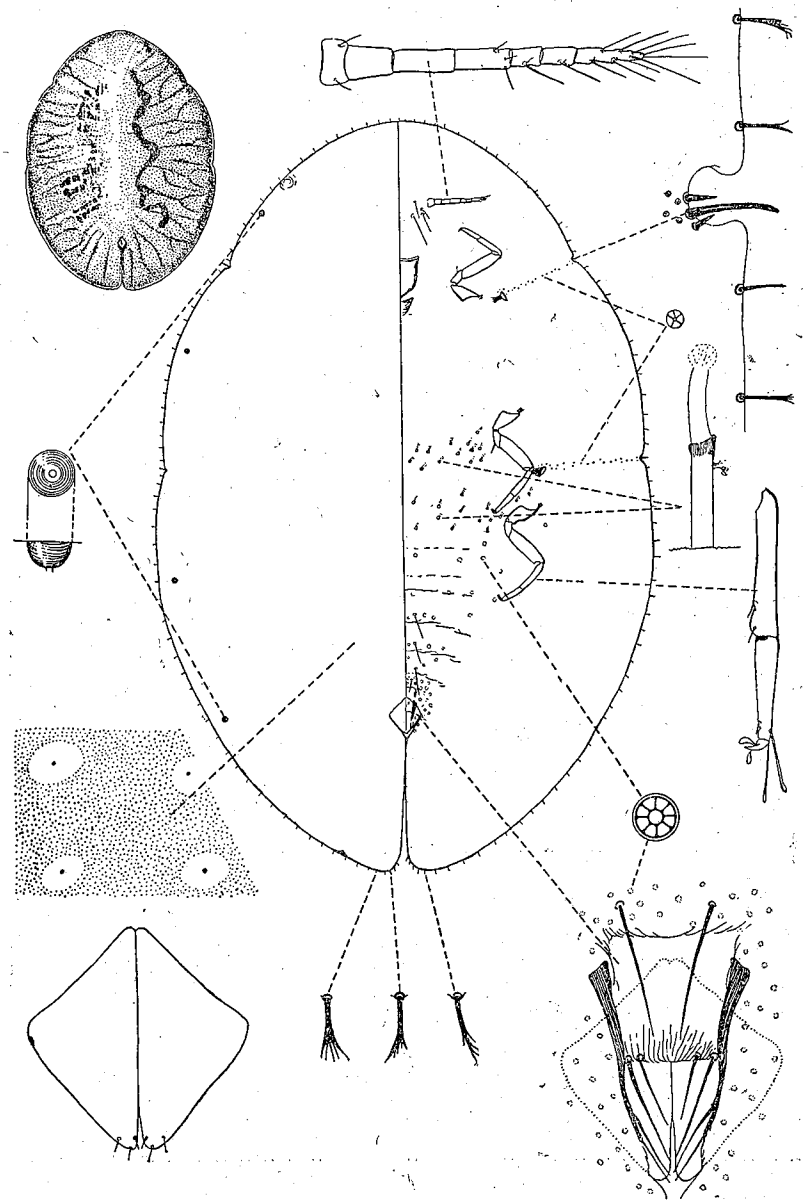


Fig. 1. Green scale *Coccus viridis*(Green) (After Ferris, 1948)

First instar: After hatching, body pale yellowish green, when settling on the feeding part, turns pale green, body flat, anal cleft visible, body length 0.3-0.4 mm.

Second instar: Body pale green, body length 0.7-0.85 mm.

Adult: (fig. 1) When matured, the blackish brown narrow marks are formed in the Malpigian tube, with skin transparent, body contents green, body length 2-2.8 mm.

Body: Bright, pale green, oval, very flat. Derm membranous at full maturity, or at most with a faint sclerotization that appears in well-stained specimens. Such specimens derm is very sparsely areolated with each areolation characterised by a minute median pore of indetermination. Marginal setae is extremely small in various shapes, some simple but mostly slightly fimbriate at apex. Anal plates almost quadrate, apical setae extremely minute, ventral fold with but four fringe setae. On ventral side, about area below anal plates and vulva, are numbers of multilocular pores, and a few such pores as far as posterior coxae. In median area between middle and posterior coxae are a few tubular ducts. Antennae are well developed, slender, normally seven-segmented. Legs are well developed, presenting on unusual charactersitics.

The very minute apically fimbriate marginal setae, combined with presence of multilocular pores as far as posterior coxae, and presence of tubular ducts in median area between middle and posterior coxae seem to be distinctive of the species.

