10.63241/AKHVvol119y2026iss4m1

UDC: 632.937:632.7

INFLUENCE OF ECOLOGICAL FACTORS ON THE FORMATION OF WHITEFLY (*BEMISIA TABACI* GENN.) POPULATIONS

Sulaymonov Botirjon Abdushukirovich
Advisor to the Rector, Tashkent University of Economics and Pedagogy
Doctor of Biological Sciences, Academician
e-mail: info@tipu.uz
Buronov Yusuf Xudaynazarovich
Director of Republican Center for Bioquality
associate professor
Musurmonqulova Maftuna Mansur qizi
master's student, Tashkent State Agrarian University
Turdimatova Nodira Shermuratovna
master's student, Tashkent State Agrarian University

Abstract. The present study investigated the influence of ecological factors on the formation and development of whitefly populations belonging to the family Aleyrodidae, particularly greenhouse whitefly (*Trialeurodes vaporariorum* West.) and cotton whitefly (*Bemisia tabaci* Genn.), in vegetable and melon crop agrobiocenoses. The research focused on determining the effects of air temperature, relative humidity, and host plant species on pest population density under open-field conditions. Field experiments were conducted on several economically important crops, including cucumber (*Cucumis sativus* L.), melon (*Cucumis melo* L.), pumpkin (*Cucurbita pepo* L.), watermelon (Citrullus lanatus L.), tomato (*Solanum lycopersicum* L.), eggplant (Solanum melongena L.), sweet pepper (*Capsicum annuum* L.), cabbage (*Brassica oleracea* L.), and carrot (*Daucus carota* L.). Entomological and ecological observation methods were applied during the study. Environmental parameters, including air temperature and relative humidity, were continuously monitored throughout the vegetation period. During the experiments, air temperature ranged from +22.4°C to 44.6°C, while relative humidity varied between 32% and 67%.

The obtained results demonstrated that ecological conditions and host plant characteristics significantly affected whitefly population density. The highest infestation levels were recorded on melon crops, where the average population density reached 84.8 individuals per leaf. High population density was also observed on pumpkin (74.7 individuals/leaf), cucumber (72.2 individuals/leaf), and eggplant (*Solanum melongena* L.) with 70.5 individuals per leaf. Moderate infestation levels were detected on sweet pepper (52.2 individuals/leaf), watermelon (48.6 individuals/leaf), and cabbage (48.3 individuals/leaf). The lowest infestation level among the investigated crops was recorded on tomato plants, where the average density reached 41.4 individuals per leaf. The study revealed that cucurbit crops create highly favorable ecological and nutritional conditions for whitefly development and reproduction. Increased relative humidity and moderate temperatures promoted population growth and accelerated pest development. Differences in infestation levels among crops were associated with plant biological characteristics, leaf morphology, nutritional composition, and microclimatic conditions within the agrobiocenosis.

The results indicate that ecological regulation methods may play an important role in integrated whitefly management. Proper crop placement, optimization of irrigation regimes, maintenance of balanced humidity conditions, and the cultivation of relatively resistant crops may contribute to reducing pest population density without excessive application of chemical pesticides. The findings provide valuable scientific information on the ecological features of whitefly population dynamics and may serve as a basis for developing environmentally safe and sustainable pest management systems in vegetable and melon crop production.

Keywords: whitefly, *Aleyrodidae*, *Bemisia tabaci*, *Trialeurodes vaporariorum*, ecological factors, population density, host plants, relative humidity, air temperature, cucurbit crops, *Cucumis melo*, *Cucurbita pepo*, *Solanum melongena*, biological control, pest management.

