Food Science and Quality Management
ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online)
Vol.47, 2016

A Review on: Role of Honey Bee Pollination in Improving Crop Productivity and Seed Quality in the Northern Ethiopia

Kewanit Alemberhe[1] Kidu Gebremeskel[2]
1. Axum Agricultural Research Center, Axum, Ethiopia
2. Department of Natural Resource Economics & Management, Mekelle University, Mekelle, Ethiopia

Abstract
Insect pollinators are very important in determining the mate opportunity of plants and they are a key stone process in both human managed and natural terrestrial ecosystems. The biggest groups of insects for pollination are solitary bees, bumblebees and honeybees; this is because of their sufficient body hair and their behaviour patterns (Du Toit, 1988). Beekeeping is an important component of agriculture that promotes rural diversification and is an alternative source of income. The role of beekeeping is providing nutritional, economic and ecological security to rural communities at the household level. This is non-land-based activity of mixed farming and does not compete with other resource demanding. Currently the government gives higher attention to beekeeping practices and providing all the necessary components of beekeeping materials to the user is important to increase hive products. Intensive studies on biotic pollination would help in policy formulation and decision making concerning management of pollination for agricultural purposes, which is lacking. Although pollination improves crop yield, there is few study in Ethiopia that links its role to the economic benefits gained by farmers.
Keywords: honeybee, pollination, Ecological

1. Introduction

Pollination, the transfer of pollen grains from the male organ (anther) of a plant to the female organ (stigma) is helpful to produce the plants and directly links wild ecosystem with agricultural production system. In agriculture, pollination is an important input of crop production, comparable to any other input such as fertilizer, labor or pesticides (McGregor, 1976). Insect pollinators are very important in determining the mate opportunity of plants and they are a key stone process in both human managed and natural terrestrial ecosystems (Collette, 2008; Gallai *et al*., 2009; Johnson, 2004; Kevan, 1999; Richards and Kevan, 2002). Plant pollinator interactions can provide some of the best examples of co-evolution (De Jong et al., 2005; Donaldson, 2002; Kearns and Inouye, 1993). From the six known types of pollination agents (insects, birds, wind, gravity, water and mammals) insects are by far the most important in pollination. According to Johannsmeier and Mostert, (2001) insects are considered to be responsible for 80-85% of all pollination, and of this 75-80% are attributable to honeybees. The biggest groups of insects for pollination are solitary bees, bumblebees and honeybees (Free, 1993); this is because of their sufficient body hair and their behaviour patterns (Du Toit, 1988). Insect pollinators are essential in increasing seed set of many flower and fruit crops; as well as the quality of seed /fruit, early flowering, oil content, pyrethrin content, rubber content and the amount of lavender oil (Free, 1993). Nowadays the natural habitat is disturbed for many reasons and the vegetation cover is declining worldwide (Kearns *et al*., 1998). Agriculture plays a great role in declining native pollinators through the modification and elimination of pollinator habitats and the use of chemicals (pesticides, fertilizers). According Donaldson, 2002 clean and intensive cultivation of land may affect wild insect pollinators. He mentioned practices such as destruction of hedgerows and rough verges which destroyed many natural food sources and nesting sites of wild pollinating insects. Generally it has been concluded that habitat degradation, pesticide misuse, diseases and intensive cultivation of lands may be the causes of declining managed honeybees and wild pollinators (Chapman and Bourke, 2001; Collette, 2008; Davila and Wardle, 2008; Dewenter, et al., 2005; Gallai et al. 2009; Gross, 2001;; Kremen *et al*., 2002; Morandin and Winston, 2005;). Therefore when many hectares are occupied by a single crop and moreover certain localities are selected for growing particular cultivars there may be too few insect pollinators due to the factors mentioned above and it may be necessary to enhance pollinators in that area (Du Toit, 1988). Honeybee pollinators are required for producing up to 30 % of the human food supply directly or indirectly and the farmers rely on managed honeybees throughout the world to provide these services (Greenleaf and Kremen, 2006). For all the United States, the annual value of increased agricultural production in yield and quality that is attributed to honeybee pollination varied from US$9.3 billion in 1989 to US$14.6 billion in 2000 (Morse and Calderone, 2000). In Western Cape (South Africa) the deciduous fruit industry which is entirely dependent on honeybees as pollinators generates 1 billion per year and creates job opportunities for 80,000 people (Picker et al., 2004). The contribution of managed honeybee pollination to crop production and quality has been estimated to be more than the value of honey and wax production (Shrestha, 2004).Honeybees must be considered the major pollinator of cultivated crops for the following reasons. Firstly, honey bees are relatively domesticated as they are kept in manageable hives which can be brought in to a monoculture otherwise too

