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The Use of Pheromones as Semiochemicals to Monitor the Density Number of Grape Insect Pests

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Abstract. The main aim of this applied study is to eliminate the uses of pesticides and its residues in our daily fruits.

It is the correct way to protect human and his animals, to replay the wordly screaming and to protect the natural balance in our environment to its essential origin and to activate the natural enemies.

This review article deals with three important destructive pests to grape, beginning 1988 through 1997.

The methods which are used to monitor the three major insect pests *i.e.,* (Grape root borer: polistiformis), (Rose chafer: subspinosus), and (Grape berry moth: viteana), by pheromone as semiochemicals were summarized as follow: releasing minute amount to hinder the males from finding females of grape root borer were used by 1 – Insect pheromones. We used also Shin-Etsu rope ties and phescon IC sticky traps were baited with pheromones as a disruption technique. The trapping held in determination of large population of grape root borer.

The authors began to conduct research to discover an attractant, which would reduce the amount of spray needed against rose chafer. The grower that owns the grapes where the trials were conducted spraying with chemical insecticides.

The third purpose of this study is to describe the results obtained with isomate – GBM pheromone in large scale, field trials conducted through Ohio state for control of grape berry moth to provide information on how the pheromones works by producing an invisible "cloud" of pheromone throughout vineyards. There for 200 tie dispensers per acre of vines (1 per 3 vines) or twice this rate (2 per 3 vines) *i.e.,* suggested to be use along the perimeter of the vineyard.

Introduction

Many factors acting together have heightened interest in alternatives to broadly toxic pesticides used in agriculture. The public has called for reduce pesticide residues in agricultural products. Growers must deal with increasingly complex regulations governing pesticide use: regulations focusing on pesticide related damage to the environment, especially ground water and wildlife, and exposure of farm workers. While it is recognized that the imperatives of modern agricultures and public health continue to necessitate use of conventional pesticides to prevent crops loss from pests, researchers the world over are striving to develop feasible alternatives to broadly toxic chemicals.

In most situations where environmentally-safe alternatives to conventional pesticides are available, they are implemented within the context of integrated pest management *i.e.,* (IPM) programs. These programs foster the use of pest monitoring procedures and pest density or cop injury thresholds coupled with optimization of non-chemical methods such as biological and cultural control (*e.g.,* sanitation and cultivation). Such is the case with the use of semiochemicals in vineyards to monitor major insect pests.

This is a review of the methods used in northeastern North America to use semiochemicals to monitor the three major insect pests grape root borer, rose chafer, and grape berry moth. Semiochemicals are chemicals produced by one organism that incite a response by another organism. Insect pheromones are natural occurring chemical that insects use to communicate with individuals of their own species. By releasing minute amounts (often less than one billionth of an ounce) of chemicals, very specific biological message are conveyed from the insect or plant releasing the semiochemicals products are commonly used by insects as a very efficient method of attracting mates for reproduction.

Materials and Techniques

Effective pheromones and successful techniques applied against three insect pests as follow:

1 – Grape Root Borer

Grape root borer *Vitacea polistiformis* (Sesiidae, Leppidoptera) is a clearing moth. Figure (1) indicates its life cycle *i.e.* bionomics. The adult is with the fore wing brown and the hind wings clear with brown border. The body mimic that of a wasp, brown with yellow marking. Male moths measure about 5/8 in. in length, while the female is larger, about 3/4 in. long. A fully developed caterpillar is about 1.5 in. long and white with a brown head capsule. The caterpillar stage of the borer is capable of inflicting considerable root damage. As

