

A Recent Bibliography of the Red Palm Weevil

بِبَلْيُوغرَافِيَا بَدْيِنْ
لِسْوَهِ النَّخِيلِ الْحَمْرَاءِ



By: Mohamed El-Said El-Zemaity

أَعْدَادٌ : مُحَمَّدُ السَّاعِدُ الزَّمَيْتِيُّ

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إهداء

أتشرف بإهداء هذه الببليوغرافيا للشبكة العراقية لنخيل التمر، متمنياً أن يجد فيها زوار الشبكة الفائدة المرجوة، وللشبكة نفسها ومؤسسها الأخ الصديق العزيز أ.د. إبراهيم الجبوري كل تقدم وإزدهار.

سعید الزمیتی

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التعريف ببليوغرافيا سوسة النخيل الحمراء (RPW) Red Palm Weevil

تم إنشاء ببليوغرافيا حديثة لسوسة النخيل الحمراء (RPW) من المؤلفات المنشورة عن الآفة على نخيل التمر حتى عام 2022. حيث تم تجميع 703 مقالة من مصادر مختلفة، بما في ذلك المنشورات في المجالات العلمية ووائلات المجتمعات العلمية والكتب المتخصصة والأطروحات العلمية والإنترنت وقواعد البيانات المتخصصة والعربية، قائمة منظمة المجتمع العلمي بالبحوث المنشورة عن آفات النخيل، وغيرها. تستهدف الببليوغرافيا مساندة العاملين والباحثين والمسؤولين عن تطوير برامج إدارة الآفات للحشرة، لأنها الآن واحدة من أخطر آفات النخيل على مستوى العالم بما في ذلك المنطقة العربية. أيضاً، ستكون مساعدة مفيدة للباحثين والمرشدين والمنتجين الزراعيين ورجال الصناعة، بالإضافة إلى المسؤولين الحكوميين المشاركين في إدارة الآفات. نظراً لأن الببليوغرافيات هي مفاتيح مهمة كمصادر المعلومات تتميز بتوفير الجهد والوقت والتكاليف، فإنها ستساعد الباحثين على إكمال أبحاثهم بشكل أسرع وأكثر شمولاً وأكثر دقة وكفاءة، ومن المتوقع أن تلعب دوراً مهماً في:

- 1- تسهيل عملية جمع المعلومات لمديري إدارة الآفات والباحث العلمي، من حيث الحصول على المصادر الخاصة بموضوع بحثه من خلال جميع الامتدادات التي يرغب فيها زمانياً ومكانياً ولغويأً وموضوعياً.
- 2- مساعدة الباحث في اختيار وانتقاء المصادر التي يرغب فيها وتوجيهه إلى مصادر لم يفكر فيها.
- 3- تمكين الباحث من التحقق من بعض المعلومات والعمل على استكمالها أو تصحيحها.
- 4- تزويد الواقع وقواعد البيانات القائمة بالمعلومات المدققة، وتشجيع إنشاء قواعد بيانات متخصصة من قبل الأطراف المهمة بمشاكل آفات النخيل.
- 5- تشجيع ونشر الأنظمة الخيرية لإدارة آفات نخيل التمر وإتاحتها بسهولة لفائدة منتجي التمور ومزارعيها في حل مشكلات الآفات التي تواجههم.

لتسييل الحصول مباشرة على المقالات المرجعية المتعلقة بأحد المجالات/ الجوانب البحثية لسوسة النخيل الحمراء، فقد تم تصنيف وإدراج المقالات المجمعة التي تحتويها الببليوغرافيا موضوعياً تحت 18 عنواناً رئيسياً و 34 عنواناً فرعياً شملت كل المعرف و الجوانب البحثية المحتملة (كما هو موضح بقائمة المحتويات)، ويمكن للقارئ من خلالها الوصول بسهولة لقائمة مرجعية محدثة وكافية عن الموضوع محل الاهتمام.