expensive for pollination. Secondly the areas planted with monoculture are usually intensively cultivated where as agricultural activities have led to a reduction in the total native pollinators. In addition to that the hairy anatomy of the honeybee is important to facilitate pollination.

At present, Onion is an important vegetable crop in Ethiopia in general and in the region in particular. The need for onion seed production is highly demanding and nationally it become an important development component (Lema and Shimeles, 2003). It is a cash crop and serves as a spice for flavoring local dishes and hence it is highly valuable crop throughout the country. Though the price varies from time to time, it fetches very high price during rituals and holidays. Inadequate pollination may result in deformed, smaller seeds which have low germination capacity of onion plant (McGregor, 1976). Insufficient pollination caused the difficulties in hybrid seed production and getting high quality seed in onion plant (Free, 1993). Several pollination factors could be taken in to consideration for agricultural production such as wind, hand pollination, some pollen dispenser methods, and insects, but wind has a little effect on onion pollination because of its sticky pollens (McGregor, 1976). McGregor (1976) summarized honeybees are effective pollinators on onion because both pollen and nectar are available from it. The pollen usually sheds before the female part is respective (protandry) (Lema, 1998). Besides honey bee pollination, other pollinators such as bumblebees, dipterans and butter flies are also observed in open pollination. However the visiting frequency is very less. The number of flowers visited by honeybees per minute is more in open pollination compared to other pollinators. Increasing pollination efficiency is a low input but a sound effect on output without much expensive to the environment. Onion seed has great value for foreign currency, this is because the seed is imported from abroad with hard currency and investors are facing the problem of germination and imported seeds are easily susceptible to disease (Lema, 1988). The productivity of the crop is very low and the low seed yield of self pollinated onion has been reported from small scale producers and state farms everywhere in the world (Yucel and Duman, 2005). Therefore, this review is designed to see the role of managed honeybee pollination in increasing seed yield, germination percentage of the plant and to identify insect visitors other than honeybees.

2. The Role of Pollination in Onion Production and Productivity

2.1 Pollination

Pollination is the transfer of pollen grains from anthers to the stigma. Once the pollen gets into contact with the stigma, pollen tube germination takes place, which precedes fertilization of ovules. Pollination is an important ancestor to sexual reproduction in plants. Many flowering plants cannot set seeds or fruits without fertilization. Similarly, fertilization cannot occur before the pollen comes into contact with stigma. Pollination is a complex for the completion of the process. Many factors such as the flower physiology and morphology, pollinator characteristics, as well as effects of weather, influence the success of pollination. For example, Morton (1987) reported that if rain occurs 1.5 hours after pollination of yellow passion fruits (*Passiflora edulis* Sims), there will be no fruit set. The level of dependency of plants on insect pollinators is depend on structure of the flower, their degree of self-fertility and their arrangement on the plant (Free 1993; Williams 1994, 1996; Richards 2001). The degree of self-fertility is very important in crop pollination. Plants that are dioecious (male and female organs occur in different plants), monoecious (male and female organs occur on same plant but on different flowers), dichogamous (male and female organs mature at different times) or heterostylous (stamen and style have different lengths, and require pollen transfer) require insects to effective pollination. In addition, some hermaphrodite flowers (with male and female organs maturing at the same time) are self-infertile and hence they also require insect pollination.

There are many crops as well that use self pollination requires insect pollination for maximum yields but which now show increased yields when bees are added in their production process. For example, Roubik (2002) reported a more than 50% yield increase in coffee (*Coffea arabica* L.) in Panama as a result of pollination by naturalized non-native honeybees. Many staple crops, e.g., maize or wheat, are wind pollinated. Although bees visit these crops for pollen, they can produce without bee pollination because in most cases wind will provide sufficient pollination. But the presence of bees has been shown to significantly increase seed set in combination with wind effects (Soderstrom and Calderon 1971; Adams et al. 1981). This occurs mainly in areas where wind velocity is too low to carry the pollen.

