

The Effects of Environmental Problems on Honey Bees in view of Sustainable Life

Ekin VAROL*, Banu YÜCEL

Ege University, Faculty of Agriculture, Department of Animal Science,
Bornova-İzmir, TURKEY

* Corresponding author e-mail:ekin.varol@gmail.com

Received: 29th October, 2019; accepted: 11th December, 2019; published: 27thDecember, 2019

A B S T R A C T

The balance and the continuity of nature is decreasing day by day due to environmental problems experienced in parallel with social, economic and industrial development. Today, this increase has reached a point that threatens the magnificent life circle that has emerged as a result of thousands of years of accumulation of nature. The balance of nature is deteriorating as a result of excessive and unconscious consumption of natural resources and increasing world population. The importance of honey bees in the ecosystem is indisputable. Honey bees help pollinate plants, increasing yields and making great contributions to the agricultural ecosystem. However, environmental problems such as pesticides, chemical that used in agriculture, chemicals that use to fight against honey bee pests, predators and diseases, environmental pollution, competitive relations between honey bees, radiation, climate change, global warming, geomagnetic disturbance and Colony Collapse Disorder threatens the life of honey bees. Therefore, it is necessary to better understand environmental problems and their effects on honeybees and to specify precautions on the subject quickly.

Keywords: Honey bee, environmental problems, Pesticides, CCD, global warming

Introduction

Humankind use to take advantage of nature since its existence. However, with the opportunities of developing technology, human started to use nature limitless and consume the nature damagingly. At the beginning, these environmental damages neglected because of nature's self-

perpetuating property. Besides, it is considered that nature will remove the pollution by its natural cycle. With the qualitative and quantitative increase of environmental damage, it went beyond the nature's self-perpetuating property and environmental degradation started rapidly

[1]. There is an ecological balance and a multifaceted interaction between the main elements that make up the environment; air, water and soil. Therefore, contamination of any of the air, water and soil elements affects others negatively. In other words, contamination is not limited only in the area where it is used.

Pollinators as bees have a big influence in ecological interaction. Including honey bees, the most important function of bees, is to provide pollination of various wild and cultivated plants. Many animal species that use plants as food and nest, benefits from honey bees indirectly [2-3].

In recent years negative impacts of environmental problems threatens the life of many animal species, especially honey bees. Pesticides that used in agriculture, chemicals that use to fight against honey bee pests and diseases, environmental pollution, competitive relations between honey bees, radiation, geomagnetic field storms, climate change and global warming, Colony Collapse Disorder (CCD or Maria Celeste Syndrome) that cause remains still unknown, can cause rapid and severe honey bee losses, are the most important environmental problems for honey bees.

Synthetic Chemicals (Pesticides, Herbicides, Insecticides, Fertilizers)

Continuous agricultural protection with hundreds of pests and diseases that causes product losses on cultivated plants, becomes an unavoidable necessity to provide food requirements of rapidly increase in World population. Chemical fight become important years ago with the usage of DDT at plant production and much more types and quantities of insecticides started to use at agricultural areas.

Honeybees that are critically important for pollination and negatively affected by pesticides.

Honey bees that directly contacted with insecticide from plant, could not be able to fly and get back to hive, or even bees are able to reach hive, they die in front of the hive. Many bee poisonings occur by the usage of insecticides on blooming period of the plants. Insecticide particles stick on to pollens those forager bees carries on their hind legs.

Bee poisoning of the insecticides occur in three ways as ingestion, contact and inhalation during collecting nectar and pollen. Piles of dead bees in front of the hive are the most known sign of bee poisoning. Another sign is the decreasing

population of forager bees [4]. Many pesticides cause increase of aggression on bees. Some symptoms like lethargy, paralysis, abnormal behavior, vomiting nectar, tongue sticking out can be seen on bees that exposed to chlorinated carbon and organophosphate insecticides. Stable bees in front of hive can be observed. Dead young bees can be seen in front of the hive by the chemical poisoning with chemicals like arsenic, methyl parathion [5].

Larvae deaths occur because of the insufficient number of nurse bees that cares nursed cells. In some cases, all bees in the hive can die. Queen bee could be negatively affected by the slow-release agrochemicals, nitrit & nitrate deposits from fertilizers and heavy metals (like arsenic, lead etc.) that bring to the hive by nectar and pollen. Also abnormal behaviors and decreased egg production could be seen on queen bee. Many weak colonies could not survive winter and die.