لِلقاء الضوء على الاحتياجات البحثية الالزام لتعزيز برامج إدارة هذه الآفة الخطيرة، فقد أجرى تحليل للوضعية السائدة للتوجهات البحثية عن سوسة النخيل الحمراء. وتشير البيانات المستخرجة من هذه البيليوغرافيا إلى أن هناك حاجة حقيقة لمزيد من الجهد والبحث لتعزيز دور بعض المكونات الأساسية في برامج الإدارة مثل مستوى العتبة والمكافحة الطبيعية، تعزيز اعتماد منتجات التكنولوجيا الحيوية وبعض المكونات الأخرى المحتملة، إجراء المزيد من التحقيقات الجزيئية لتوفير فهم أفضل لسلوك الحشرة والتفاعل بين جهاز المناعة وعوامل المكافحة البيولوجية، تشجيع الأبحاث حول مكافحة سوسة النخيل الحمراء تبعاً للموقع الجغرافي وتقديم برامج إدارتها في ضوء الظروف المحلية لكل دولة.

المؤلف

محمد السعيد صالح الزميتي
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A Recent Bibliography of the Red Palm Weevil, *Rhynchophorus ferrugineus* Oliver. By: Mohamed El-Said El-Zemaity, PhD

Plant Protection Department, Faculty of Agriculture, Ain Shams University. P.O.Box:68 Hadeyk
Shoubra, 11241Cairo, Egypt. E-mail: elzemaity_said@agr.asu.edu.eg

ABSTRACT

A recent bibliography of the red palm weevil *Rhynchophorus ferrugineus* Oliver (Coleoptera: Curculionidae) was established by compiling 703 articles from different sources, including publications in scientific journals, proceedings of scientific meetings, specialized books, scientific theses, internet, specialized databases, the Arab Scientific Community Organization list of published research on palm pests, and others. The objectives of the bibliography are to assist workers, technicians, and officials responsible for developing pest management programs for the insect as it is now one of the most dangerous palm pests globally including in the Arab region. Also, it will be a useful aid to researchers, extension agents, agricultural producers, and industry, as well as government officials involved in pest management. Since bibliographies are important keys as sources of information characterized by saving effort, time, and costs, they will help researchers to complete their research faster, more comprehensively, more accurately, and more efficiently. The analysis of the dominant research trends was started by classifying the compiling scientific papers into 18 major research areas and 34 sub-fields. Data extracted from such bibliography indicate that there is a real need for more efforts and research to strengthen the role of some of the basic components in IPM programs such as threshold level and natural control; enhancing the adoption of biotechnology products, and some other potential components; carry out more molecular investigations to provide a better understanding of the insect's behavior and the interaction between its immune system and biological control agents; encouraging researches on evaluating the current RPW management programs in light of the local conditions of each country.

Keywords: Bibliography, Date palm pests, Red palm weevil, IPM programs.

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A. INTRODUCTION

The word bibliography has become an expressive term well-established in use by all conferences, specialized organizations, and researchers in the field of libraries and information in the Arab world. It is expected that the bibliographic list for each pest includes a comprehensive inventory of all independent and arranged data sources for information related to the main palm pests in the Arab region, especially the red palm weevil RPW, according to the known scientific bases. It is expected that this approach will have a role in assisting workers, technicians and officials responsible for developing pest management programs in general and date palm pests in particular. Establishing this bibliography as a specialized source of information will undoubtedly be relied upon in program planning, implementation and evaluation. The bibliography will also be a useful aid to researchers, extension agents, agricultural producers, industry and government officials involved in pest management. Since bibliographies are important keys as sources of information characterized by saving effort, time and costs, they will help researchers to complete their research faster, more comprehensively, more accurately and more efficiently, and it is expected to play an important role in:

- 1- Facilitating the process of gathering information for pest management managers and the scientific researcher, in terms of obtaining the sources for the subject of his research through all the extensions he desires, temporally, spatially, linguistically and objectively.
- 2- Helping the researcher to choose and select the sources he desires, as well as guiding him to sources he did not think of.
- 3- Enable the researcher to verify certain information and work on completing or correcting it.
- 4- Providing the existing sites and databases with audited information, and encouraging the establishment of specialized data bases by the parties interested in the problems of date palm pests.
- 5- Encouraging and disseminating expert systems for the management of date palm pests, and making them easily available to benefit date producers and growers in solving the pest problems facing them.