Annotatsiya. Mazkur tadqiqotda Aleyrodidae oilasiga mansub oqkanotlar, xususan issiqxona oqkanoti (*Trialeurodes vaporariorum* West.) va g‘o‘za oqkanoti (*Bemisia tabaci* Genn.) populyatsiyalarining sabzavot va poliz ekinlari agrobiotsenozlarida shakllanishi hamda rivojlanishiga ekologik omillarning ta’siri o‘rganildi. Tadqiqot ochiq dala sharoitida havo harorati, nisbiy namlik va o‘simlik xo‘jayin turlarining zararkunanda populyatsiyasi zichligiga ta’sirini aniqlashga qaratildi. Dala tajribalari iqtisodiy jihatdan muhim bo‘lgan bodring (*Cucumis sativus* L.), qovun (*Cucumis melo* L.), qovoq (*Cucurbita pepo* L.), tarvuz (*Citrullus lanatus* L.), pomidor (*Solanum lycopersicum* L.), baqlajon (*Solanum melongena* L.), bulg‘or qalampiri (*Capsicum annuum* L.), karam (*Brassica oleracea* L.) va sabzi (*Daucus carota* L.) ekinlarida olib borildi. Tadqiqot davomida entomologik va ekologik kuzatuv usullaridan foydalanildi. Vegetatsiya davri davomida havo harorati va nisbiy namlik muntazam monitoring qilindi. Tajribalar davrida havo harorati +22,4°C dan 44,6°C gacha, nisbiy namlik esa 32% dan 67% gacha o‘zgardi.

Olingan natijalar ekologik sharoitlar va o‘simlik xo‘jayinlarining xususiyatlari oqkanot populyatsiyasi zichligiga sezilarli ta’sir ko‘rsatishini aniqladi. Eng yuqori zararlanish darajasi qovun ekinlarida kuzatilib, o‘rtacha populyatsiya zichligi bir bargda 84,8 donaga yetdi. Yuqori populyatsiya zichligi qovoqda (74,7 dona/barg),

bodringda (72,2 dona/barg) va baqlajonda (70,5 dona/barg) ham qayd etildi. O‘rtacha zararlanish darajasi bulg‘or qalampirida (52,2 dona/barg), tarvuzda (48,6 dona/barg) va karamda (48,3 dona/barg) kuzatildi. Tadqiq qilingan ekinlar orasida eng past zararlanish pomidorda aniqlanib, o‘rtacha zichlik bir bargda 41,4 donani tashkil etdi. Tadqiqot poliz ekinlari oqkanotlarning rivojlanishi va ko‘payishi учун juda qulay ekologik hamda oziqlanish sharoitlarini yaratishini ko‘rsatdi. Nisbiy namlikning ortishi va mo‘tadil harorat populyatsiya o‘sishini jadallashtirib, zararkunanda rivojlanishini tezlashtirdi. Ekinlar o‘rtasidagi zararlanish farqlari o‘simliklarning biologik xususiyatlari, barg morfologiyasi, oziq moddalari tarkibi va agrobiotsenozdagi mikroiqlim sharoitlari bilan bog‘liq ekanligi aniqlandi.

Natijalar ekologik boshqaruv usullari oqkanotlarga qarshi uyg‘unlashgan kurash tizimida muhim ahamiyat kasb etishini ko‘rsatdi. Ekinlarni to‘g‘ri joylashtirish, sug‘orish rejimini optimallashtirish, muvozanatli namlikni saqlash va nisbatan chidamli ekinlarni yetishtirish kimyoviy pestitsidlarni ortiqcha qo‘llamasdan zararkunanda populyatsiyasi zichligini kamaytirishga yordam berishi mumkin. Olingan ma’lumotlar oqkanot populyatsiyasi dinamikasining ekologik xususiyatlari haqida muhim ilmiy axborot berib, sabzavot va poliz ekinlarida ekologik xavfsiz va barqaror himoya tizimlarini ishlab chiqish uchun asos bo‘lib xizmat qiladi.

Kalit so‘zlar: oqqanot, Aleyrodidae, *Bemisia tabaci*, *Trialeurodes vaporariorum*, ekologik omillar, populyatsiya zichligi, xo‘jayin o‘simliklar, nisbiy namlik, havo harorati, poliz ekinlari, *Cucumis melo*, *Cucurbita pepo*, *Solanum melongena*, biologik nazorat, zararkunandalarni boshqarish.