Pests

As in all animal species, many pests, predators and diseases threaten bee life. Environmental pollution, global warming that caused by waste products and gases, intensive migratory beekeeping and improper practices on beekeeping applications causes the rapid spread of

honey bee pests and diseases. Today, *Varroa destructor* is the most harmful pest of honeybees. Varroa is a serious external parasite that causes the decreasing number of adult bees, growth deficiency of young bees, irregular brood pattern, disease-causing pathogen growth, adult bees to leave the hive, low productivity of honey and colony losses in an advanced stage [6].

Loss of Natural Habitat

Loss of natural habitats has major effects on bee colonies. Main reasons of nature destruction are monoculture planting, loss of biodiversity, excessive pasture feeding, irrigation and land clearing. Extinction of the natural flora could cause losses of bee colonies [7]. Bees needs extensive, continuous, interconnected and convenient flora. Small scaled habitats decrease the spreading ability of bees, number of nest areas and available food sources.

Environmental Pollution

Honey bees collect nectar and pollens from plants to feeding. Therefore, they have a continuous interact with environment. While making these activities, they bring some of the chemical substance and waste from environment to hive together with the pollen they collected. In the nature, waste and toxic substances (generally industrial

gases, gas from the vehicles, pesticides and insecticides) absorbed and stored by the plants. As mentioned before, toxic substances in environment poisons honey bees.

The large part of air pollution causes by anthropological factors (urbanization, industrialization, energy generation, mobile sources and other pollutants). One of the most important results of the air pollution is heavy metal pollution [8].

Heavy metal pollution in the atmosphere caused by chimney and exhaust gases has brought with it various negative effects for people, animals and plants. Not only the vegetative organs of plants but also the generative organs of plants are affected by these negative conditions. One of them is the male reproductive cell; pollen. Various heavy metal cations such as cadmium, cobalt, copper, zinc, lead, nickel and mercury are known to adversely affect direct pollen and indirectly the honey bees that feed on them.

Since bees collect pollen from different kinds of flowers, heavy metals, which are found in large quantities within the plant, cause increased concentration of toxic heavy metals in the body of bees and the honey produced from the nectars of these plants.

Chemical wastes that produced by industrial plants and urban areas; causes the acidification of the soil, the pollution of existing and potential underground and aboveground water resources, the reduction of biological activities and the negative impact of the soil structure.

These substances cause plants to not make adequate use of nutrients in the soil and reduce plant growth, reducing productivity, and toxic levels of certain micronutrients in grown crops. All these negative conditions make it difficult for honeybees to find clean sources of pollen and nectar.

Competitive Relations

Another important problem for honey bees is due to foreign honey bee breeds, ecotypes and hybrids brought from foreign countries in order to increase honey production. Imported bee genotypes restrict the habitats of indigenous races and lead to the gradual extinction of our indigenous gene resources.

Imported queen bee genotypes can compete with native bee races and ecotypes in terms of the use of plant resources and place of home, prevent the pollination of plants in the natural flora, transport parasites and pathogens, and mate with native ecotypes to they can cause genetic divergency [9].

Global warming

Global climate changes could affect the behavior of honey bees. There is not much information about how bees will react physiologically or adapt to changes in the environment as a result of global warming. Global warming often affects bees indirectly by changes environmental conditions.

The most important effect of global warming on nature is the changes in climates. Climate changes will also change the characteristics of the environment in which includes all living creatures and these changes will indirectly affect the behavior of bee societies that lives in that ecological environment.

As a result of global warming, changes will occur in the vegetation of the ecological system. Due to the interactive relationship with honey bees and ecology, global warming will create pressure on bee colonies [10].

Climate changes due to global warming have several effects on plants. In addition to the expansion of arid and semi-arid areas, increases in the duration and severity of the summer drought will accelerate the desertification process and many plant species will dry up and disappear.

Thus, many plant species will change their flowering periods. Honey bees will effect negatively. In addition, changes in air temperature and humidity may also affect biological and behavioral properties of honey bees. Competition between wild bees and honey bees will increase as seasonal changes and the spread of wild bee breeds will be affected. The spread of wild bees to new areas and excessive population surge will cause competition with natural pollinators in the use of herbal resources [11].