The RPW, *Rhynchophorus ferrugineus* (Oliv.) is a dangerous pest that infects palm trees, especially the coconut and date palm. As an invasive pest, it was established in recent decades in most Arab countries and many other regions at the global level. It is now one of the most dangerous pests threatening the date palm, which occupies great importance and interest to palm growers throughout the Arab world. Because of its economic importance, it has attracted special interest to researchers from all over the world, which has led to the emergence of a huge number of scientific literature and publications on various aspects of the pest, which has made researchers and documentaries feel an urgent need for a bibliography of the pest. In fact, efforts in this direction began with an attempt in 1984 by Divakaran Pillai, who at that time included a list of 48 publications about RPW on the coconut palm. In 2000, Thajudin published a bibliography titled "An annotated bibliography on *Rhynchophorus ferrugineus* - a pest of coconut". After that Thajudin and Mohan noted that there are a large number of publications that had subsequently accumulated on the pest, and that there was a need to update the bibliography. So they compiled the literature on the red palm weevil, and published as bibliography by CPCRI in 2013. The last bibliography included 518 publications, mostly about the biology of the insect, its life aspects, and its control on coconuts:

(<https://krishi.icar.gov.in/jspui/bitstream/123456789/9080/1/RPW%20Bibliography.pdf>).

With the invasion of the pest and its establishment in the date palm regions, the scientific literature focused on its management on date palms. Accordingly, the current compiled bibliography deals with the published literature on the pest on date palm without ignoring the valuable researches published on coconut so that the picture is complete for those interested. The objective of the present work is to update a bibliography includes the recently published articles until 2022 about RPW on date palm.

B. ESTABLISHING THE BIBLIOGRAPHY

The work began by compiling 703 articles (presented as a subjective bibliography list) from different sources, including publications in scientific journals, proceedings of scientific meetings, specialized books, scientific theses, internet, specialized databases, the Arab Scientific Community Organization list of published research on palm pests, Grafiati Bibliography on the topic RPW, EPPO Datasheet on *Rhynchophorus ferrugineus* and others. The compiling articles/literature were classified subjectively into 18 major research areas and 34 sub-fields as follows:

1. Identification\ Diagnosis\ Symptoms\ Damage
2. Biological and Ecological aspects\ Molecular biology
- 2.1- Life cycle and factors affecting the insect development
- 2.2 - Seasonal activity\ Population dynamics
- 2.3- Longevity, fecundity and fertility
- 2.4 - Rate of multiplication\ growth and development
3. Other principle information
 - 3.1- Morphology
 - 3.2 -Physiology
 - 3.3- Behavior
 - 3.4-Biochemistry
 - 3.5- Defense mechanism
 - 3.6- Rearing
 - 3.7 -Host plants
4. Distribution\ Threat\ Infestations
5. General Aspects\ Databases\ Fact & datasheets
6. Survey\ Field Monitoring \ Scouting
7. Detection
 - 7.1 - Smell by dogs
 - 7.2 – Bioacoustic\ acoustic methods
 - 7.3. Signal processing technology
8. Sampling & Action levels\ Area-wide management (operation)
9. Natural Controls
 - 9.1- Entomophagous enemies
 - 9.2 - Entomopathogenic microorganisms
10. Control\ IPM \ Management practices
11. Preventive strategy\ Regulation and legislative interventions
 - 11.1- Quarantine
 - 11.2- Regional campaigns
12. Agricultural & Mechanical Methods

- 12.1. Agricultural Methods
- 12.2 - Mechanical methods
- 13. Resistant cultivars (plants)\ Transgenic date palms\ Biotechnology techniques
- 14- Biological Control\ Bio-insecticides
 - 14.1-Natural enemies
 - 14.2-Entomopathogenic nematodes
 - 14.3- Entomopathogenic fungi (*Beauveria bassiana, Metarhizium anisopliae*)
 - 14.4- Entomopathogenic bacterium (*Bacillus thuringiensis*)
- 15. Pheromone Traps\ Attractants\ Adult trapping
 - 15.1- Natural or synthetic attractants
 - 15.2 - Aggregation pheromone
 - 15.3 - Pheromone lures
- 16. Chemical Control (Insecticides) \ Nano pesticides
 - 16.1- Trunk Injection
 - 16.2-Fumigation
 - 16.3- Root feeding
 - 16.4- Nano pesticides
- 17- Genetic Control\ Sterilization\ Irradiation\ Sterile Male Technique 21
- 18. Information and communication technologies (ICT)
 - 18.1- IoT
 - 18.2- GIS
 - 18.3. Image Processing Techniques

C. Review of the Bibliography Trends

A. Trends of comprehensive knowledge and basic components of IPM

The number of compiling articles published about comprehensive knowledge and other basic IPM components needed for management of RPW, such as: principle information of biological and ecological aspects; monitoring/ survey/ scouting; sampling, detection and the action levels/ economic threshold or area-wide management /operation and natural controls were presented in Table 1.