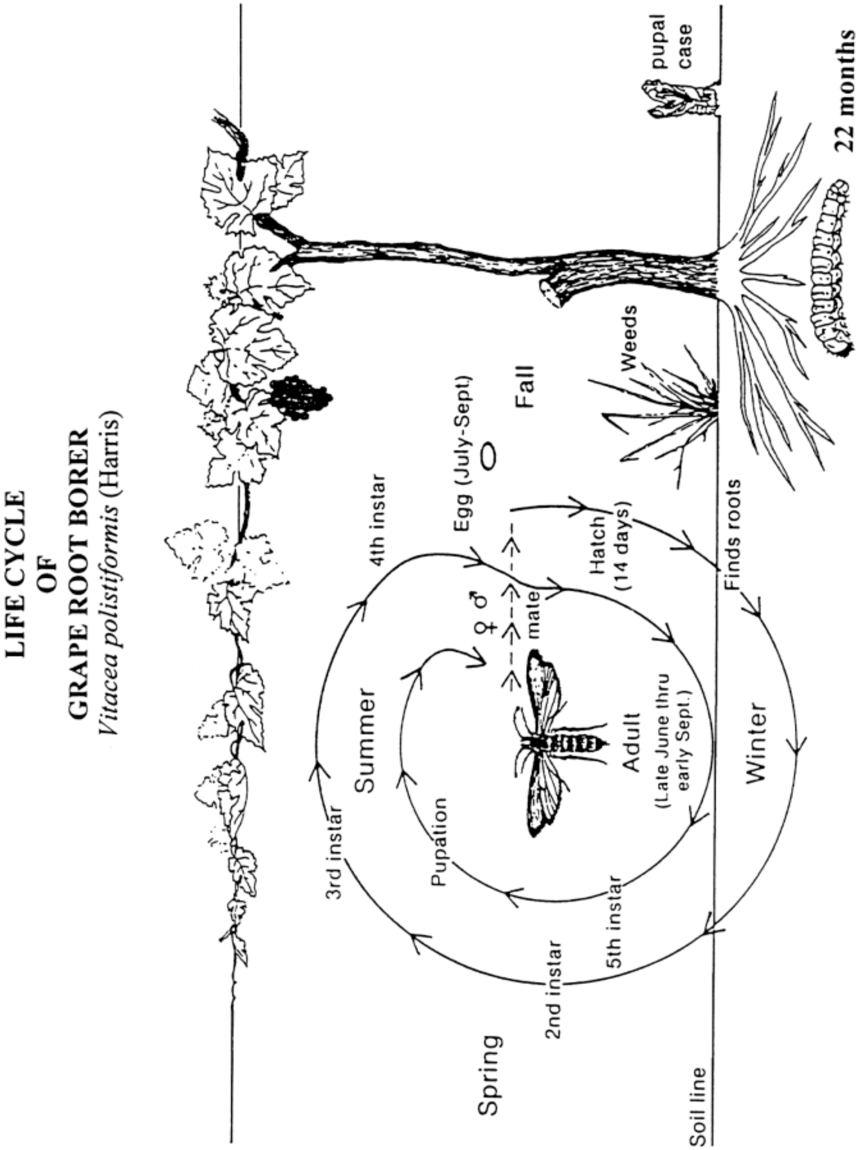

FIG. 1. Life cycle of grape root borer (Williams, R.N.).

shown in Fig. (1) the moths emerge from the soil during July and August. They deposit ova individually on grape leaves and surrounding weeds. The caterpillar hatch and burrow into the soil, find the roots, and begin feeding, the attack the roots and crowns of grapevines by tunnelling into the roots and feeding internally (Cahoon *et al.,* 1991). Their feeding weakness the vine providing a point of entry for disease pathogens. This damage may eventually kill the vine. Caterpillars remain in the vine roots feeding approximately 22 months.

Then they *i.e.,* mature caterpillar, move to just under the surface of the soil, where they pupate, and finally emerge as an adult. This moth's range is primarily in southern United States, yet they cause considerable damage as far north as southern Ohio, and eastern Pennsylvania.

In order to determine that this grape pest had a viable sex attractant, virgin females were placed in a cage within a sticky trap as a caged females. The females attracted males in great numbers thus proving a semiochemicals *i.e.,* sex pheromones existed.

In 1986, a new synthetic pheromones became available to the researches of this applied study. Pheroconic sticky traps *i.e.,* (Trece, Salinas, CA) were baited with a rubber septum charged with this pheromone (Williams, *et al.,* 1986). Traps (Fig. 2) were set out in three vineyards in southern Ohio along with one near Lake Erie.