Comparision of related species infesting on Citrus

Other related species: Besides *Coccus viridis* (Green) there are three species infesting citrus namely *C. elongatus* (Signoret), *C. hesperidum* Linnaeus, and C. *kuraruensis* Takahashi. They may be separated by the following key.

Key to species of *Coccus* infesting citrus in Formosa

1. Anal plates noticeably elongated, anterolateral margion of each plate at least twice as long as postero-lateral margin, with outer angle near posterior apex. ..... *kuraruensis* Takahashi
   This species may be the synonym of *Coccus mangiferae* (Green)
   Anal plates together present an approximately quadrate shape, postero-lateral margin of each plate usually slightly longer than antero-lateral margin. ...2
2. An elongate-oval species; anal region normally with six to eight fringe setae on fold leading into anal tube (beneath anal plates); each anal plate with a "discal seta" (this is situated toward apex, and is associated with three other similar dorsal setae on apical angle; antennae normally eight segmented. ....*elongatus* (Signoret)
   Common name: long brown scale; Synonyms *Coccus celticum* Kuwana, *Coccus frontale* Green, *Lecanium acaciae* Newst., *Lecanium wistariae* Brain, *Lecanium*

kraunhiarum Lindinger.

Broad ovoid species; anal region normally with only four fringe setae on fold leading into anal tube; anal plates with "discal setae"; antennae normally seven segmented. ……3

3. Ventral multilocular disc pores restricted to a cluster about the base of anal cleft, below anal plates, and a few may be present on abdominal segments immediately anterior to these; tubular ducts entirely lacking; marginal setae elongate, entire or only slightly cleft or fimbriate apically.…… …… *hesperidum* Linnaeus

Common name: Soft brown scale; Synonyms: *Calypicus hesperidum*(Linnaeus), *Lecanium punctuliferum* Green, *Lecanium mauritiensis* Mamet.

Ventral multilocular disc pores, although few and often difficult to locate, present in midregion of abdominal venter as far forward as thorax; tubular ducts present in midregion of thoracic venter; marginal setae small, short, broad and strong fimbriate.…… *viridis* (Green)

The above mentioned four citrus infesting Coccus have the same generic characteristics that remain flat or become but slighly convex at full maturity and that they form no ovisac or other evident waxy secretion. Antennae and legs are usually well developed. Tibiotarsal articulation not free, or but slighly so. Tubular ducts on ventral side of the body either absent or present in small number, never arranged in a distinct, submarginal zone.

Life history

One generation takes 50–70 days in summer and 80–100 days in winter, 4–5 generations a year. 20–46 days after maturation of the adult before it begins to lay eggs, oviposition period takes 10–28 days and about 100 eggs are laid, incubation period one day.

From egg to adult takes 25–40 days in summer and 40–60 days in winter.

It infests on the tender foliages like green twigs and young leaves. Old leaves are comparatively fewer and take more days to complete their life history. Adults and nymphs infest both upper and lower sides of leaves as well as in favour of the main vein especially on the basal halves.

Natural enemies

There are three species of parasitic wasps attacking *Coccus viridis* Green namely: *Aneristes ceroplastes* Howard, *Coccophagus tibialis* Compere, and *Microterys speciosus* Ishii. The morphology of each species may be outlined in below.

1. *Aneristes ceroplastes* Howard, (fig. 2) Mesoscutum black or dark brown without the marginal vein and extending convexly outward a short distance beyond the stigma. Tibiae of middle legs more or less extensively yellowish or whitish apically, First funicle joint plainly longer than wide. Distribution: Ceylon, West Indies, Australia, India, China mainland, Hawaii, Philippine Isla-

nds, Virgin Islands, Panama. Other hosts in Taiwan: *Pulvinaria polygonata* Cockerell, *Coccus elongatus* Signoret, *C. hesperidum* Linnaeus, *Saissetia hemisphaerica* Targion. The generic characters is in having strong setae at the base of the middle tibiae and the scape of antennae is not widened and the funicle is more or less compresced.