Table (1). The published compiled articles about comprehensive knowledge and basic IPM components needed for management of RPW.

Field of Research's	No	%
1. Identification\ Diagnosis\ Symptoms\ Damage	13	3.86
2. Biological and Ecological aspects\ Molecular biology	70	20.83
2.1- Life cycle and factors affecting the insect development	2	
2.2 - Seasonal activity\ Population dynamics	3	
2.3- Longevity, fecundity and fertility	7	
2.4 - Rate of multiplication\ growth and development	11	
3. Other principle information	97	27.97
3.1- Morphology	10	
3.2 -Physiology	25	
3.3- Behavior	17	
3.4-Biochemistry	10	
3.5- Defense mechanism	1	
3.6- Rearing	20	
3.7 -Host plants	14	
4. Distribution\ Threat\ Infestations	63	18.45
5. General Aspects\ Databases\ Fact & datasheets	18	5.65
6. Survey\ Field Monitoring \ Scouting	8	2.38
7. Detection	51	15.47
7.1 - Smell by dogs	2	
7.2 – Bioacoustic\ acoustic methods	14	
7.3. Signal processing technology	10	
8. Sampling & Action levels\ Area-wide management (operation)	2	0.59
9. Natural Controls	16	4.76
9.1- Entomophagous enemies	4	
9.2 - Entomopathogenic microorganisms	12	
Total	339	100

1. Comprehensive knowledge

The number of articles related to the basic aspects of the red palm weevil RPW that were included in the prepared bibliography reached 260 papers (Table.1), including: 13 papers of identification, diagnosis, symptoms of infestation and damage caused by this dangerous insect to the date palm; 70 papers on biological and ecological aspects including molecular biology, life cycle and factors affecting development and growth (two papers), seasonal activity and population dynamics (3 papers), lifespan and fertility (7 papers), rate of multiplication\ growth and development (11 papers); 97 papers for other background information, including morphological studies (9), physiological and defense mechanisms (25), behavioral (17), biochemical (10), defense mechanism (only one paper), rearing (20) and host plants (14); 62 papers of the occurrence of infestation and the geographical distribution of the insect; 18 Research on different general aspects, such as controversial aspects about the red palm weevil,

the species associated with the insect, especially the mite and the nematode, and larval gut microbes.

2. Monitoring, sampling, detection and the economic threshold

The number of papers that were concerned with the process of monitoring, sampling and detecting the insect and proposing the levels or threshold of economic intervention reached 61, including 51 on methods of detection and early detection by using non-traditional methods such as the dogs' sense of smell (2 papers), audio/acoustic methods (14), and modern technologies such as signal processing technology (10 papers).

3. Natural control

The total number of articles related to natural control was 16, including 4 papers on the natural enemies of the insect, adding to 12 articles on entomopathogenic microorganisms.

To conclude the trends of compiled articles previously mentioned, Fig.1 shows a comparison between the % numbers of articles published about comprehensive knowledge and basic IPM components needed for the management of RPW.

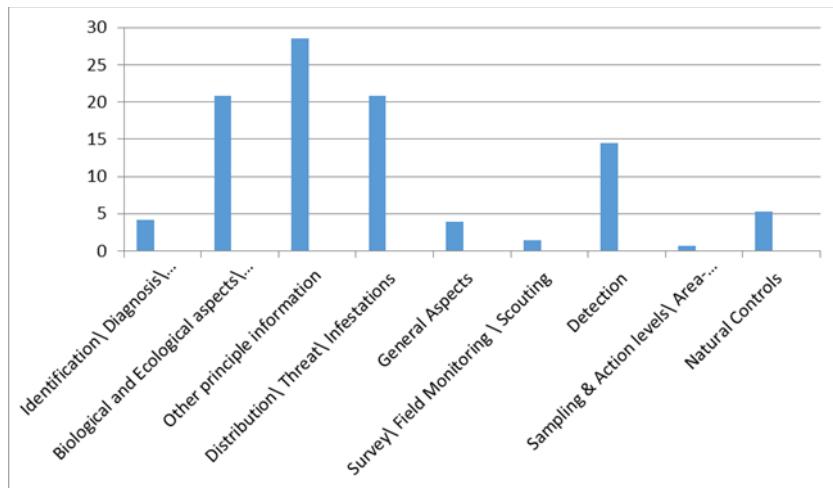


Fig.1. Comparison between the % numbers of articles published about comprehensive knowledge and basic IPM components needed for management of RPW.