Аннотация. В данном исследовании изучено влияние экологических факторов на формирование и развитие популяций белокрылок семейства Aleyrodidae, в частности тепличной белокрылки (*Trialeurodes vaporariorum* West.) и хлопковой белокрылки (*Bemisia tabaci* Genn.), в агробиоценозах овощных и бахчевых культур. Исследование было направлено на определение влияния температуры воздуха, относительной влажности и растений-хозяев на плотность популяции вредителя в условиях открытого грунта. Полевые опыты проводились на экономически важных культурах: огурце (*Cucumis sativus* L.), дыне (*Cucumis melo* L.), тыкве (*Cucurbita pepo* L.), арбузе (Citrullus lanatus L.), томате (*Solanum lycopersicum* L.), баклажане (Solanum melongena L.), сладком перце (*Capsicum annuum* L.), капусте (*Brassica oleracea* L.) и моркови (*Daucus carota* L.). В ходе исследования применялись энтомологические и экологические методы наблюдений. На протяжении вегетационного периода проводился постоянный мониторинг температуры воздуха и относительной влажности. В период экспериментов температура воздуха варьировала от +22,4°C до 44,6°C, а относительная влажность от 32% до 67%.

Полученные результаты показали, что экологические условия и особенности растений-хозяев существенно влияют на плотность популяции белокрылки. Наибольший уровень заселения был отмечен на дыне, где средняя

плотность популяции достигала 84,8 особей на лист. Высокая плотность также наблюдалась на тыкве (74,7 особей/лист), огурце (72,2 особей/лист) и баклажане (70,5 особей/лист). Средний уровень заселения отмечен на сладком перце (52,2 особей/лист), арбузе (48,6 особей/лист) и капусте (48,3 особей/лист). Наименьшая степень заселения среди исследованных культур была зарегистрирована на томате, где средняя плотность составила 41,4 особей на лист. Исследование показало, что бахчевые культуры создают наиболее благоприятные экологические и трофические условия для развития и размножения белокрылки. Повышенная относительная влажность и умеренные температуры способствовали росту популяции и ускорению развития вредителя. Различия в уровнях заселения между культурами были связаны с биологическими особенностями растений, морфологией листьев, питательным составом и микроклиматическими условиями агробиоценоза.

Полученные результаты свидетельствуют о том, что методы экологического регулирования могут играть важную роль в системе интегрированной защиты растений от белокрылки. Правильное размещение культур, оптимизация режимов орошения, поддержание сбалансированной влажности и выращивание относительно устойчивых культур могут способствовать снижению численности вредителя без чрезмерного применения химических пестицидов. Результаты исследования представляют важную научную информацию об экологических особенностях динамики популяций белокрылки и могут служить основой для разработки экологически безопасных и устойчивых систем защиты овощных и бахчевых культур.

Ключевые слова: Белокрылка, Aleyrodidae, *Bemisia tabaci*, *Trialeurodes vaporariorum*, экологические факторы, плотность популяции, растения-хозяева, относительная влажность, температура воздуха, бахчевые культуры, Cucumis melo, Cucurbita pepo, Solanum melongena, биологический контроль, управление вредителями.

INTRODUCTION

Despite many years of scientific research and the development of new plant protection products, effective control methods against several pest species remain insufficient. In particular, serious damage is caused in agriculture by whitefly species belonging to the family Aleyrodidae of the order Homoptera, including the greenhouse whitefly (*Trialeurodes vaporariorum* West.), cotton whitefly (*Bemisia tabaci* Genn.), and citrus whitefly (*Dialeurodes citri* A.). These pests infest more than 200 vegetable and melon crops, over 30 technical crops, and more than 60 species of ornamental flowers and shrubs. Therefore, regulation of these pest populations requires the improvement of environmentally safe and effective ecological control methods. To date, scientists have not reached a unified conclusion regarding the formation of host parasitoid relationships in nature. Each phytophagous species is associated with entomophagous species; however, even when the diversity of natural enemies is high, they are not always capable of effectively regulating pest populations. Optimal air temperature plays an important role in the development of whiteflies and their parasitoid Encarsia partenopea Masi, while each species possesses specific ecological characteristics.