Since honey bees are very affected by seasonal conditions and sudden temperature changes, an increase in bee losses can be expected. Due to global warming, winters are "hot" and may not have enough "cooling" that plants need in winter. This can lead to plants not producing enough pollen and nectar in the spring. In the absence of sufficient nectar and pollen in the environment, honey bees colonies are on their way to leave the hive, even if there is honey in their hives, in order to ensure the continuity of future generation. This shows how honey bees are sensitive "bio-indicators" [12]. In other words, during the nectar flow period, honey bees can determine the extent to which nectar and pollen sources are sufficient in

the environment and can plan their lives [13].

Colony Collapse Disorder (CCD)

Although the cause of colony collapse disorder (CCD), which has been extremely busy with the media in recent months and has caused nervousness among beekeepers, is still unclear, many of the triggering possibilities are being considered. These possibilities include external parasites, adult and infant diseases, known/unknown pathogens, inadequate feeding of adult bees, GMO farming, lack of genetic diversity, stress elements in adult bees, drug residues in honey and wax, new chemicals used in agricultural combat, radiation emitted from base stations [14]. Scientists that investigate colony collapse disorder, found high levels of bacteria, viruses and fungi in the honey stomach of collected bees that cannot return to the hive. Studies have shown that severe infection breaks down the immune system in honey bees due to the high toxic effect. It is stated that the stress that occurs in bees due to frequent displacement of hives may cause bees to become sensitive to diseases and become susceptible to other diseases and parasites.

The most typical characteristic of CCD is that adult bees in healthy-looking hives disappear overnight without any signs of

death. Adult bees that leave behind the queen bee and young bees in the hive, do not return to the hive and the number of adult bees in the hive is gradually decreasing [15]. However, those who know bee behavior will understand that this is an extremely unusual event. These hives are weakened because of malnutrition due to the decrease in the number of adult bees and disappear even if they have queen bees. Therefore, such a large scale of the loss of honey bees, makes it difficult to examine CCD. Besides, there is not any clue that the hive carries disease [16].

Although the exact cause has not been understood till today, scientists are expressed their opinions about the measures to be taken in the apiary under suspicion of CCD.

In the apiaries that seen CCD, it is not recommended to combine bees in lost hives with strong hives. If CCD is based on an infection-related factor, it may also cause loss of healthy colonies. It is also suspected that CCD could have a connection with insidious progressive bee diseases such as Nosema. Because the fungal spores seen in honey stomachs of bees performed with CCD suspicion increases the suspicion that Nosema may have caused this [17]. Especially in colonies with Nosema spores,

the susceptibility to other disease-causing pathogens is also very high.

If Varroa is extremely high in the colony, the use of strong chemicals (oxalic acid, fluvalinate, coumaphos, amitraz, apistan) that have a negative effect on malpighi tubes of bees, should be avoided. After the use of these chemicals, problems are increasing such as rapid discharge of hives and fertilization in the queen bee.

Neonicotinoids applied to the stated plants are the systemic insecticides that used in the control of absorbent insects that harm plants. This group of insecticides has been widely used recently and has a negative effect on honey bees, even at very low doses. Young bees that fed with nectar and pollen brought to the hive are more affected, disrupt brood feeding, and abandoned larvae frames in CCD hives attract attention.

On the other hand, adult field bees, having memory loss by the effect of neonicotinoid group insecticides and lose their ability to navigate. Their immune systems are weakening and they are becoming more susceptible to diseases [18]. The effect can also occur months later. Imidacloprid, thiamethoxam and clothianidine from this neonicotinoid group are strictly prohibited

except for intra-greenhouse use in the EU and Turkey [19]. Studies show that systemic insecticides such as imidacloprid cause behavioral disorders in bees, that bees lose their ability to navigate, lose their memory and have difficulty returning to hives. There are also studies that show that radiation waves emitted from increasing base stations adversely affect the ability of bees to navigate.

It is certain that, bee losses are seen all over the world for various reasons. Besides all these, CCD is less harmful in domestic ecotypes than imported bees. Also, these bees have a strong immune system because they have higher adaptability to ecology in the region.