Animal pollination is effected by many different species ranging from vertebrates (e.g., bats) to invertebrates such as insects. Insects provide more than 85% of the animal pollination in crops, of which bees are the main pollinators worldwide.

Humans have relied on bees since long to provide pollination services to the crops (Kevan .et.al2001). Bees have many traits that make them good pollinators, e.g., their numerous body hairs, their foraging behavior and the fact that they collect food for themselves and their young. This last trait is very important, as other insects just feed on nectar and pollen, but do not collect them, hence they may not be reliable although they supplement bees in pollination (Free 1993). Apart from the importance of pollination in fruit or seed set, the process enhances higher yields of better quality (McGregor 1976; Free 1993). Some crops benefit also in terms

of uniform ripening, which reduces yield losses in the field. Plant vigor has also been shown to be enhanced by cross-pollination, e.g., in broad beans (*Vicia faba* L.), which requires flower tripping to produce viable seeds (Stoddard and Bond 1987).

2.2 Natural History of bees

The social behavior of bees (Hymenoptera: Apiformes) is highly varied ranging from solitary to highly eusocial forms (Michener 2000). A solitary bee makes her own nest and provides food to her offspring with no help from other bees, and she usually dies before maturation of her offspring. On the other hand, highly eusocial bees have division of labor (e.g., egg layers, foragers) among cooperating adult females of two generations (mothers and daughters). The queen cannot survive on their own because she depends on workers for food, while the workers cannot survive on their own as they are not mated and hence cannot reproduce. Between the solitary and eusocial bee life, there are different social forms. For example, sub social life where the solitary bee feeds and cares for the emerging young ones, and the communal form where bee colonies lack division of labor and all members behave in a similar way and are united by one nest (but each bee managing its own cells). While it is easy to recognize highly eusocial bees, other social forms are quite variable and bees may pass through many ontogeny stages of sociality Michener (2000). Therefore, in this study, eusocial bees will refer to *Apis mellifera* (honey bees) and *Meliponula* spp. (stingless bees) while solitary bees will refer to the rest. *Apis mellifera* L. is the most widely known eusocial bee, having been reared by man for many ages mainly for honey production. The stingless bees (such as *Meliponula* species) are also widely distributed in the pan tropical world. Their role as pollinators and honey producers is gaining popularity and there is growing market in their utilization for crop pollination (Macharia et al. 2007).

Bees comprise seven main families (Michener 2000) of which only a few are currently utilized for crop pollination. Except *A. mellifera*, other bees, e.g., *Bombus* spp., *Megachile* spp., and *Osmia* spp. are reared for pollination of highly priced crops such as greenhouse tomato or alfalfa seed crops. Rearing of bees other than *A. mellifera* is practiced in several countries where the need for better pollination of crops is highly regarded. In other countries, inputs of crop production other than pollination, e.g., fertilizer or pesticides are given priority in policy formulation and have masked the importance of pollination in crop productivity. *Apis mellifera* rearing in these countries is more for honey and wax production and less for provision of pollination (Gichora 2003). The main food resource of bees is nectar and pollen, which they get from flowers of different plant species. In some instances, bees may forage for floral oil in specific plants, e.g., *Lysimachia* spp. Therefore, both plants and pollinators could have co-evolved, such that flowers of different plants would require specific bee pollinator (s) for effective pollination to occur (Michener 2000, p. 13-18). However, agricultural crops have been manipulated by breeders over many decades, with resulting negative impacts on the role of flowers as a possible advertiser/attractant to pollinators. Many bees visiting crop flowers have been gain access to pollen or nectar. Some bees perforate holes on the flower side to extract nectar from the nectarines. This denies the flower all possibilities of being pollinated. Other bees glean on the fallen pollen after a larger bee has visited the given flower. These are mainly small bees that cannot access or forcefully open such flowers, as observed by Gikungu (2006).