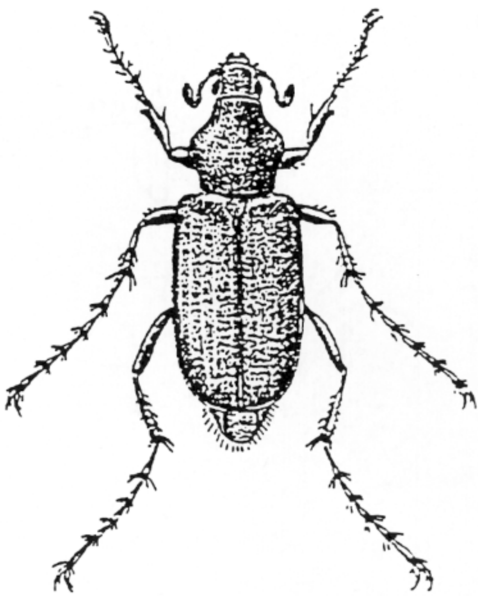

FIG. 2. Image of the rose chafer (Williams, R.N.).

Three traps were set out in each vineyard, and the number of males captured was recorded weekly. This trapping helped in determination a large population of grape root borers existed in southern Ohio. This led to the question was answered in two ways: 1) examination of the ground surface under the vines for the exuviae *i.e.,* pupal cases and, 2) examination of the roots of unhealthy vines. These two investigations revealed a substantial number of pupal cases, and caterpillars in the roots of vines. This discovery was the first evidence to indicate the potential economic importance of the grape root borer to Ohio growers.

In 1988 a meeting was held to develop strategies to study feasibility of confusing the grape root borer with its own pheromone. The study of a four state cooperative project to use the new synthetic pheromone to hinder the males from finding females began in the summer of 1988. Each state treated one or two small vineyards (not to exceed 5 acres). The control (check) was chosen from a vineyard of like variety, similar age, and managed similarly. The second guideline was each state was provide with enough attractants in Shin-Etsu rope ties (Pacific Biocontrol of Davis, CA) to place 100 ties per acre in the treated vineyards. The next step to place three pheroconic sticky traps *i.e.,* (Trece, Salinas, CA) baited with the pheromone loaded in a rubber septum inside the treated area. This guideline was to monitor the effectiveness of this disruption techniques. Another way of monitoring the disruption was to count pupal cases of emerging adults under 100 vines in each vineyard. This was accomplished by examining the soil surface in a 1 m radius around the base of the trunk. The last monitoring technique was to capture females and placed them in a cage above a sticky trap to see if any males were attracted.

Three vineyards in southern Ohio, two concord and one seyval, are treated with 100 rope tie pheromone dispensers/acre (Pacific Biocontrol of Davis, CA). These ties are placed on the top trellis between every sixth vine in the shade if possible. Three pheroconic sticky traps *i.e.,* (Trece, Salinas, CA) each baited with a pheromone impregnated rubber septum (USDA, Byron, GA) *i.e.* are placed in the vineyard to monitor the effectiveness of the rope ties disruption. Additional traps are placed outside of the treated vineyard.

Each year late season (August) *i.e.* pupal case surveys are used to indicate the emergence of grape root borers in the treated vineyards.

In the other hand the use of lorsban 4E for control of grape root borer by treating just before the pest emerge from the soil. In Southern Ohio this would be the last week of June or very early in July. Mix 4.5 pints of lorsban 4E with 100 gallons of water and apply 2 quarts of the diluted spray mixture to soil surface on a 15 square foot area around the base of each vine. Do not allow spray to contact fruit or foliage. Do not make more than one application per seasons or apply within 35 days before harvest. Based on residue data, the use of lorsban 4E in grapes is restricted to states east of the Rocky Mountains.

2 – Rose Chafer

For the rose chafer *Macrodactylus subspinosus,* Scarabaeidae, Coleoptera is a serious pest in eastern North American. It feeds on ornamental flowers, and fruit crops. The rose chafer begins emergence in late May to early June. Soon after emergence the chafers mate and immediately begin feeding on foilage, buds, and newly set fruits. This time emergence is what makes the rose chafer such as serious pest. Williams (1995) reported the rose chafer adults attack grapes at bloom as they emerge from the soil. Not only due they destroy the fruit at blossom, in addition, they frequently skeletonize the leaves, leaving only the large veins intact. This insect is especially abundant in areas of light, sandy soil where beetles may appear suddenly as grapes to bloom.