B. Trends of IPM tactics

Compiling articles concerning management practices and control methods of RPW, as well as information & communication technologies were presented in Table 2. Papers that dealt with the management practices and methods of controlling the RPW, including studies on preventive methods to avoid infestation with the insect (Proactive practices), and studies related to the effectiveness and efficiency of treatment methods or based on IPM tactics (Effective practices), and the total of these studies amounted to 61 papers (Table 2).

Table (2).The published compiled articles about management practices and control methods of RPW.

Field of Research's	No	%
10. Control\ IPM \ Management practices	61	16.71
11. Preventive strategy\ Regulation and legislative interventions	12	3.28
11.1- Quarantine	4	
11.2- Regional campaigns	1	
12. Agricultural & Mechanical Methods	3	0.82
12.1. Agricultural Methods	2	
12.2 - Mechanical methods	1	
13. Resistant cultivars (plants)\ Transgenic date palms\ Biotechnology techniques	8	2.19
14- Biological Control\ Bio-insecticides	107	29.31
14.1-Natural enemies	6	
14.2-Entomopathogenic nematodes	42	
14.3- Entomopathogenic fungi (<i>Beauveria bassiana</i> , <i>Metarhizium anisopliae</i>)	31	
14.4- Entomopathogenic bacterium (<i>Bacillus thuringiensis</i>)	8	
15. Pheromone Traps\ Attractants\ Adult trapping	95	26.02
15.1- Natural or synthetic attractants	5	
15.2 - Aggregation pheromone	14	
15.3 - Pheromone lures	7	
16. Chemical Control (Insecticides) \ Nano pesticides	53	14.52
16.1- Trunk Injection	7	
16.2-Fumigation	4	
16.3- Root feeding	1	
16.4- Nano pesticides	2	
17- Genetic Control\ Sterilization\ Irradiation\ Sterile Male Technique	20	5.47
18. Information and communication technologies (ICT)	6	1.64
18.1- IoT	2	
18.2- GIS	3	
18.3. Image Processing Techniques	1	
Total	365	100

1. Proactive practices

The research that dealt with the preventive strategy, regulatory and legislative interventions amounted to 12 papers, including quarantine measures (4 papers) on the quarantine protocol and one paper on problems and challenges facing quarantine measures. It is noted that there was no research on health measures and the role of extension campaigns in measures to avoid weevil infestation.

2. Active practices

2.1. Agricultural and mechanical methods

The bibliographic list included only two papers on agricultural methods and one investigation on mechanical measures, and two other papers on the importance of field operations to reduce the

spread of RPW on date palms and a case study of the effect of farming practices on the infestation of red palm weevil on date palms, while the number of studies that dealt with resistant cultivars and genetically modified palms to resist the pest and other biological techniques (8 papers).

2.2. Biological control and biopesticides

The investigations that dealt with biological methods amounted to 107 papers, of which 6 were about natural enemies, and the rest dealt with the bio-agents or its formulations that are pathogenic to insects, including 42 about pathogenic nematodes, 31 about pathogenic fungi, especially *Beauveria bassiana*, and *Metarhizium anisopliae*, 8 papers on pathogenic bacteria all using *Bacillus thuringiensis*. Often, biopesticides investigations focused on the use of plant extracts such as: neem seed extract black pepper, cashew apple extracts, as well as active substances from natural extracts such as camphene. It is striking that the investigations that focused on the role of specific natural enemies of predators and parasitoids and their use on the applied scale is very rare, and this may be because the red palm weevil is an invasive pest to many of the locations in which it was established due to the appropriate environmental conditions and the absence of such enemies.