Tobacco whitefly, cotton whitefly, and greenhouse whitefly possess several ecologically differentiated forms that are interpreted under different names. According to scientific literature, each species has more than ten synonymous names used in different countries and regions by local populations (Striganova B.R., Zakharov A.A., 2000). Researchers indicate that one of the main reasons for the imbalance between whiteflies and their parasitoids is the diversity of ecological factors influencing their development. For example, some scientists reported that 25°C is the optimal temperature for the development of Encarsia partenopea Masi, whereas temperatures below 15°C are unfavorable (Kimsanboev Kh.Kh., Zakhidov F.M., Kadyrov A., 1997). Furthermore, environmental conditions with elevated temperatures play a major role in both the increase and sharp decline of whitefly populations (Shivanna B.K., Nagaraja D.N., Manjunatha M., Naik M.I., 2009; Selvaraj S., Ramesh V., 2012; Ashfaq M., Ane M.N.U., Zia K., Nasreen A., Hasan M.U., 2010). Such scientific findings contribute to understanding the mechanisms responsible for rapid increases in whitefly populations.

Consequently, ecological factors can be used as a basis for pest population management. For example, the development of cotton whitefly (*B.tabaci*) is closely associated with temperature conditions, while host plant species also play an important role in shaping interactions between the pest and the plant. In Egypt, one generation of whitefly develops within 14-20 days during summer, whereas in winter greenhouse conditions development requires 74-75 days (Azab et al., 1971). At an air temperature of 26.7°C, the developmental duration of one generation depends on the host plant species; populations feeding on cabbage and carrot leaves complete development approximately 30% later than those feeding on lettuce, cucumber, eggplant, and squash (Coudriet et al., 1985). Under the conditions of Uzbekistan, the influence of ecological factors on the development of greenhouse whitefly populations on different vegetable crops was investigated. The objective of the study was to evaluate the effects of ecological conditions on whitefly population density and to determine the dependence of population fluctuations on crop species.