Apart from food, bees require plants for other purposes such as for nest material, hiding, mating or just as resting sites. Undisturbed habitats provide the best home for different bees, as here there are enough dead logs, leaves, etc. for the bees to construct their nests. There are also holes left by wood-boring beetles, tree cavities, pithy hollow plant stems, abandoned rodent burrows, soils of suitable texture, depth and slope, vegetation cover and moisture etc. suitable for use as nests (Cane 2001). Bees also require mud, resins, pebbles or plant hairs for nest construction (O'Toole and R0aw 1991; Rust 1993), which can only be provided optimally in undisturbed areas. Lack of safe sites causes bees to seek other areas, e.g., construction of nests on buildings or furniture, which is perceived as damage to property. This can lead to decimation of bees as long as people do not recognize their importance, do not know how to handle them, and government policy does not address the need for their conservation.

2.3 Bee pollination of agricultural crops

For the animal-pollinated agricultural crops, bees are the most important pollinators worldwide because of their foraging behavior and floral constancy (ability to visit flowers of only one plant species on every foraging bout). But, only about 15% of the world's crops are pollinated by a few managed bee species, e.g., *A. mellifera* and *Bombus* spp., while the rest are pollinated by un-managed solitary bees and other wildlife (Almanza 2007). The crucial role of bees as providers of pollination services in developing countries cannot be ignored with farmers having *A.mellifera colonies*, although this service is mainly feral there. This is done even without determining whether this bee species is the most effective pollinator for those crops (Goulson 2003). Management of bees for commercial pollination purposes only began in the et al. 1987). In developed countries currently there are several bee species that can be rented for crop pollination purposes. e.g. *Bombus* spp. for greenhouse tomato (Heemert et

al. 1990). In many agriculture systems, pollinator force is important for successful pollination of the crops (Banaszak 1983). This is sully determined by the characteristics of an effective pollinator, there are different factors that affect pollinator efficiency such as abundance, pollen load, frequency of visitation and flower constancy are very important for adequate pollination. Pollinator diversity is also important in pollination. Bees complement each other in pollination. A more diverse bee community provides better pollination service especially in areas where mixed cropping is done, as different pollinators target different flowers. Diversity can help to reduce the risk that may arise due to lack of a pollinator during the critical period of crop flowering. For example, *A. mellifera* are known to abandon flower patches for more suitable ones and in such a case, having other bee species can help counteract the lost honeybee function, although this also depends on the crop requirements. Competition arises where the floral resources are limited while at the same time there --are many individuals of different foraging bee species. This is rare in most agricultural systems.

2.4 Effects of human activities on bees and pollination

There are many natural and human made challenges that decline many groups of pollinators. Declines are associated with habitat loss, fragmentation, and deterioration, non target pesticide exposure, and invasive species (cited in Berenbaun. June26, 2007). Human activities concern with the establishment of monocultures, overgrazing, land clearing, irrigation so as to modify their habitat in the area of agriculture affect the population of bee species and their abundance (Richards 2001; Richards and Kevan 2002). Some crop management approaches, such as pesticide sprays or smoking, kill or repel foraging bees especially when applied during the flowering period. But as compared the effect of zero tillage with that of mechanical farming, it has minimum negative effect, because zero tillage does not disturbing soil nesting bees. Any human activities that decrease population size of bees will usually results in inadequate pollination, unless the dominant bee is an effective pollinator and its population size is sufficient. Even if so, many other crops will undergo shortage of pollination and may not produce optimally, as the dominant bee may not be a pollinator of these crops. Farmers Knowledge of bees and pollination has been shown in many parts of the world to improve sustainable use of pollinating agents (Olmstead and Wooten 1987) especially when they expect income. There are also natural factors that reduce bee population such as drought, flooding, pests, fire and other disease through the negative effects on bee forage, nests and on individuals, or a mixture of these.