The ungainly beetles have a straw-colored body, reddish-brown head and thorax with black undersurface. The adult is about 0.5 in. in length with long, spiny, reddish-brown legs that gradually become darker near the tip. As they age, hairs are worn off the head and thorax darker near the tip. As they age, hairs are worn off the head and thorax with normal activity revealing the black color below. Thus they become mottled in color as they mate and move around in the flower clusters making it possible to distinguish new emerged adults from older specimens. Females frequently loss more hairs, particularly on the thorax, in the mating process. Eggs are oval, white, shiny in appearance, and about 0.05 in. long and 0.03 in. in width, larvae are C shaped with grubs about 0.8 in. long and 0.12 in. wide when fully grown, a brown head capsule, and a dark rectal sac visible through the integument. The larvae can be identified a distinctive rastral pattern. The pupae are light yellowish-brown in color and have prominent legs. They length about 0.63 in. Adults become active in northeastern North America from late May to early June. The entire population reaches maturity practically at the same time. Beetles feed and mate soon after emerging from the soil. Females deposit eggs singly a few centimeters below the soil surface, each females depositing 24 to 36 eggs, mating and oviposition continuously for about two weeks. The average life span of the adult is about three weeks. The hatching after two weeks. The emergence larvae ting white C-shaped grubs. They feed on the roots of grasses, weeds, grains, and other plants throughout the summer, becoming fully developed by autumn. Larvae move downward in the soil as temperatures decline and from an earthen cell in which they overwinter. In the spring, larvae return to the soil surface, feed for short time, and pupate in May. After two weeks in the pupal stage the adults emerge and crawl to the soil surface to begin their cycle again. There is but one generation per year.

Rose Chafer Damage Symptoms

It attacks the flower, buds, foilage and fruit of numerous plants including grape, rose, strawberry, peach, cherry, apple, raspberry, blackberry, clover, hollyhock, corn, bean, beet, pepper, cabbage, peony and many more plants, trees, and shrubs. Adults emerge about the time of grape bloom and often cause extensive damage to foilage. Blossom buds are often completely destroyed, resulting in little or no grape production. Feeding activity on various plants may continue for four to six weeks. Damage can be especially heavy in sandy areas, the preferred habitat for egg-laying.

It is very important note that a toxin present in the beetles may kill poultry.

In the past the only control for this destructive pest was to spray for it. For thus season it was necessary to conduct research to discover an attractant which would reduce the amount of spray needed and conserve the environment. During 1979, two experiments were conducted. The first was to determine if rose chafer was trappable while the second was to assay several candidate lures. The traps used in those experiments were standard Ellisco Japanese beetle traps (Fig. 3). Traps were suspended 1 m above the ground on steel rods and spaced 8 m apart. Each candidate lure was replicated four times in a randomized complete blocks. Also, in the second experiment female rose chafers were placed in a vented vial with a dental wick dampened with water. This vial was placed in a trap to determine if females produce a sex attractant. Through the years of 1982-1984, testing of candidate lure was the primary purpose of the experiment. Candidate materials were used by saturating no. 2 cotton dental rolls (36 mm long by 11 mm in diameter) with 5 ml of the compound to be tested. The wick was placed in an open 25 ml to 7 dram plastic vial lined with aluminum foil. The vial was then placed in a yellow receptacle of a metal Ellisco trap with a green receptacle for holding the beetles. Traps again were suspended 1 m above the ground and spaced 8 m apart on steel rods. Each lure was replicated four times in a randomized complete block. While traps within a row were placed 10 m apart. During this testing of lures a color test showed strong preference for applicance white over the four other colors including the standard yellow Japanese beetle trap.

In 1985, a change was made in the method of attractant dispensing, instead of using dental rolls, blank *i.e.,* uncharged Loral Ploy-Con discs, were saturated with 5 ml of a candidate lure. This method of trapping continued to be used to determine the most attractive mixture of compounds.