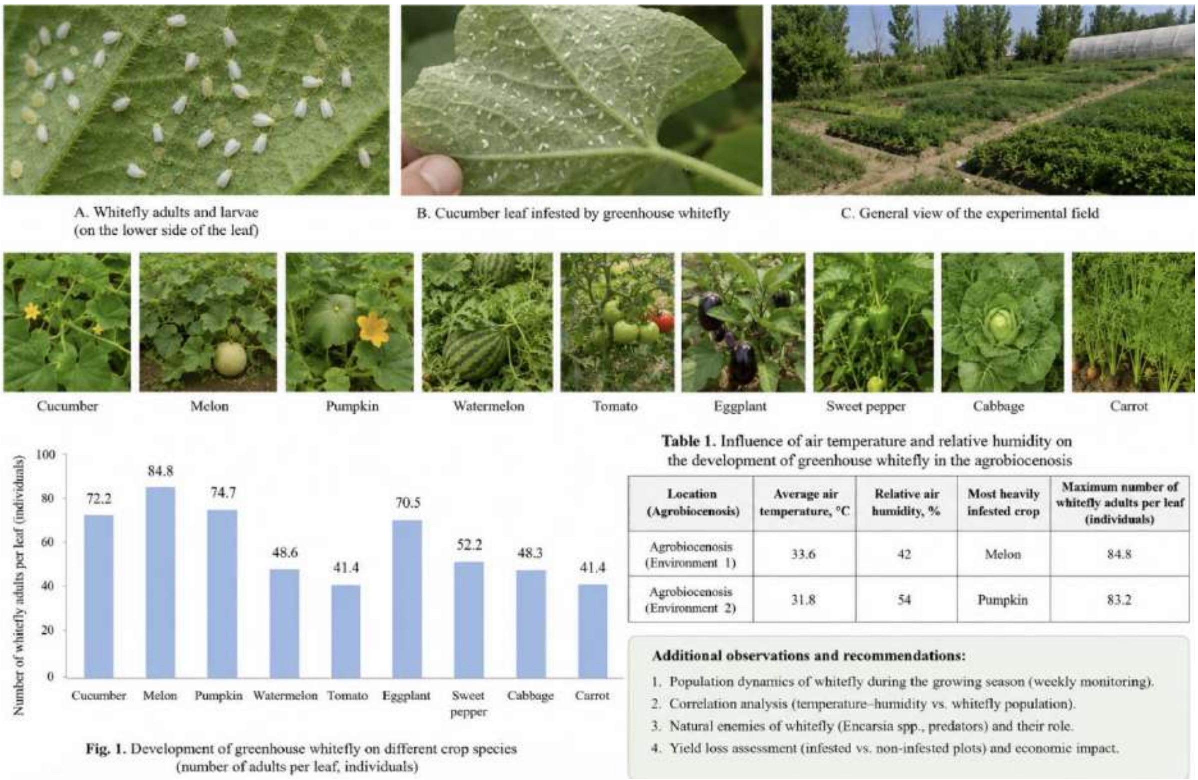
MATERIALS AND METHODS

The experiments were conducted in open-field vegetable crop areas characterized by different ecological conditions. The Syrdarya region, representing relatively xerophilic conditions, and the Tashkent region, representing relatively hygrophilic conditions, were selected for comparative studies. Among cucurbit crops, cucumber (*Cucumis sativus* L.), pumpkin (*Cucurbita pepo* L.), and melon (*Cucumis melo* L.) were cultivated. In addition, tomato (*Solanum lycopersicum* L.), eggplant (*Solanum melongena* L.), and sweet pepper (*Capsicum annuum* L.)

belonging to the family Solanaceae were planted in experimental plots of one hundred square meters each. Entomological research methods were applied throughout the study. Soil and climatic conditions of the experimental regions were continuously monitored. Vegetable and melon crop cultivation practices were carried out according to the methods of B.D. Azimov (1995). During the experiments, the minimum air temperature reached +22.4°C, while the maximum air temperature reached 44.6°C. Relative air humidity varied from 32% to 67%.

RESULTS AND DISCUSSION

The obtained results demonstrated significant differences among experimental variants. Relative humidity and air temperature were monitored daily in cucurbit crops under both regional conditions. The experiments included all developmental stages of the crops, from true leaf emergence to flowering, fruit formation, and ripening. During periods when nighttime air temperature averaged 26°C, whitefly generations developed differently depending on crop species.



Location (Agrobiocenosis)	Average air temperature, °C	Relative air humidity, %	Most heavily infested crop	Maximum number of whitefly adults per leaf (individuals)
Agrobiocenosis (Environment 1)	33.6	42	Melon	84.8
Agrobiocenosis (Environment 2)	31.8	54	Pumpkin	83.2

Figure 1. Influence of ecological factors on the development of greenhouse whitefly (*Bemisia tabaci* Genn.) populations in vegetable and melon crop agrobiocenoses.

According to the obtained results, the population density of greenhouse whitefly differed depending on crop species and ecological conditions. The highest infestation level was observed on melon crops, where the average number of whiteflies reached 84.8 individuals per leaf. High population density was also recorded on pumpkin (74.7 individuals/leaf), cucumber (72.2 individuals/leaf), and eggplant (70.5 individuals/leaf). Moderate infestation levels were observed on sweet pepper (52.2 individuals/leaf), watermelon (48.6 individuals/leaf), and carrot (48.3 individuals/leaf). The lowest infestation level among the studied crops was detected on tomato plants, where the average population density reached 41.4 individuals per leaf.

The obtained results indicate that cucurbit crops, particularly melon and pumpkin, create favorable ecological and nutritional conditions for whitefly development and reproduction. In contrast, tomato plants were relatively less favorable for pest population formation. These differences may be associated with host plant biological characteristics, leaf morphology, nutritional composition, and microclimatic conditions around the plants.

