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Modern integrated control measures against fruit moths in the southern regions of Uzbekistan

O'zbekistonning janubiy hududlarida tarqalgan meva kuyalariga qarshi zamonaviy integratsiyalashgan kurash choralari

Современные комплексные меры борьбы с плодовыми молями в южных регионах Узбекистана

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Abstract. The article describes a modern integrated protection system aimed at reducing the harmfulness of fruit moths found in orchards in the southern regions of Uzbekistan, in particular in the Kashkadarya and Surkhandarya regions. Fruit moths, especially representatives of the Yponomeutidae family, can damage the leaf apparatus of fruit trees, reduce photosynthetic activity, and negatively affect yield and fruit quality. In a modern approach, pest control is based on the integration of agrotechnical, mechanical, biological, biotechnical, and, if necessary, selective chemical methods into a single system. The article analyzes the prospects for pheromone monitoring, phenological monitoring, economic damage criteria, protection of natural enemies, the use of entomopathogenic microorganisms, and digital monitoring.

Keywords: fruit moths; Yponomeutidae; Yponomeuta; apple moth; integrated management; IPM; pheromone monitoring; biological control; entomophages; entomopathogens; forecasting

O'ZBEKCHA

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Annotatsiya. Maqolada O'zbekistonning janubiy hududlari, xususan Qashqadaryo va Surxondaryo viloyatlarida meva bog'larida uchraydigan meva kuyalarining zararliligini kamaytirishga qaratilgan zamonaviy integratsiyalashgan himoya tizimi yoritilgan. Meva kuyalari, ayniqsa Yponomeutidae oilasi vakillari, meva daraxtlarining barg apparatiga zarar yetkazib, fotosintetik faollikni susaytirishi hamda hosildorlik va meva sifatiga salbiy ta'sir ko'rsatishi mumkin. Zamonaviy yondashuvda zararkunandalarga qarshi kurash agroteknika, mexanika, biologik, bioteknika va zarurat tug'ilganda selektiv kimyoviy usullarni yagona tizimga birlashtirishga asoslanadi. Maqolada feromon monitoringi, fenologik kuzatuv, iqtisodiy zarar mezonlari, tabiiy kushandalarni muhofaza qilish, entomopatogen mikroorganizmlardan foydalanish va raqamli monitoringning istiqbollari tahlil qilingan.

Kalit so'zlar: meva kuyalari; Yponomeutidae; Yponomeuta; olma kuyasi; integratsiyalashgan himoya; IPM; feromon monitoring; biologik kurash; entomofaglar; entomopatogenlar; prognoz

РУССКИЙ

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Аннотация. В статье описывается современная комплексная система защиты, направленная на снижение вредности плодовых молей, встречающихся в садах южных регионов Узбекистана, в частности, Кашкадарьинской и Сурхандарьинской областей. Плодовые моли,

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особенно представители семейства Yponomeutidae, могут повреждать листовой аппарат плодовых деревьев, снижать фотосинтетическую активность и негативно влиять на урожайность и качество плодов. В современном подходе борьба с вредителями основана на интеграции агротехнических, механических, биологических, биотехнических и, при необходимости, селективных химических методов в единую систему. В статье анализируются перспективы феромонного мониторинга, фенологического мониторинга, экономических критериев ущерба, охраны естественных врагов вредителей, использования энтомопатогенных микроорганизмов и цифрового мониторинга.

Ключевые слова: плодовые моли; Yponomeutidae; Yponomeuta; яблоневая моль; интегрированная борьба с вредителями; IPM; феромонный мониторинг; биологический контроль; энтомофаги; энтомопатогены; прогнозирование

1. KIRISH

Introduction

Mevachilik O'zbekiston qishloq xo'jaligining muhim tarmoqlaridan biri bo'lib, mamlakatning janubiy hududlari issiq vegetatsiya davri va meva yetishtirish uchun qulay agroiklimiy sharoitlari bilan ajralib turadi. Biroq yuqori harorat, suv ta'minotidagi o'zgaruvchanlik, bog'larning intensivlashuvi va zararkunandalarning biologik xususiyatlari fitosanitar xavflarni oshirishi mumkin.