2.3. Pheromones and attractants

The most investigated potential components researches dealt with pheromone traps, attractants and adult traps, with 95 investigations, of which 5 are about Natural or synthetic attractants, 14 are about aggregation pheromone, and 7 are about Pheromone lures. This research dealt with different aspects of the use of pheromone traps in managing RPW in terms of: pheromone type, efficiency, longevity of pheromone, improvement of trap contents and placement in terms of trap position and density relative to area, the effect of trap size and color on the numbers that are caught and traps equipped with pheromone bait. As for the attraction with food baits, it included investigations on bait-free attraction and killing technology, the efficiency of different types of natural and synthetic baits, and the periodic replacement of food baits.

2.4. Chemical control (Insecticides) and nano pesticides

The investigations that concerned with the use of different insecticides amounted to 53 papers, of which 7 were using the stem injection method, 4 using the fumigation method, and only one research using root feeding. These investigations were concerned with evaluating the effectiveness of different old groups of insecticides (e.g. phosphorous, carbamates, mineral oils and inorganic salts, etc.) and relatively new (e. g. amidaclorpid, abamectin, emamectin benzoate) against adults and other stages of the red palm weevil under laboratory and field conditions, and there is some investigations which dealt with the status or development of resistance of RPW field populations to the action of insecticides, or the factors affecting the efficiency of insecticides and their histopathological effects on the insect. The investigations that dealt with nano pesticides only two papers, the first on nano essential oils, and the second on the evaluation of certain nano pesticides against the RPW.

2.5. Genetic control, sterilization and irradiation

The bibliographic list included 20 papers on genetic control methods, sterilization and irradiation, as well as the method of male sterilization. These papers dealt with determining the basics and doses of gamma irradiation, the effect of irradiation processes on some morphological and biological aspects, insect ovaries and mating competitiveness. Also, that dealt with the use of some radioactive isotopes in male sterilization.

3. Information and communication technologies ICT

The number of researches that dealt with the applications of ICT in the management of the red palm weevil reached 6, including 3 papers on GIS, and 2 papers on the Internet of Things and one on image processing technologies.

To conclude the trends of compiled articles previously mentioned, Fig. 2 show a comparison between the % numbers of articles published about management practices and control methods of RPW.

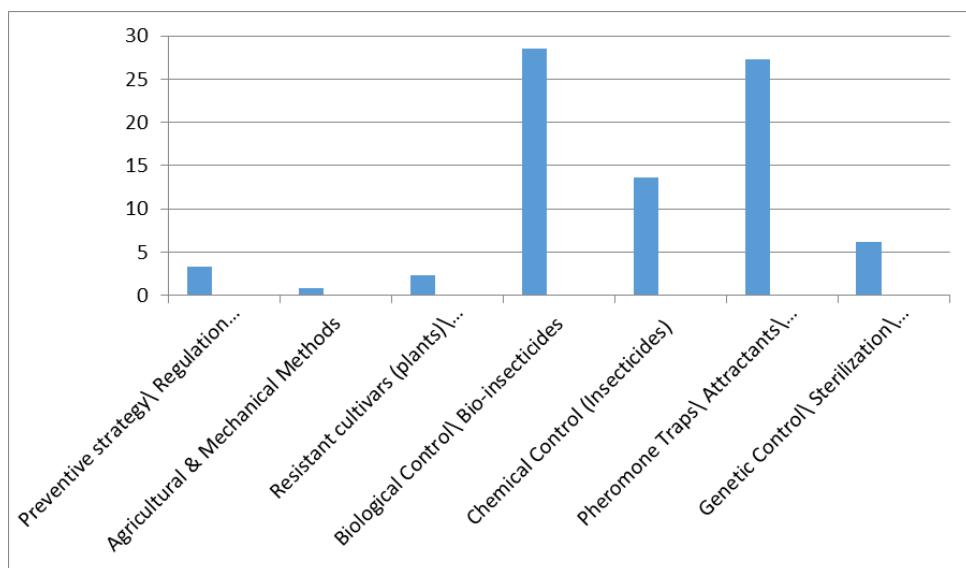


Fig.2. Comparison between the % numbers of articles published about management practices and control methods of RPW.

D. SUBJECTIVE BIBLIOGRAPHY LIST

1. Identification\ Diagnosis\ Symptoms\ Damage

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