2.5. Economic and ecological Consequences of Pollinator declines

Pollination is a valuable ecosystem service, on condition that a variety of benefits including food and fibre, plant-derived medicines, ornamentals and other aesthetics, genetic diversity, and overall ecosystem resilience (Millennium Ecosystem Assessment 2003, Naban and Buchmann 1997). Declines in pollinator population and species diversity more broadly have potential risks to global food security and economic development, particularly in countries where agriculture is a large portion of the economy and this risk has global concern (Kluser et al. 2007, Packer et al. 2005, Wardell et al. 1998). From an ecological perspective, declining of pollinator has effect on ecosystem stability and loss of biodiversity and the plants they pollinate by insects (Biesmeijer et al. 2006,) Evidence exists of local and regional declines of both managed and wild insect pollinators (Meixner et al. 2010, Potts et al. 2010), which appear to be a result of pests, diseases, pesticides, habitat destruction, and agricultural intensification (Le Feon et al. 2010, Winfree et al. 2009, Kremen, Williams, and Thorp 2002, Cunningham 2000). Flowering plants require pollination to produce seed or fruit. Some plants are depending on wind-pollination and others are self-pollinated, but many plant species require animal-mediated cross-pollination (NRC 2007). Even self pollinated plants require additional animal pollinator to raise quality and quantity of the crop production (Tshcarntke 2003, Roubik 2002). At the global level, 75 percent of primary crop species and 35 percent of crop production rely on some level of animal pollination (Klein et al. 2007). According the estimation of Gallai et al. (2009) the value of this pollination service is to be €153 billion (~$200 billion). In the United States, more than half of primary crop species and 20 percent of primary crop production rely in part on animal pollination (cited in Anne et al. 2010)

2.6. Agriculture's Dependence on Pollinators

According to Naban et al. 1997animal pollinators include many insect species and several species of birds. Animal pollination of agricultural crops is provided by both managed and feral pollinators. European honey bees (Apis mellifera) are the most common managed pollinator species. There are several characteristics that Apis mellifderas make dominant (NRC 2007):They are generalist pollinators that are capable of pollinating many different plant species because they are physically huge body, they exist in large number of perennial colonies with up to 30,000 individuals that are available for crop pollination year-round, are able to forage over large distances, so that their placement within large monoculture fields allows them to provide pollination services over a wide area, they communicate with other members of the hive regarding location of food sources, making them highly efficient pollinators, honey bees produce honey which is valuable, commercially marketed product,

according to the idea of Veddeler et al. 2008 and Klein, Steffan-D et al. 2003 although honey bees can pollinate many plant species, wild pollinator has also an important role for agricultural production because the number of honeybees are not enough on a bee-per-plant-visit basis. For example, yucca plants are highly dependent on yucca moths for their pollination (NRC 2007). Different plants depend on different pollination agent. It varies based on plant species, geographical location, and time of year (NRC 2007, Kearns et al. 1998). Wild and managed pollinators have complementary relationship and contribute to efficient pollination service worldwide. But in many developing countries wild pollinators are the only provider of pollinator service available to small-scale farmers because of the high costs associated with maintaining managed colonies (Kasina et al. 370 *October 2010 Agricultural and Resource Economics Review* 2009).

Pollinator dependency is a measure of the level of impact that animal pollination has on the productivity of particular plant species. The level of pollinator dependency varies dramatically among crops. Fruits, vegetables, and nuts are highly dependent. Crops that are essentially dependent on animal pollination include Brazil nuts, cantaloupe, cocoa beans, kiwi fruit, pumpkins, sq ash, vanilla, and watermelon (Klein et al. 2007). Many crops have reduced production in the quantity or quality of the plant part consumed directly by humans, while other crops have reduced production of seeds that are used to produce the vegetative parts of plants that humans consume (cited in Anne et al.)

2.7. List of Crops depend on Bee Pollination

Entomophily is a group of plant pollination where by pollen is distributed by the respective insects, particularly bees. Note that honey bees will pollinate many plant species that are not native to areas where honey bees occur, and are often inefficient pollinators of such plants.

Table 6 some of crop varieties and their pollination agents.

Common name	Scientific name	Pollinators	Commercial product of pollination	Pollinator impact
Tomato	Solsnumlycoprsicum	Bumblebee, solitary bee	Fruit	
Sunflower	Helianthusannuus	Honeybee,bumblebee,solitary bee	Fruit	≥90%
Strawbarytree	Arbutuaunedo	Bumblebee, solitary bee	Fruit	10-40%
Strawbary	Fragaria Spp	honeybee,bubelebee,solitarybee and stinglebees	Seed	10-40%
Soybean	Glycine Max	honeybee,bubelebee,solitarybee	Seed	40-90%
Sesame	Sesamumindicum	Honeybee solitarybee,wasps,flies	Fruit	40-90%
Safflower	Carthamusstinctorius	Honeybee solitarybee	Seed	≤10%
Papaya	Carica papa	Honeybee ,trips,moths,butterflies	Fruit	≤10%
Onion	Alliumcepa	honeybee solitarybee	Seed	
Oilpalm	Elaeisguineensis	Weeves,thrips	Fruit	≤10%
Mango	Mangiferaindica	Honeybees stinglebees flies,Antes,wasps	Fruit	40-90%
Lemon	Gossypium spp	Honeybee	Fruit	
Cotton	Daucuscerota	bumblebees,solitarybees ,honeybee	Seed	≤10%
Carrot		Flies, solitary bees, honeybees	Seed	