Yponomeutidae oilasiga mansub turlar meva bog'larida muhim zararkunanda sifatida namoyon bo'lishi mumkin. Masalan, olma meva kuyasi — Yponomeuta malinellus Zeller lichinka bosqichida barglarga zarar yetkazib, kuchli zararlanishda daraxtning fotosintetik apparatini susaytiradi.

Zamonaviy entomologiyada maqsad zararkunandani mutlaq yo'q qilish emas, balki uning populyatsiya zichligini iqtisodiy jihatdan maqbul darajada ushlab turishdir. Shu nuqtai nazaridan integratsiyalashgan zararkunanda boshqaruvi (IPM) monitoring, profilaktika, biologik, mexanik, agroteknik va zaruratda kimyoviy choralarni uyg'unlashtiradi.

1.1. Tadqiqotning maqsadi

Tadqiqotning maqsadi O'zbekistonning janubiy hududlarida tarqalgan meva kuyalariga qarshi ekologik xavfsiz, iqtisodiy samarali va zamonaviy texnologiyalarga asoslangan integratsiyalashgan himoya tizimini ilmiy jihatdan asoslashdan iborat. Asosiy vazifalar:

- 1) meva kuyalarining tarqalishi va mavsumiy rivojlanishini monitoring qilish;
- 2) populyatsiya dinamikasini aniqlash;
- 3) feromon va vizual kuzatuv usullarini birlashtirish;
- 4) tabiiy kushandalar faoliyatini baholash;
- 5) agroteknik va mexanik choralarni takomillashtirish;
- 6) biologik himoya vositalarining istiqbolini baholash;
- 7) iqlim ma'lumotlari asosida prognozlash;
- 8) IPM modeli ishlab chiqish.

2. TADQIQOT OBYEKTI VA METODOLOGIYASI

Materials and methods

Tadqiqotlarni janubiy O'zbekistonning mevacchilikka ixtisoslashgan hududlaridagi olma, nok va boshqa urug'li meva bog'larida tashkil etish maqsadga muvofiq.

Monitoringda feromon tutqichlar, vizual marshrut kuzatuvlari, zararlangan barg va novdalarni hisoblash, lichinka va g'umbaklar zichligini aniqlash, tabiiy kushandalarni hisobga olish, meteorologik ma'lumotlarni yig'ish, GPS asosida zararlanish nuqtalarini belgilash va elektron ma'lumotlar bazasini shakllantirish usullaridan foydalanish mumkin.

3. NATIJALAR

Results

Meva kuyalarining zarariligi. Meva kuyalarining zarariligi asosan lichinka bosqichi bilan bog'liq. Lichinkalar barg to'qimalari bilan oziqlanishi natijasida fotosintetik faol yuza kamayadi. Kuchli zararlanish daraxtning fiziologik holati va hosildorligiga ta'sir qilishi mumkin.

Yponomeuta malinellus lichinkalari dastlab barg to'qimalarini zararlaydi, keyinchalik bir nechta bargni ipaksimon to'rlar bilan birlashtirib koloniya hosil qiladi. Shuning uchun zararkunanda rivojlanishining dastlabki bosqichlarida aniqlash va boshqarish muhim.

Bog'larni sanitar holatda saqlash, zararlangan qismlarni o'z vaqtida olib tashlash, daraxt tojini meyorda shakllantirish, qalinlashgan shox-shabbani siyraklashtirish, sug'orish va oziqlantirish rejimini muvozanatlashtirish muhim. Agroteknik tadbirlarning maqsadi zararkunandani to'g'ridan-to'g'ri yo'q qilishdan ko'ra daraxtlarning fiziologik barqarorligini oshirish va zarar natijasini kamaytirishdir.