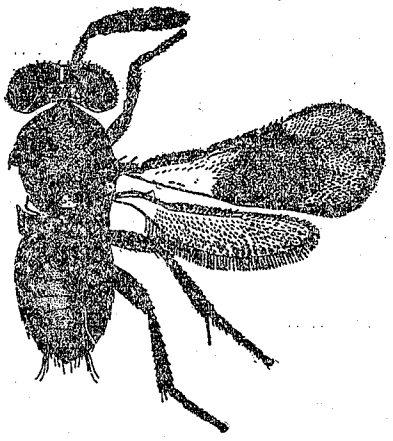


Fig 2. *Aneristus ceroplastae* Howard Female (After Compere. 1936)

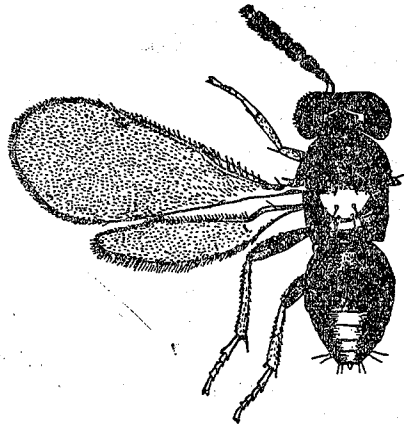


Fig 3. *Coccophagus tibialis* Compere (After Ishii 1923)

2. *Coccophagus tibialis* Compere, (fig. 3) General color of female black; scutellum and median piece of metanotum bright lemon yellow except that the anterior margin of the former may be very narrowly black, Coxae, trochanters, and femora of all legs black or dark brown except that the femora of the fore and middle legs are paler at the apices and the middle pair have a faint annulus at base. Fore tibiae mostly brown, pale at apices. Forewings hyaline; cilia fine and dense; the posterior basal hairless streak bent upward at its distal end. Marginal vein slightly longer than the submarginal. Ovipositor as seen through the derm arises near the middle of abdomen. Sculpture and vestiture similar to *C. lecanii* (Fitch). Male body entirely black. Face in proximity to mouth and the scape and pedical brownish; flagellum dark due to blackish sensoria. Except the tarsi, all legs are entirely dark brown to blackish. Tarsi brownish yellow except the apical joints, which are fuscous. Other host in Philippine is *Saissetia hemisphaerica* (Targioni)

3. *Microterys speciosus* Ishii (fig.4) Head finely scaly, reticulate. Eyes dark chocolate, almost bare; antennal scape yellowish, moderately dilated below, as wide as one-third its length; pedical yellowish brown, except the lower half yellowish, about three-tenths the length of the scape; funicle joints yellowish brown except the last three, which are whitish, the upper part of the first three funicle joints brownish, funicular joints gradually increasing in width and decrea-

sing in length distad, the first joint one and a half times the length of the pedical, slightly narrower than the latter, and cylindrical in form; club wider than the last funicle joint, and slightly shorter than the last three combined, the bristles of the first three funicle joints long and strong, while those of the last three are fine and whitish. Mandibles yellowish brown, and brownish at the tip, subequally tridentate, Thorex a little wider and slightly longer than abdomen. Pronotum, mesoscutum, axillae and scutellum finely, scaly reticulate; mesopleurae longitudinally, finely striate reticulate。 Metanotum transversely

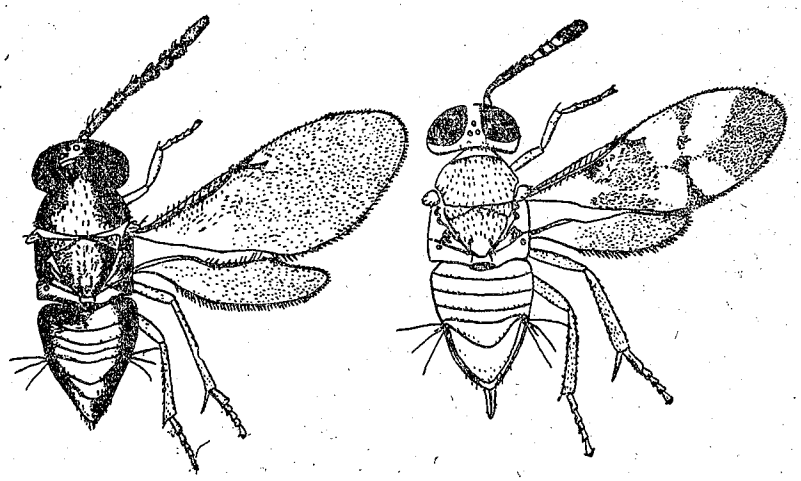
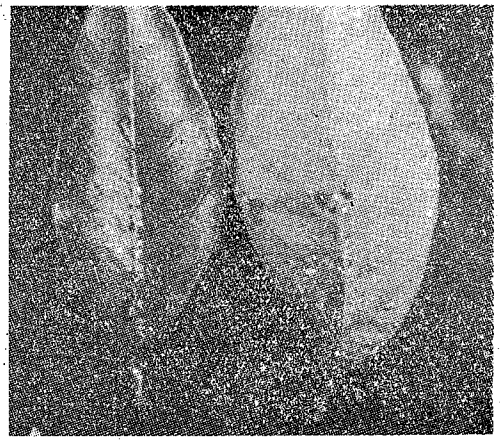