Source, Klein et al. (2007)

2.8. Pollinator Community of Onion (*Allium cepa* L.) and its Role in Crop Reproductive

Pollinators has a great role to enhance biodiversity by ensuring survival of many plant species.Insect pollination is necessary for many cross pollinated crops especially in the case of hybrid seed production e.g. onion (*Allium cepa* L.) (Mayer and Lunden, 2001). The role of managed honey bee (*Apis mellifera* L.*)* in onion pollination has widely been documented by many authors (Tolon and Duman, 2003), but managed bee pollination is not always possible in all environments. In an area where the weather condition is too dry and cold is not suitable for bee keeping. e.g. Southern Punjab, Pakistan where the average temperature in summer is 46ºC (PARC, 1980) or very cold and dry Balochistan province, Pakistan, where stationery bee keeping cannot be practiced because of prevailing dry and cold climatic conditions and lack of forage during the large part of the year.(cited in Pakistan J.2001 vol. 40) pp.451-456. 2008)

According Ollerton and Louise, 2002 Pollinator species and their composition may vary with geographical area, latitude and time. For example, in the mountainous Hindu Kush Himalayan region *Apis mellifera*, *A. dorsata*, *A. cerana* and *A. florea* are the most frequent visitors (Chandal *et al*., 2004), but in the plains of Punjab, Pakistan, *A. mellifera* and *A. cerana* are poorly represented. Most of the experiments on the onion have been done in caged conditions using different flies and bees *e.g. Calliphora*, *Lucilia* (Diptera:

Calliphoridae), *Eristalis* sp. (Diptera: Syrphidae), *Osmia rufa* (Hymenoptera: Megachillidae) (Schittenhelm *et al*., 1997) but very few studies have been done in open field conditions. Onion flowers are protandrous and pollen is shed within 2-3 days before the stigma is receptive (Lesley and Ockendon, 1978), therefore, self-pollination within a flower is not possible. In order for pollination to occur, pollen must come from another flower of the same or a different plant (Zdzislaw *et al.*, 2004). Thus, cross-pollination is common in onion (Chandel *et al.,* 2004), which A. SAJJAD *ET AL*results in early seed set and higher yields. Wind is not a factor of significance in onion pollination and onion does not produce quality seed if insects do not visit the flowers (Chandel *et al*., 2004). Non-availability of pollinators during the flowering period of onion causes only 17% fruit setting and free availability of pollinators increased fruiting up to 73% (Rao and Sunyanarayana, 1989). Cross-pollination is obligatory in the fertilization of male-sterile onions used in hybrid seed production (Vander Meer and Van Bennekom, 1968). Onion suffers severe inbreeding depression with drastic decrease in growth bulb size, and seed production after only two cycles of self-pollination within a plant (Jones and Davis, 1944). In onion when the flowering begins, only a few flowers open each day on an umbel, but the number increases until at full bloom where 50 or more florets may be open on a single day (Mol, 1954). Apart from honeybees, onion flowers are visited by bumblebees, dipterans and butterflies (Jablonski *et al*., 1982). In various regions of India (Chandel *et al*., 2004), syrphids are important contributors in the process of pollination along with the most effective *Apis dorsata* and *A. florea*. The lack of intense attractiveness of onions may cause the bees to neglect the crop (Franklin, 1970), particularly if another highly attractive crop is in flowering nearby.