Feromon tutqichlar yordamida imagolarning uchish davri, avlodlar soni, populyatsiya dinamikasi va zararkunanda faolligining boshlanishi aniqlanishi mumkin. Eng muhim afzallik — qarorni kalendar sanasiga emas, real populyatsiya dinamikasiga asoslashdir. Kelgusida feromon tutqichlarini avtomatik hisoblagichlar, mobil ilovalar va geoaxborot tizimlari bilan integratsiyalash mumkin.

Tabiiy entomofaglarni muhofaza qilish zararkunanda populyatsiyasini tabiiy ravishda cheklashning muhim mexanizmi hisoblanadi. Yponomeuta malinellus bo'yicha tadqiqotlarda parazitoidlar qayd etilgan.

Ageniaspis fuscicollis kabi parazitoidlarning olma kuyasi populyatsiyasiga ta'siri xorijiy tadqiqotlarda o'rganilgan. Biroq O'zbekiston sharoitida xorijiy entomofaglarni joriy etishdan oldin ularning xavfsizligi, xo'jayin doirasi va samaradorligi ilmiy baholanishi shart.

Entomopatogen zamburug'lar, bakteriyalar va boshqa mikrobiologik vositalar zamonaviy biologik himoyaning istiqbolli yo'nalishlaridir. Yponomeuta malinellus ga qarshi entomopatogen zamburug'lardan foydalanish imkoniyatlari bo'yicha tadqiqotlar olib borilgan.

Janubiy O'zbekistonda ushbu vositalarning samaradorligi harorat, namlik va zararkunanda rivojlanish bosqichlari bilan bog'liq holda alohida o'rganilishi lozim.

Zararlangan barg va to'rlarni aniqlash, zararlangan qismlarni mexanik olib tashlash, sanitar kesish va zararlangan o'simlik qismlarini bog'dan chiqarish kichik va o'rta hajmdagi bog'larda samarali bo'lishi mumkin.

Zamonaviy IPM tizimida zararkunanda aniqlangani bilan avtomatik ravishda kimyoviy ishlov berilmaydi. Qaror qabul qilishda zararkunanda zichligi, zararlanish darajasi, tabiiy

kushandalar faolligi, o'simlik fenologiyasi, ob-havo va kutilayotgan iqtisodiy zarar kompleks baholanadi.

Har bir kuzatuv nuqtasini GPS koordinatalari bilan qayd etish, zararkunanda zichligi, fenologik faza, harorat, nisbiy namlik, yog'ingarchilik va tabiiy kushandalar haqidagi ma'lumotlarni elektron bazaga kiritish mumkin.

Keyinchalik ushbu ma'lumotlar asosida zararkunanda rivojlanishining qisqa muddatli prognoz modeli ishlab chiqilishi mumkin. "Meteostansiya + feromon tutqich + dalaviy kuzatuv + raqamli prognoz" kombinatsiyasi fitosanitar qarorlarni aniqlashtirish imkonini beradi.

Janubiy O'zbekistonda yuqori harorat va iqlim o'zgaruvchanligi zararkunandalar fenologiyasiga ta'sir qilishi mumkin. Shu sababli himoya tadbirlarini faqat kalendar muddatlariga emas, har yili yangilanadigan fenologik va meteorologik ma'lumotlarga asoslash maqsadga muvofiq.

Kimyoviy himoya integratsiyalashgan tizimda butunlay istisno qilinmaydi, ammo monitoring natijalari zararkunanda iqtisodiy xavfli darajaga yetganini ko'rsatgan holatda qo'llanishi lozim.

Bunda O'zbekistonda rasman ruxsat etilgan vositalardan foydalanish, selektiv ta'sirga ega preparatlarni ustuvor ko'rish, tabiiy kushandalarni asrash, ta'sir mexanizmini navbatlashtirish va yorliq talablariga rioya qilish muhim.