In 1988, 105 of these Japanese beetle style traps (Fig. 3) were set out on the perimeter of a vineyard in Conneaut. These traps consisted of white plastic traps with green tin receptacles to hold captured beetles. These traps were set up in the same manner as the testing in 1985. The traps were collected onto twice a week and the beetles were counted.

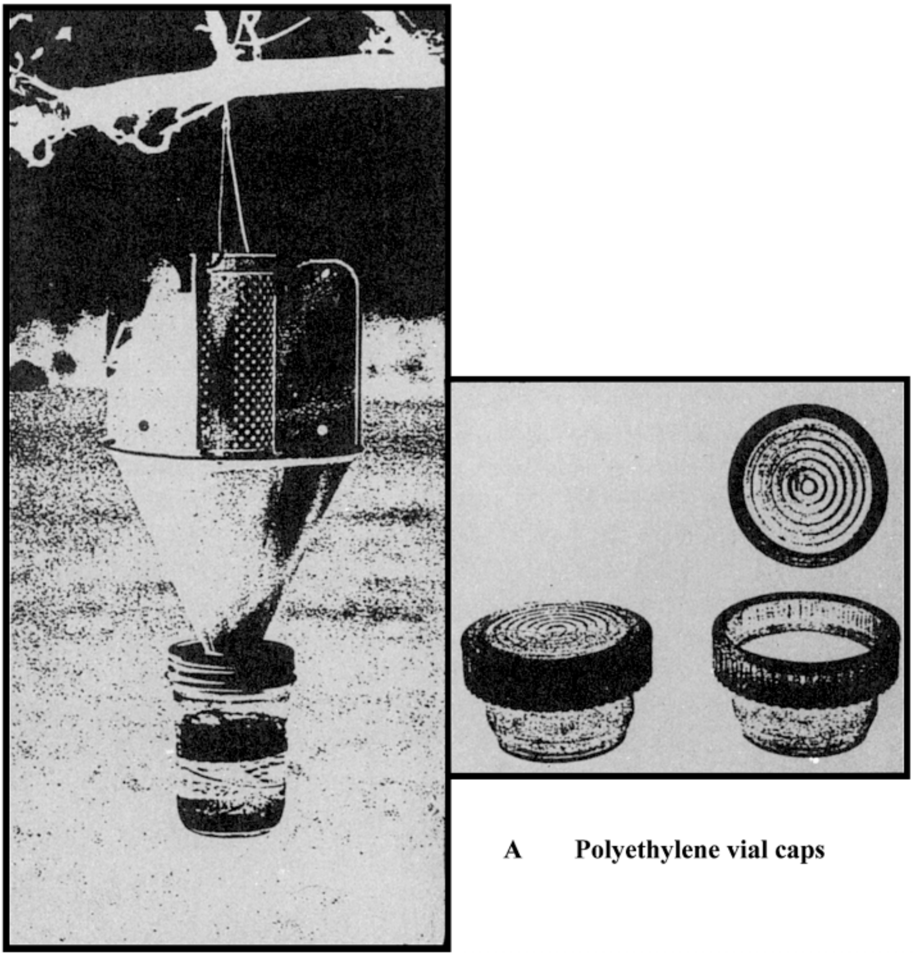

FIG. 3. A modified Ellisco Japanese beetle trap (Williams, R.N.).

The early years of trapping were used to develop a lure suitable to be sold to trap rose chafer. In 1994 a mixture of compounds was deemed powerful enough to be a lure and is now being sold by Great Lakes IPM of Vestaburg, Michigan. Following 1994 trapping was continued to suppress the chafer populations.

In 1995, the trapping out study located in *Vitis labrusca* vineyards near Conneaut, Ohio was continued. Traps were suspended 1 m above the ground and spaced 8 m apart. Blank uncharged Loral Poly-Con deodorant dispensers containing Mini Poly-Con discs, Lermer packaging crop. Garwood, N.J., were saturated with approximately 5 ml of our best attractant (valeric acid + hexanoic acid + octyl burate + trans – 2 – nonanol + alpha ionone (1:1:1:1:1). One hundred and five Japanese beetles traps were placed around the entire perimeter of the vineyard at Conneaut, Ohio in an attempt to intercept beetles were migrating into the vineyard and keep the population below the economic threshold level.