Fig. 4. *Microterys speciosus* Ishii (After Ishii, 1923 left male, right female)

striate; propodeum rather smooth; tegulae scaly reticulate, Fore wings hyaline with three pale fuscous bands, the first very broad, beneath the marginal and stigmal veins the second narrow and irreguarly interrupted, and the third at the apex, extending medially towards the second band, Marginal vein brown, and the submarginal, stigmal, and postmarginal veins pale brown. submarginal vein with about 17 bristles. Abdomen brownish, finely, scaly reticulate, and each segment with 4 or 5 short bristles in a transverse row on each side. Ovipositor yellowish exterted about one-fifth the length of the abdomen. Body Length 1.8 mm.

Stricting difference between male and female, as shown in the accompanying figure. Other host in Japan is *Ceroplastes rubens* Maskell.



Fig, 5. Citrus leaf infested with green scale

Chemicai control

The Chemical control test was carried out at Taiwan Agricultural Research Institute and National Taiwan University. The host is *Gardenia* sp. It was sprayed on December 7, 1962 and examined on December, 14, 21, 28, 1962 and January 4, 1963 respectively. Chemical names and percentage of active ingredients are listed in Table I.

After 1, 2, 3, and 4 weeks of spraying of the insecticides, 5 leaves of each treatment were picked at random and examined under binocular. When examination, both upper and lower surfaces of leaves were separated for counting, color of adult and nymph changed into brown and body of adult shrinked seem to be dead. The parasites were not included in counting。Unfortunately, the dead scales had been fallen due to shrinkage of the body since the chemicals applied were not counted too, because the chance of each treatment might be same。The influence of chemical treatments on parasitic wasp is also considered. It is shown in Table III. Color of pupa of the parasitic wasp is fresh with fluid contents as alive, otherwise it is dead.

Table I: Results of the Chemical Treatment on the Nymph of Green Scale

Treatment	Dec. 14, 1962		Dec. 21,		Dec. 28,		Jan. 4, 1963		Average
	No. of Obser.	Mortality	No. of Obser.	Mortality	No. of Obser.	Mortality	No. of Obser.	Mortalaty	
Dimethoate 0.05%	5469	81.68	4408	94.69	4274	93.58	2581	84.31	88.41
Parathion 0.05%	3076	84.75	2718	98.56	1885	100.00	3299	99.75	95.76
Gusathion 0.05%	2541	80.01	3810	88.32	2842	99.57	2617	99.15	91.76
Sumithion 0.05%	1776	82.93	2140	97.57	1093	99.63	1164	99.22	94.84
Dibrom 0.05	1252	42.81	1326	75.94	1341	75.02	2056	79.81	68.40
Summer oil 1%	1366	67.11	879	59.19	1317	86.71	1645	93.43	76.61
Malathion 0.05%	1683	52.46	1519	92.49	3543	99.16	1495	99.93	86.01
Diazinon 0.05%	2641	74.66	2487	90.85	2695	92.75	898	98.19	86.86
Check	1392	14.29	1255	16.65	2517	14.81	1289	18.32	16.02

L. S. D. 0.05=8.01 0.01=10.85

Table II: Results of the Chemical Treatment on the Adult of Green Scale

Treatment	Dec. 14 1962		Dec. 21, 1962		Dec. 28, 1962		Jan. 4. 1963		Average
	No. of Obser.	Mortality	No. of Obser.	Mortality	No. of Obser.	Mortality	No. of Obser.	Mortality	
Dimethoate 0.05%	294	53.40	269	48.69	220	48.18	312	58.97	52.31
Parathion 0.05%	242	90.91	100	94.00	285	98.59	193	98.96	93.11
Gusathion 0.05%	91	89.01	236	92.26	103	92.29	133	92.48	91.01
Sumithion 0.05%	92	95.65	33	94.28	70	95.71	71	91.54	94.29
Dibrom 0.05%	119	84.03	94	64.89	41	60.97	79	46.83	64.18
Summer oil 1%	235	93.19	121	88.01	62	61.61	80	58.75	65.39
Malathion 0.05%	180	90.12	154	95.84	300	97.66	65	95.83	94.86
Diazinon 0.05%	108	75.00	98	67.34	91	78.02	117	69.31	72.42
Check	173	17.51	449	17.12	160	16.25	527	12.16	15.76