4. MUHOKAMA

Discussion

Janubiy O'zbekistonda meva kuyalariga qarshi kurashda eng muhim masalalardan biri himoya tadbirlarini zararkunanda populyatsiyasining real dinamikasiga bog'lashdir. Harorat va namlik yillar bo'yicha farq qilishi sababli kalendar bo'yicha ishlov berish har doim ham optimal natija bermasligi mumkin.

Shuning uchun «kalendar bo'yicha ishlov berish» modeli o'rniga «monitoring asosida qaror qabul qilish» modeli joriy qilinishi lozim. Kimyoviy vositalarga ortiqcha tayanish tabiiy entomofaunaga salbiy ta'sir qilishi va rezistentlik xavfini oshirishi mumkin.

5. XULOSA

Conclusion

O'zbekistonning janubiy hududlarida meva kuyalariga qarshi samarali kurash zararkunandani faqat kimyoviy usulda yo'q qilishga emas, balki uning populyatsiyasini ekotizim doirasida boshqarishga asoslanishi va quyidagilarga e'tibor qaratish kerak bo'ladi:

- Integratsiyalashgan himoya tizimi maqbul yondashuvlardan biridir;
- Feromon monitoringi zararkunanda uchish dinamikasini aniqlash imkonini beradi;
- Kurash kalendar muddatlari emas, monitoring natijalari asosida tashkil qilinishi kerak;
- Tabiiy entomofaglarni muhofaza qilish muhim biologik mexanizmdir;
- Entomopatogen zamburug'lar va boshqa biologik vositalarni mahalliy sharoitda sinovdan o'tkazish istiqbolli;
- Meteorologik ma'lumotlar, feromon monitoringi va raqamli texnologiyalarni birlashtirish prognozlashni yaxshilaydi;
- Kimyoviy himoya faqat iqtisodiy xavf asoslangan holatda qo'llanishi kerak;
- Janubiy O'zbekiston uchun eng istiqbolli modeli: "monitoring + prognozlash + biologik himoya + agrotexnik profilaktika + zaruratda selektiv himoya".

DECLARATIONS

Declarations

Author contributions *CRedit*

Conceptualization; Methodology; Investigation; Writing – original draft; Writing – review & editing. The author has read and agreed to the published version of the manuscript.

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Ethics approval

The article is based on an analysis of published scientific literature and monitoring methods for insect pests of orchards; the work involved no experiments on vertebrate animals and no human participants, and therefore required no separate ethics committee approval.

Informed consent

The author has read and approved the final version of the manuscript and has given his consent to its submission and publication. The study involved no human participants and no personal data.

Data availability statement

All sources analysed in the article are listed in the reference list; no new datasets were generated.

Conflict of interest

The author declares no conflict of interest.

Generative AI disclosure

Generative AI (Claude, Anthropic) was used in the editorial preparation of this article: for language editing, translation of the title, abstract and keywords between Uzbek, Russian and English, preparation of the extended English summary from the author's text, and formatting of the reference list. No data, results or conclusions were generated by AI. The author is responsible for the content of the publication.

EXTENDED SUMMARY IN ENGLISH

Kengaytirilgan inglizcha xulosa / Расширенный реферат на английском языке

Purpose and research problem

Fruit growing is one of the important branches of agriculture in Uzbekistan, and the southern regions of the country are distinguished by a warm growing season and favourable agro-climatic conditions for fruit production. At the same time, high temperatures, variable water supply, the intensification of orchards and the biological features of pests can increase phytosanitary risks. Species of the family Yponomeutidae can become important orchard pests; for example, the apple ermine moth *Yponomeuta malinellus* Zeller damages leaves at the larval stage and, under heavy infestation, weakens the photosynthetic apparatus of the tree. Modern entomology aims not at the complete elimination of a pest but at keeping its population density at an economically acceptable level, and integrated pest management (IPM) combines monitoring, prevention and biological, mechanical, agrotechnical and, when necessary, chemical measures. The aim of the work was to substantiate an ecologically safe, economically effective and technology-based integrated protection system against fruit moths in the southern regions of Uzbekistan, with tasks covering the monitoring of moth distribution and seasonal development, population dynamics, the combination of pheromone and visual surveys, the assessment of natural enemies, the improvement of agrotechnical and mechanical measures, the prospects of biological control, climate-based forecasting and the development of an IPM model.