3 – Grape Berry Moth

The grape berry moth, *Endopiza viteana,* Tortricidae, Lepidoptera (Fig. 4) is the most serious grape insect in northeastern North America. Much of the research on this has been conducted in New York, Pennsylvania, Ontario, and Ohio. Williams (1995) explain its description and life cycle that this pest is one of the insect attacking flower, clusters and berries. It is the major insect pest of grape berries in the eastern USA and Canada. When vineyards are left unmanaged up to 90 per cent of the fruit often is destroyed by the larvae and the diseases facilitated by the damage inflicted upon the fruit. Infestation vary greatly from vineyard to vineyard. From year to year, and within a vineyard. However, infestations bordering wooded areas are most vulnerable.

The adult is a method-brown colored moth with some bluish-gray on the inner halves of the front wings (Fig. 4). The larvae of this small moth are active, greenish to purplish caterpillars about 3/8 in. long when fully grown. Grape berry moths over winter in cocoons within folded leaves in debris on the vineyard floor and within adjacent woolots. After emerging in the spring, the adults mate, and females lay eggs on or near flowers or berry clusters. Newly hatched larvae feed upon flowers and young fruit clusters. Larvae that hatch in June make up the first generation of grape berry moth (Fig. 4) and will mature from mid to late July or August. After mating, females lay eggs on developing berries, and this second generation matures in August or September. Larvae of the second generation, after completing their development, from cocoons in which they over winter. A third generation occurs commonly in the southern range of the pest and occasionally in the northern tier of states. First generation larvae web small flower buds or berries together in early June and feed externally on them or on tender stems. Larvae that attack grape bunches during this time are difficult to see.

Second generation larvae tunnel directly into the berries and feed internally conspicous reddish spots develop on the berries at the point of larval entry. Berries affected in this manner are known as “stung” berries. The second generation is potentially more damaging than the first. A single larva may destroy 2 to 6 berries in a cluster, depending on berry size, and several larvae frequently inhabit a single cluster. At harvest, severely infected bunches may be completely hallowed. In many cases bunches are covered with bunch rot fungi and infested with *Drosophila* spp. Fruit flies, and often having an unhealthy appearance.

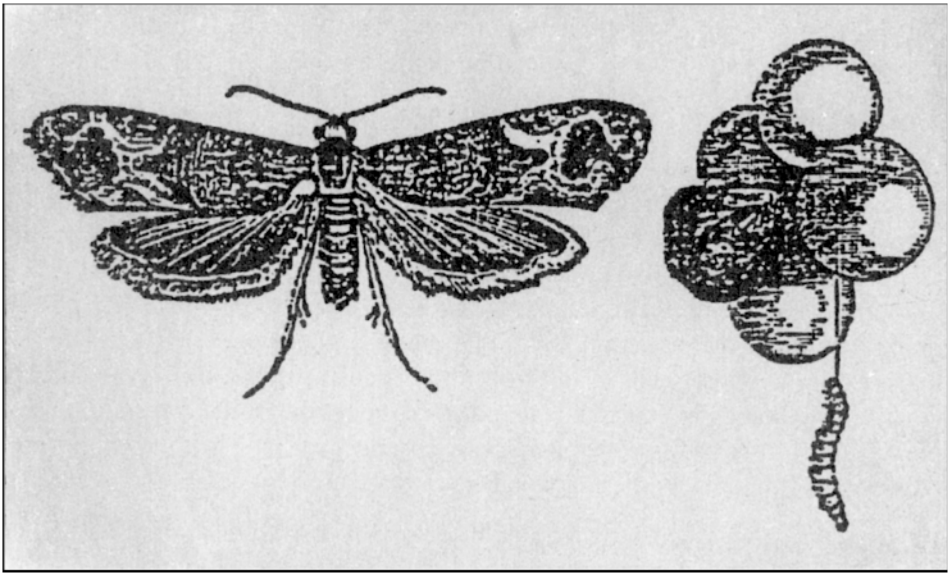

FIG. 4. Caterpillar and adult of the grape berry moth (Williams, R.N).