L. S. D. 0.05=8.16 0.01=11.04

Table III: Results of the Chemical Treatments on the Parasitic Wasps of Green Scale

Treatment	Dec. 14, 1962		Dec. 21 1962		Dec. 28, 1962		Jan. 4. 1963		Average
	No. of Obser.	Mortality	No. of Obser.	Mortality	No. of Obser.	Mortality	No. of Obser.	Mortality	
Dimethoate 0.05%	64	29.51	59	30.76	27	75.00	20	60.00	48.82
Parathion 0.05%	42	66.67	24	69.45	28	86.00	28	84.00	76.53
Gusathion 0.05%	32	40.00	42	48.11	20	60.00	35	63.68	52.95
Sumithion 0.05%	53	44.89	115	36.73	44	67.56	29	62.31	52.87
Dibrom 0.05%	88	62.98	84	80.37	68	85.45	78	66.19	73.75
Summer oil 1%	100	45.02	74	36.08	72	38.00	37	34.61	35.93
Malathion 0.05%	91	36.12	156	36.06	369	52.04	36	68.88	48.28
Diazinon 0.05%	94	34.62	107	49.23	82	66.67	26	83.33	58.46
Check	107	2.23	140	8.23	171	16.89	120	15.00	10.58

L. S. D. 0.05=9.69 0.01=13.12

According to table I. it shows that mortality of nymph of green scale dibrom 0.05% is lower than other chemicals. The remaining chemicals are effective especially parathion, sumithion, gusathion and malathion. Diazinon, summer oil, and dimethoate are less effective. Mortality of these chemicals is the highest untill the third week after spraying.

Mortality of adult of green scale, parathion gusathion, sumithion, malathion is higher than other chemicals. Dimethoate is not so good as to control other groups of scale insects infesting citrus.

Above tested chemicals are very harmful to parasitic wasps, especially parathion. To insure safety for operator, natural enemies, and control efficacy, malathion is the first choice for recommendation to control this pest as we recommended before, The result was the same as obtained in Brazil.

Summary

The green scale, *Coccus viridis* (Green) had distribued over this island, it infested Citrus especially nonbearing fruit trees were very badly. The characteristics of this species and its genus as well as its differences among other species belonging to the same genus that infesting Citrus is also separated in the key.

It takes 4-5 generations a year. 50-70 days in summer and 80-100 days in winter to complete one generation. The gravid period is 20-46 days, oviposition period 10-28 days and about 100 eggs are laid. The male is still unkown.

There are 3 species of parasitic wasps, namely: *Aneristes ceroplastes* Howard, *Coccophagus tibialis* Compere and *Microterys speciosus* Ishii all of them were endoparasitic. The characheristics of each species have been briefly noted. The percentage of parasitism during the winter of 1962 of *Coccophagus tibialis* was 27.76%.

0.05% Active ingredient of dimethoate, parathion, gusathion, sumithion, malathion, diazinon and 1% of summer oil were tested in the field. The mortality of nymphs, adults and its parasitic wasp *Coccophagus tibialis* were recorded. Among them, parathion, gusathion, sumithion, malathion were more effective than other tested insecticides and also more harmful to its parasitic wasps.

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綠介殼蟲

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中文提要

綠介殼蟲 *Coccus viridis* (Green) 爲外來害蟲之一，現已分布全島，主害柑橘，尤以未結果之幼樹受害最重。本蟲之特徵與同屬其他爲害柑橘之三種介殼蟲之區別，有作扼要說明。

本蟲一年發生4～5代，完成一代，夏天需 50～70天，冬天需80～100天。產卵前期20～46天，產卵期10～28天，每隻雌蟲產卵量約100粒。雄蟲猶未發現。

本省已發現有三種寄生蜂爲害本蟲介殼蟲；卽*Aneristes ceroplastes* Howard, *Coccophagus tibialis* Compere, *Microterys speciosus* Ishii. 此三種均爲內寄生，其形態有作扼要說明。

有效成分0.05%之 dimethoate, parathion, gusathion, sumithion, dibrom, malathion, diazinon 及1%之夏油，曾作田間防治比較測定，記載對於其成蟲、若蟲及寄生蜂 *Coccophagus tibialis* Compere 之死亡率，發現其中以 parathion, gusathion, sumithion, malathion 較其他試驗之殺蟲劑爲更有效，但同時亦有害寄生蜂，爲顧及農民使用及天敵寄生蜂之安全與防治之效果。仍以馬拉松爲首選建議防治本蟲之良藥。