Materials and methods

The author proposes that the studies be organised in apple, pear and other pome-fruit orchards in the fruit-growing areas of southern Uzbekistan, in particular the Kashkadarya and Surkhandarya regions. The monitoring methods considered include pheromone traps, visual route surveys, counting of damaged leaves and shoots, determination of the density of larvae and pupae, accounting of natural enemies, collection of meteorological data, GPS marking of infestation points and the creation of an electronic database. The article analyses these

approaches on the basis of published international studies and FAO materials on integrated pest management, and the national legislation on plant protection.

Results and discussion

The harmfulness of fruit moths is associated mainly with the larval stage: feeding on leaf tissue reduces the photosynthetically active surface, and heavy damage can affect the physiological condition and yield of the tree. Larvae of *Y. malinellus* first damage the leaf tissue and then join several leaves with silken webs into colonies, so early detection and management are essential. Agrotechnical measures — orchard sanitation, timely removal of damaged parts, proper crown formation, thinning of dense branches and balanced irrigation and nutrition — aim mainly at increasing the physiological resistance of the trees. Pheromone traps make it possible to determine the flight period of adults, the number of generations, population dynamics and the onset of pest activity, so that decisions are based on real population dynamics rather than on calendar dates; in future the traps can be integrated with automatic counters, mobile applications and geographic information systems. The conservation of natural enemies is an important mechanism of natural population regulation: parasitoids of *Y. malinellus*, including *Ageniaspis fuscicollis*, have been studied abroad, but their safety, host range and efficiency must be evaluated scientifically before any introduction into Uzbekistan. Entomopathogenic fungi, bacteria and other microbiological agents are promising, and their efficiency in southern Uzbekistan should be studied in relation to temperature, humidity and the developmental stages of the pest. Mechanical removal of damaged leaves and webs and sanitary pruning can be effective in small and medium orchards. In modern IPM, detection of a pest does not automatically lead to chemical treatment: the decision takes into account pest density, the degree of damage, the activity of natural enemies, plant phenology, weather and the expected economic loss. Recording each observation point with GPS coordinates together with pest density, phenological phase, temperature, humidity, precipitation and natural enemies allows short-term forecasting models to be developed, and the combination "weather station + pheromone trap + field survey + digital forecast" refines phytosanitary decisions. Chemical protection is not excluded from the integrated system but should be used only when monitoring shows that the pest has reached an economically dangerous level, with officially approved and selective products, rotation of modes of action and observance of label requirements.

Conclusion and contribution

Because temperature and humidity vary from year to year, calendar-based treatments do not always give optimal results, and the author recommends replacing the "calendar treatment" model with "monitoring-based decision making"; excessive reliance on chemicals may harm the natural entomofauna and increase the risk of resistance. Effective control of fruit moths in southern Uzbekistan should be based on managing the pest population within the ecosystem rather than on chemical elimination alone. The integrated protection system is one of the optimal approaches; pheromone monitoring reveals the flight dynamics of the pest; control should be organised according to monitoring results rather than calendar dates; the conservation of natural enemies is an important biological mechanism; entomopathogenic fungi and other biological agents should be tested under local conditions; and meteorological data, pheromone monitoring and digital technologies should be combined for forecasting. The most promising model for southern Uzbekistan is "monitoring + forecasting + biological protection + agrotechnical prevention + selective protection when necessary".

ADABIYOTLAR RO'YXATI

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