Conclusion

Pollination is an important input in crop production to improve crop quantity and quality and it a valuable ecosystem service, on condition that a variety of benefits including food and fiber, plant-derived medicines, ornamentals and other aesthetics, genetic diversity, and overall ecosystem resilience. For the animal-pollinated agricultural crops, bees are the most important pollinators worldwide because of their foraging behavior and floral constancy. But, only about 15% of the world's crops are pollinated by a few managed bee species, while the rest are pollinated by un-managed solitary bees and other wildlife. The crucial role of bees as providers of pollination services in developing countries cannot be ignored with farmers having *A.mellifera colonies*, although this service is mainly feral there. Honeybee pollinators are required for producing up to 30 % of the human food supply directly or indirectly and the farmers rely on managed honeybees throughout the world to provide these services. There are many natural and human made challenges that decline many groups of pollinators. Declines are associated with habitat loss, fragmentation, and deterioration, non target pesticide exposure and invasive species. Human activities concern with the establishment of monocultures, overgrazing, land clearing, irrigation so as to modify their habitat in the area of agriculture affect the population of bee species and their abundance.

References

CHANDEL R.S., THAKUR, R.K, BHARDWAJ, N.R. AND PATHANIA, N., 2004. Onion seed crop pollination: a missing dimension in mountain horticulture. *Acta Horticult.*, 631: 79-86.

Chapman, R. E. and Bourke, A. F. G. 2001. The influence of society on the conservation biology of social insects. *Ecology Letters* 4: 650-662.

Collette, L. 2008. A contribution to the international initiative for the conservation and sustainable use of pollinators. FAO, Rome Italy.

Davila, Y. C. and Wardle, G. M. 2008. Variation in native pollinators in the absence of honeybees: implications for reproductive success of an Australian generalist pollinated herb *Trachymene incia (*Apiaceae). *Botanical Journal of the Linnean Society* 156: 479-490.

de Jong, T. J., Batenburg, J. C. and Klinkhamer, P. G. L. 2005. Distance-dependent pollen limitation of seed set in some insect pollinated dioecious plants. *Acta Oecologica* 28: 331-335.

Donaldson, J. S. 2002. Pollination in Agricultural landscapes, a South African perspective. In: Kevan P. and Imperatriz Fonseca VL (eds) Pollinating Bees The Conservation Link between Agriculture and Nature Ministry of Environment/Brasilia Pp 97-104.

du Toit, A. P. 1988. Pollination ecology of commercial sunflower (*Helianthus annuus* L.) in South Africa with special reference to the honeybee (*Apis mellifera* L.). MSc Thesis, University of Pretoria, South Africa.

FRANKLIN, D. F., 1970. Problems in the production of vegetable seed. In: *The indispensable pollinators*. *Ark. Agr. Ext. Serv. Misc. Pub*., 127: 112-140.

Free, J. B. 1993. *Insect Pollination of Crops* (2nd ed.). San Diego, CA: Academic Press.

Gallai, N., Salles, J. M., Settele, J. and Vaissiere, B. E. 2009. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. *Ecological Economics* 68: 810-821.

Greenleaf, S. S. and Kremen, C. 2006. Wild bees enhance honeybees' pollination of hybrid sunflower.
Proceedings of the National Academy of Sciences of the USA103: 13890-13895.

Gross, G. 2001. The effects of introduced honeybees on native visitation and fruit set in *Dillwynia juniperina* (Fabaceae) in a fragmented ecosystem. Conservation

JABLONSKI, B., SKOWRONEK, J., WOYKE, H. W. AND DORUCHOWSKI, R. W., 1982. Biologia kwitnienia, nektarowanie, zapylanie i owocowanie mêskosterylnych linii cebuli (*Allim cepa* L.). *Pszczel. Zesz. Nauk,* 26: 57-104. Biology 102:89-95. *Systematics* 28: 83-112

Johannsmeier, M. F. and Mostert, J. N. 2001. Crop pollination. In: Johannsmeier, M. F. (Ed.), Beekeeping in South Africa, 3rd edition, revised, Plant Protection Research Institute handb.

JONES, H.A. AND DAVIS, G.N., 1944. Inbreeding and heterosis and their relation to the development of new varieties of onions. *USDA Tech. Bull*., 874. ook 14. Agricultural Research Council of South Africa, Pretoria, South Africa, pp 235-245.

Kearns, C. A. and Inouye, D. W. 1993. *Techniques for pollination biologists*. Boulder CO: University of Colorado Press.