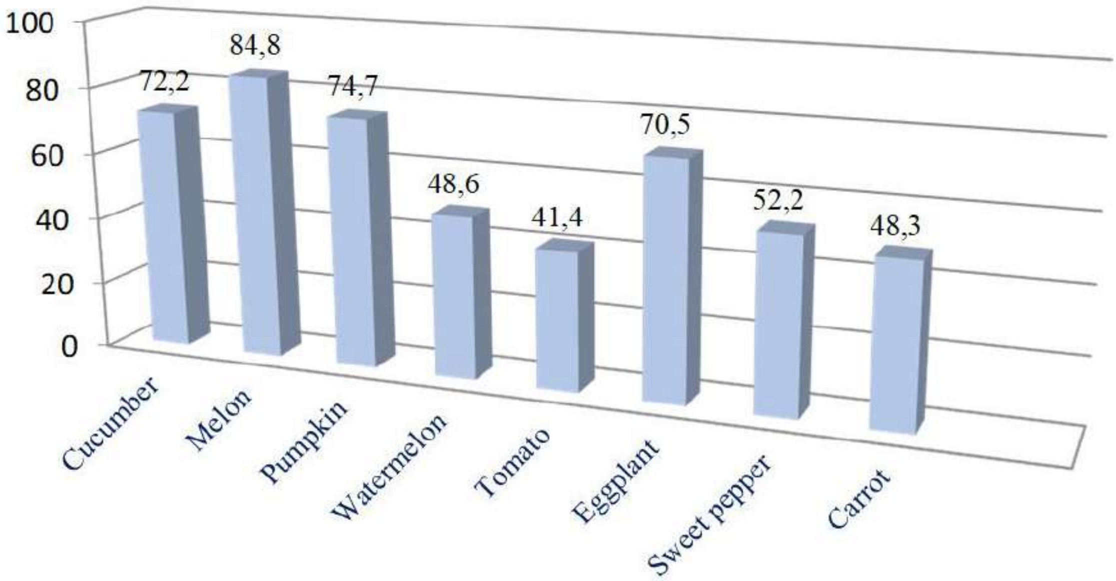


Figure 2. Development of greenhouse whitefly populations on different crop species.

For example, under conditions where the air temperature was 33.6°C and relative humidity was 42%, the whitefly population density on cabbage plants reached 53.9 individuals per leaf. However, under conditions with an air temperature of 31.8°C and relative humidity of 54%, this показатель decreased to 42.7 individuals per leaf. Similar differences were also observed in other crop species. Among the investigated crops, carrot plants were the least infested and showed the lowest whitefly population density. However, among the crops belonging to the family Solanaceae, eggplant (*Solanum melongena* L.) was identified as the most favorable host plant for the formation of high whitefly populations.

CONCLUSION

The results of the present study demonstrated that ecological factors play a significant role in the formation, development, and population dynamics of greenhouse whitefly populations on various vegetable and melon crops. Air temperature, relative humidity, host plant species, and regional soil-climatic conditions directly affected the level of pest infestation and the intensity of whitefly reproduction.

Under the environmental conditions of Syrdarya region, characterized by relatively high temperatures (33.6°C) and low relative humidity (42%), whitefly populations developed differently depending on crop species. In contrast, under the comparatively moderate climatic conditions of Tashkent region (31.8°C and 54% relative humidity), whitefly population density increased on most investigated crops. These findings indicate that moderate temperature and relatively higher atmospheric humidity create favorable ecological conditions for whitefly survival, development, and reproduction.

Among the studied crops, cucurbit plants, especially melon (*Cucumis melo* L.) and pumpkin (*Cucurbita pepo* L.), were identified as the most favorable host plants for whitefly population formation. High infestation levels were also observed on cucumber (*Cucumis sativus* L.) and eggplant (*Solanum melongena* L.) crops. In contrast, carrot (*Daucus carota* L.) plants showed relatively low susceptibility to whitefly infestation. These differences are associated with the biological and morphological characteristics of host plants, nutritional quality, leaf surface structure, and microclimatic conditions surrounding the plants.

The study also confirmed that ecological management approaches may play an important role in regulating whitefly populations under field conditions. Proper crop placement, optimization of irrigation regimes, maintenance of balanced humidity conditions, and the selection of relatively resistant crop species may contribute to reducing pest population density without excessive application of chemical pesticides. In addition, understanding the ecological preferences of whiteflies may improve the effectiveness of integrated pest management (IPM) systems and biological control strategies involving natural enemies and entomophagous insects.