The importance of honey bees in our life is an undeniable fact. Increase of negative effects on environmental conditions destroy gradually of honey bees life also future of the world. Ensuring the sustainability of honey bees life and agriculture systems we have to get precautions for minimizing environmental problems.

Conclusion

The role and place of bees in the ecosystem are quite large and vital. Unfortunately, due to the degradation of nature and the depletion of natural resources, honey bees are under serious threat. That is why serious precautions should be taken about the factors that threaten the life of bees leading to the loss of nature. Pesticides and insecticides used in agricultural production directly cause bee poisoning and bee deaths. Instead of synthetic chemicals, natural and bee-friendly ways to fight should be investigated and used. Attention should be taken for against pests that threaten the life of honey bees. It is very important that honey bees are accessed to clean water, nectar and pollen sources, so attention should be taken against any pollution that harms nature and bee. Competitive relations between bees should be observed and problems that may arise due to the reunion of indigenous races with imported races should be taken into account. Global warming will affect honeybees as it affects the entire ecosystem and natural order. Therefore, due to climate changes related to global warming, problems that affect bees should be studied.

CCD is a problem that threatens all bees and the cause is still unknown. The typical

characteristic of CCD is that adult bees in healthy-looking hives disappear overnight without any signs of death. Adult bees that leave behind the queen bee and young bees in the hive, do not return to the hive and the number of adult bees in the hive is gradually decreasing. Many researchers report that CCD, which causes such major problems, is not a single cause, but a disease that arises as a result of a number of causes, including the use of neonicotinoids. Research and studies on CCD, which has such a negative effect on honey bees, should be increased and developed.

It is very important to make effort to solve these environmental problems which directly threaten the life of honey bees who are of such importance in the ecosystem and solutions should be brought to these problems.

Sürdürülebilir Yaşam Açısından Çevresel Sorunların Balarılar Üzerine Etkileri

Öz: Sosyal ve ekonomik kalkınmaya paralel olarak yaşanan çevre sorunları nedeniyle doğanın dengesi ve sürekliliği her geçen gün bozulmaktadır. Bugün, bu artış doğanın binlerce yıllık birikiminin bir sonucu olarak ortaya çıkan muhteşem yaşam döngüsünü tehdit etmektedir. Doğal

kaynakların aşırı ve bilinçsiz tüketimi ve artan dünya nüfusunun bir sonucu olarak doğanın dengesi bozulmaktadır. Bal arılarının ekosistemdeki önemi tartışılmazdır. Bal arıları bitkilerin tozlaşmasına yardımcı olur, verimi arttırır ve tarımsal ekosisteme önemli katkılarda bulunurlar. Ancak, pestisitler, tarımda kullanılan kimyasallar, bal arısı zararlıları ve hastalıklarla mücadelede kullanılan kimyasallar, çevre kirliliği, bal arıları

arasındaki rekabet ilişkileri, radyasyon, iklim değişikliği, küresel ısınma ve koloni çökme sendromu (CCD) bal arılarının yaşamını tehdit etmektedir. Bu nedenle, çevre sorunlarını ve bunların bal arıları üzerindeki etkilerini daha iyi anlamak ve konuyla ilgili önlemleri hızlı bir şekilde belirlemek gerekmektedir.