Kearns, C. A., Inouye, D. W. and Waser, N. M. 1998. Endangered mutualisms: the conservation of plant-pollinator interactions. *Annual Review of Ecology and Systematics* 28: 83-112.

Kevan, G. P. 1999. Pollinators as bioindicators of the state of the environment: species, activity and diversity. *Agriculture, Ecosystems and Environment* 74: 373-393.

Kremen, C., Williams, N. M. and Thorp, R. W. 2002. Crop pollination from native bees at risk from agricultural intensification. *Proceedings of the National Academy of Science of the USA* 99: 16812-16816.

Lemma Dessalegn . 1998. The seed production of onion, Hot pepper and Tomato.

LESLEY C. AND OCKENDON D.C., 1978. Protandry and sequence of flower opening in the onion (*Allium cepa* L.). *New Phytol*., 81: 419-428.

MAYER, D.F AND LUNDEN, J.D., 2001. Honey bee management and wild bees for pollination of hybrid onion seed. *Acta Horticult.*, 561: 275-278.

McGregor, S. E. 1976. *Insect pollination of cultivated crop plants*. Agricultural handbook 496. Agricultural Research Service, U.S. Department of Agriculture Washington, pp 411.

MOLL, R. H., 1954. Receptivity of the individual onion flower and some factors affecting its duration.*Am. Soc. Hort. Sci. Proc*., 64: 399-404.

Morse, R. A. and Calderone, N. W. 2000. The value of honeybees as pollinators of U.S. crops in 2000. *Bee Culture* 128: 1-15.

Morandin, L. and Winston, M. 2005. Wild bee abundance and seed production in conventional, organic and genetically modified canola. *Ecological Applications* 15: 871-881.

OLLERTON, J. AND LOUISE, C., 2002. Latitudinal trends in plant-pollinator interactions: are tropical plants more specialized? *Oikos*, 98: 340-350.

RAO, G.M. AND SURYANARAYANA, M.C., 1989. Effect of honeybee pollination on seed yield in onion (*Allium cepa* L.). *Indian Bee J*., 51: 9-11.

PARC, 1980. *Agro-ecological regions of Pakistan*. PARC, Islamabad.

.Richards, A. J. 2001. Does low biodiversity resulting from modern agricultural practice affect crop pollination and yield? *Annals of Botany* 88: 165-172.

Richards, K. W. and Kevan, P. G. 2002. Aspects of bee biodiversity, crop pollination, and conservation in Canada. In: Kevan, P. and Imperatriz, F. VL (eds) Pollinating Bees the Conservation Link between Agriculture and Nature Ministry of Environment/Brasilia, pp 77-94.

SCHITTENHELM, S., GLADIS, T. AND RAO, V. R., 1997. Efficiency of various insects in germ plasm regeneraton of carrot, onion and turnip rape accessions. *Plant Breed.*, 116: 369-375.

Suresh,D . h . 2008 Impact of honeybee pollination production of Niger on seed.

TOLON, B. AND DUMAN, Y., 2003. The effect of pollination by honeybee (*Apis mellifera*) on onion (*Allim cepa*) seed production and quality. XXXVIII Apimondia International Apicultural Congress, pp. 554.

VAN DER MEER, Q. P. AND VAN BENNEKOM, J.L., 1968. Research in pollen distribution in onion seed fields. *Euphytica*, 17: 216-219.

Veddeler, D., R. Olschewski, T. Tscharntke, and A.-M. Klein. 2008. "The Contribution on Non-Managed Social Bees to Coffee Production: New Economic Insights Based on Farm-Scale Yield Data." *Agroforestry Systems* 73(2): 109– 114.

Yücel, B. and Duman, I. 2005. Effects of foraging activity of honeybees (*Apis mellifera* L.) on onion (*Allium cepa*) seed production and quality. *Pakistan Journal of Biological Sciences* 8: 123-126.

ZDZISLAW, W. GIEJDASZ, J. AND PROSZYNSKI, G., 2004. Effect of pollination on onion seeds under isolation by the mason bee (*Osmia rufa* L.) (Apoidea, Megachilidae) on the setting and quality of obtained seeds. *J. Apic. Sci*., 48:35-41. *(Received 28 August 2008, revised 21 September 2008)*