In this investigation the authors are using primarily the information from New York. Cornell University Scientists have conducted research on pheromones of the grape berry moth for nearly 20 years (Hoffman *et al.,* 1992). These efforts provided a foundation for the development of isomate-GBM pheromone product. This product received EPA and New York State registrations in 1990.

The authors purpose is to describe the results obtained with the isomate-GBM pheromone in large scale field trials conducted throughout the state, and to provide information on how the pheromone product can be used effectively.

The isomate-GBM pheromone works by producing an invisible “cloud” of pheromone throughout vineyards. Its tie looks much like an oversized “twist-tie” of the sort that is used to close garbage bags. It is eight in. long, less than 1/8 in. wide, and contains a wire embedded within the polyethylene plastic. Liquid pheromone is contained within the closed channel that runs along the wire for the entire length of the tie. Slow release of the pheromone is achieved over the course of approximately 100 days as the pheromone moves through the plastic walls of the channel and is released into vineyards.

In 1988, a test was set up in the Lake Erie and Finger Lakes region to evaluate the control of the grape berry moth in vineyards treated with the isomate-GBM pheromone. The evaluation compared the interior of the vineyards and the exterior edge or high risk area with vineyards treated by conventional insecticide programs for the grape berry moth.

The isomate-GBM pheromone can used another way. Pheromone traps can be used to estimate the phenology of the grasp berry moth (Hoffman *et al.,* 1992).

Discussion and Conclusion

1 – Grape Root Borer

This disruption technique continues to be used today for its effectiveness. The authors always catch more males outside the treated vineyards than where the rope ties are employed for the disruption of females to attractive males.

Each year the late season *i.e.,* (August) pupal case surveys are used to indicate the emergence of grape root borers in the treated vineyards. Overall the grape root borer population seems to be rebounding slightly, but the populations are still very low. The first year the capture was 725 grape root borers in Morrow, Ohio. Total control of this pest with this technique cannot be expected as some individuals always come in from surrounding wild grapes. However, continuous trapping helps keep the population at a manageable number where vine loss is at a minimum. Growers have said repeatedly that their vines are healthier now, than when the study began.

2 – Rose Chafer

Through the years of this applied studies, it was determined that a J.B. style trap with a white top and green receptacle in combination with this developed lure was most attractive set up for the rose chafer. In the first official years of the authors test, 1988 the average number of rose chafer caught in a trap was 889 for a total 93,387. In comparison 9.645 chafers were caught in 1997 for an average of only 91 per trap.

These result demonstrate the effectiveness of trapping rose chafers in areas where they are a major pest. As mentioned before a color test showed strong preference for applicance white over the four other colors including the standard yellow Japanese beetle trap.

Similar research on trapping of rose chafers has been conducted in Michigan and Pennsylvania with similar results. So as shown rose chafers can be a serious pests, but with the use of the lure developed at the OARDC and with a few traps the population can be suppressed to an acceptable level. The grower that own the grapes were the authors conducted the trials has long since stopped spraying. In 1995, 8071 beetles were capture. This number was up from the previous years but still well below the economically damaging numbers encountered in 1988-1995 (Table 1). The increase in the number of beetles captured over the last couple of year seems to be due to the fluctuating population external to the vineyard. Trapping continued for the fourth straight year to provide a means of controlling the beetle population and preventing the need for an application of pesticide.

TABLE 1. Rose chafer population reduction utilizing artificial attractant in a 3.5 acre *Labrusca* vineyard, Conneaut, Ohio.

Year	No. beetles Total
1988	93.387
1989	26.491
1990	48.140
1991	27.573
1992	4.430
1993	4.317
1994	6.992
1995	8.071

3 – Grape Berry Moth

The isomate GBM pheromone traps evaluation was excellent predication of egg deposition. From the years of research, it is recommended that the pheromone should be placed in vineyards during the second week of May and before May 15. It is recommended to use 200 tie dispensers per acre of vines *i.e.,* (1 per 3 vines and suggest that twice this rate *i.e.,* 2 per 3 vines) be use along the perimeter of the vineyard. Dispensers should be placed on the top trelllis wire, about four to five above the ground.