Anahtar Kelimeler: Bal arısı, çevre sorunları, Pestisitler, CCD, küresel ısınma

REFERENCES

- [1] GALLAI, N; SALLES, J M; SETTELE, J; VAISSIAE, B E (2009) Economic valuation of the vulnerability of World agriculture confronted with pollinator decline. *Ecological Economics*, 68: 810-821.
- [2] AIZEN, M A; GARIBALDI, L A; CUNNINGHAM, S A; KLEIN, A M (2009) How much does agriculture depend on pollinators? Lessons from long-term trends in crop production. *Annals of Botany*, 103: 1579-1588.
- [3] MORANDIN, L A; WINSTON, M L (2006) Pollinators provide economic incentive to preserve natural land in agro-ecosystems. *Agriculture, Ecosystems&Environment*, 116: 289-292.
- [4] HENRY, M I; BEGUIN, M; REQUIER, F; ROLLIN, O; ODOUX, J F; AUPINEL, P; APTEL, J; TCHAMITCHIAN, S; DECOURTYE, A (2012) A common pesticide decreases foraging success and survival in honey bees. *Science*, 336 (6079): 348-350.
- [5] THOMPSON, H M (2012) Interaction between pesticides and other factors in effects on bees. EFSA supporting Publications, EN-340, 204pp. Available from: <http://www.efsa.europa.eu/publications>
- [6] GILL, R J; RAMOS-RODRIGUEZ, O; RAINE, N E (2012) Combined pesticide exposure severely affects individual and colony level traits in bees. *Nature*, 491: 105-108.
- [7] POTTS, S G; BIESMEIJER, J C; KREMEN, C; NEUMANN, P; SCHWEIGER, O; KUNIN, W E (2010) Global pollinator declines, trends, impacts and drivers. *Trends in Ecology & Evolution*, 25: 345-353.
- [8] YUCEL, B; MATIN, G; KARGAR, N (2014) Survey of honey bees and bee products for monitoring environmental pollution. In International Congress on "Green Infrastructure and Sustainable Societies/Cities" GreInSus'14, Izmir, Turkey, May 8-10 2014, P 200.
- [9] BRITAIN, C; KREMEN, C; KLEIN, A M (2013) Biodiversity buffers pollination from changes in environmental conditions. *Global Change Biology*, 19: 540-547.
- [10] BIESMEIJER, J C; ROBERTS, S P M; REEMER, M; OHLEMÜLLER R; EDWARDS M; PEETERS T; SCHAFFERS, A P; POTTS, S G; KLEUKERS, R; THOMAS, C D; SETTELE, J; KUNIN, W E (2006) Parallel declines in pollinators and insect-pollinated plants in Britain and the Netherlands. *Science*, 313: 351-354.
- [11] MEMMOTT, J; CRAZE, P G; WASER, N M; PRICE, M V (2007) Global warming and the disruption of plant-pollinator interactions. *Ecology Letters*, 10: 710-717.
- [12] KEVAN, P G (1999) Pollinators as Bio-indicators of The State of The Environment: Species, Activity and Diversity. *Agriculture, Ecosystems & Environment*, 74(1-3): 373-393.
- [13] CELI, G; MACCAGNANI, B (2003) Honey bees as bio-indicators of environmental pollution. *Bulletin of Insectology*, 137-139.
- [14] KENCE, A; ASLAN, O C; KAYIM, M; TOZKAR, O; KUKRER, M; YUCEL, B; DOGAROGLU, M; MUZ, M; GIRAY, T; KENCE, M (2010) The survey combining the COLOSS questionnaire and the questionnaire prepared for colony losses in Turkey. COLOSS Workshop of Standardized Protocols for Honey bee Vitality and Diversity. In Aarhus University, Denmark, June 16-18 2010. P 7.
- [15] WILLIAMS, G R; TARPY, D R; VANENGELSDORP, D; CHAUZAT, M P; COX-FOSTER, D L; DELAPLANE, K S; NEUMANN, P; PETTIS, J S; ROGERS, R E L; SHUTLER, D (2010) Colony Collapse Disorder in context. *BioEssays*, 32: 845-846.
- [16] APENET (2011) Effects of coated maize seed on honey bees. Report based on results obtained from the third year activity of the APENET Project.
- [17] DECOURTYE, A; ARMENGAUD, C I; RENO, M; DEVILLERS, J; CLUZEAU, S; GAUTHIER, M; PHAM-DELEGUE, M H (2004) Imidacloprid impairs memory and brain metabolism in the honey bee (*Apis mellifera* L.). *Pesticide Biochemistry and Physiology*, 78: 83-92.
- [18] ALAUX, C; BRUNET, J L; DUSSAUBAT, C; MONDET, F; TCHAMITCHAN, S; COUSIN, M; BRILLARD, J; BALDY, A; BELZUNCES, L P; LE CONTE, Y (2010) Interactions between Nosema microspores and a neonicotinoid weaken honeybees (*Apis mellifera*). *Environmental Microbiology*, 12: 774-782.
- [19] EASTON, A H; GOULSON, D (2013) The neonicotinoid insecticide imidacloprid repels pollinating flies and beetles at field-realistic concentrations. *PLoS ONE*, 8:e54819.