The obtained results provide valuable scientific information on the ecological characteristics of whitefly population development under the conditions of Uzbekistan and may serve as a practical basis for the development of environmentally safe, sustainable, and scientifically grounded pest management technologies in vegetable and melon crop production.

REFERENCES

1. Integrated Pest Management Pedigo, L.P., Rice, M.E. Entomology and Pest Management. 6th ed. New York: Pearson Education, 2014.

2. Whitefly Biology and Management Byrne, D.N., Bellows, T.S. “Whitefly biology.” In: Gerling D. Whiteflies: Their Bionomics, Pest Status and Management. Andover: Intercept Ltd., 1990. – P. 227-261.

3. Biological Control van Lenteren, J.C. IOBC Internet Book of Biological Control. Wageningen: International Organisation for Biological Control, 2012.

4. Entomology Hoddle, M.S., van Driesche, R.G., Sanderson, J.P. Biology and Use of the Whitefly Parasitoid Encarsia formosa. Annual Review of Entomology, 1998. Vol. 43. – P. 645-669.

5. Agricultural Entomology Cloyd, R.A. Greenhouse Pest Management. Boca Raton: CRC Press, 2016.

6. Jumaev R.A, Karimbaevich S.S., Jumaeva N.B. *Bioecology of generations of Trichogramma diluted by different methods*. - European science review, 2018. 7-11.

7. Jumaeva N.B, Khimsanbaev X.X, Rustamov A.A. *Study and determination of the most suitable microorganism and entomophage against cotton bollworm in Uzbekistan* //Scientific Journal Of Medical Science And Biology. – 2024. - T. 2. - №. 2. - S. 21-28.

8. Rasul Jumaev. *Methods of determining the optimal temperature and humidity in dryness and storage of in vitro propagated parasitic entomophages*. *E3S Web of Conferences*. 2024. – P. 553. https://doi.org/10.1051/e3sconf/202456303003.

9. Rasul Jumaev, Abdurakhim Kuchboev, Nozimakhon Jumaeva, Farukh Yakubov, Shamsi Esanbaev. *Molecular identification and polymerase chain reaction analysis of Xanthogaleruca Luteola (Chrysomelidae) species*. *E3S Web of Conferences*. 2024. –P. 563. https://doi.org/10.1051/e3sconf/202456303001.

10. Rasul Jumaev. *Invitro rearing of parasitoids*. *E3S Web of Conferences* 371, 01032 (2023). https://doi.org/10.1051/e3sconf/202337101032.

11. Rasul Jumaev. *Methods of determining the optimal temperature and humidity in dryness and storage of in vitro propagated parasitic entomophages*. E3S Web Conf. Volume 563, 2024. 1-6. https://doi.org/10.1051/e3sconf/202456303003.

12. Lebedeva N, Akhmedova Z, Kholmatov B, Jumaev R. *Revision of stoneflies insecta: plecoptera fauna in Uzbekistan*. E3S Web of Conferences 258, 08030 (2021). https://doi.org/10.1051/e3sconf/202125808030.

13. Sulaymonov O, Jumaev R., Sobirov B, Gazibekov A. *Representatives of Lepidoptera groups occurred in forestry and agricultural crops and their effective entomophage types*. E3S Web of Conferences 244, 02020 (2021).https://doi.org/10.1051/e3sconf/202124402020.

14. Kimsanboev K, Rustamov A, Usmonov M, R.Jumaev. *Euzophera Punicaella Mooze Lepidoptera bioecology and development of host entomophagic equilibrium in biocenosis*. E3S Web of Conferences 244, 01003 (2021). https://doi.org/10.1051/e3sconf/202124401003.

15. Rasul Jumaev. *In vitro mass reproduction of parasitic entomophages Braconidae Trichogrammatidae*. E3S Web of Conferences 389, 03100 (2023). https://doi.org/10.1051/e3sconf/202338903100.

16. Esanbaev Sh, Jumaev R. *Study on stem pests of elm tree in Uzbekistan*. E3S Web of Conferences 563, *03004 (2024)*. 162-169. https://doi.org/10.1051/e3sconf/202456303004.