Clearly, pheromones are not without their drawbacks. Because they are not broadly toxic like conventional pesticides, (Dennehy *et al.,* 1991), they require that greater attention be given by the grower to monitoring for the secondary pests that usually are suppressed by broadly-toxic insecticides (Martinson *et al.,*

1991) fortunately, the principal secondary pests, leaf hoppers and Japanese beetles, are relatively easily monitored, and are very effectively controlled by a single application of pesticide, when necessary. Though the authors will continue to rely upon broadly-toxic conventional insecticides to clean up secondary pests and severe *e.g.,* grape berry moth problems, utilization of mating disruption for control of the *e.g.* grape berry moth could bring growers a long way towards fulfilling the call for reduced reliance on toxic chemicals in grapes.

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استخـدام الفرمـونات كمشابهات كيماويـة لتقليص الكثافـة العـدديـة للآفـات الحشريـة للعنب

روجر وليامز[١] ، طلعت علي أبو حشيش[٢] ، كريس جرتز[١] و دان فيكلي[١]
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المستخلص . هذه مقالة مرجعية عن عمل تطبيقي عنيت بسبيل غير تقليدي أثبت وجوده في مكافحة ثلاثة آفات هامة تصيب العنب بالشمال الشرقي لأمريكا الشمالية ألا وهي الفرمونات ضد :

١ – حافرة جذور العنب (من حرشفية الأجنحة) *Vitacea polistiformis* .

٢ – الخنفساء المهلكة (المبلية) للأزهار (من غمدية الأجنحة) *Macrodactylus subspinosus*

٣– فراشة ثمار العنب (من حرشفية الأجنحة) *Endopiza viteana* .

وهذا البحث ما هو إلا استعراض لتقنية المعاملات للتحكم وضبط أعداد الآفات آنفة الذكر عند مستوى ضررها الاقتصادي .

استغرقت هذه الدراسة الفترة من سنة ١٩٨٨ إلى سنة ١٩٩٧ بقصد التوصل إلى استخدامات أخرى غير نمطية من سبل مكافحة الآفات تقلل من استعمال المبيدات وآثار متبقياتها على فاكهتنا اليومية وذلك لحماية الإنسان وحيواناته وللحفاظ على التوازن البيئي الطبيعي عند معدلاته الأصلية ولتنشيط فعل الأعداء الطبيعية المتدني من جراء الاستخدام غير المرشد للمبيدات الكيماوية في مكافحة الآفات .

١ – تستخدم الفرمونات الحشرية ضد حافرة جذور العنب بإطلاقها بنسبة ضئيلة لتضليل الذكور من أن تصل إلى الأناث باستخدام أربطة بلاستيكية خاصة مجوفة ومملوءة بالفرمون كتقنية للتشويش لمنع التزاوج ويستخدم ملازم لها المصائد المجهزة بالفرمونات ولتقليل تعداد الجفار .

٢- بدأ المؤلفون بالنسبة للخنفساء المهلكة (المبلية) للأزهار في إجراء بحوث لاكتشاف جاذب يوضع في هذه المصايد لهذه الخنافس لتقليل الرش بالمبيدات وبالفعل استخدم المزارعون هذه الطريقة من سنة ١٩٨٤ حتى سنة ١٩٩٧ ثم أوقفوا الرش بالمبيدات الكيماوية .

٣- كان الغرض من الدراسة الثالثة استخدام الفرمونات لمكافحة فراشة ثمار العنب في مدى تطبيقي واسع لتأكيد الدور المؤثر لهذا الاستخدام في الحفاظ على البيئة عن طريق إطلاق سحابة من الفرمون في الحقول باستخدام الأربطة المحتوية بداخلها الفرمونات (بمعدل ٢٠٠ رابطة لكل آكر) أي رابطة واحدة لكل ٣ تفريعات عنب في كل الخطوط ورابطتين لكل ٣ تفريعات عنب في الخطوط الخارجية للحقل .