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REVIEW ON ECOLOGICAL ASPECTS OF ANTS WITH SPECIAL REFERENCE TO AGRICULTURAL HABITATS

Entomology

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ABSTRACT

Agricultural systems are areas of land where humans manipulate physical, chemical, and biological processes using a cluster of practices to obtain a beneficial product for their use. To understand the level of organization in a particular region we must consider biotic and abiotic factors and the interaction between them to employ best conservation practices to restore biodiversity in this region. Ants perform a different role in agro ecosystems like pollination, soil turbation, bio indication and the regulation of crop-damaging insects. Agro ecology management of ants in tree cropping systems required some information about positive and negative impacts on crops and pest species. This review article provides an overview of knowledge of the roles performed by ants in agricultural habitats.

KEYWORDS

Ants, Agriculture, Ecosystem engineers, Bio-indicators

INTRODUCTION:

Ants are classified as single-family Formicidae under order Hymenoptera of class Insecta. Hymenoptera is the primarily most significant order of the phylum Arthropodain terms of numbers, dominance and ecological importance (LaSalle & Gauld, 1993) [1]. According to Bolton (1994) [2] the known living ants involve 16 families, 298 genera, 15000 species and around 10,000 are described. Sivadasan et al., (2013)[33] noted that about 1% of all described species of insects with 2,136 subspecies and 12,116 extant species in 298 genera coming under 21 subfamilies all over the world. Numerically, geographically and ecologically ants are dominant and their impact on an ecosystem rarely ignored (Gotwald, W. H. 1986) [3]. Chate and Chavan (2016) [48] studied the variations in ant community at the urban and agricultural ecosystem. They stated that urban habitat is a highly disturbed site as compared to agricultural site. Ant is an important link in the food chains of ecosystemsas a prey. They have various functional roles such as scavenging, predation, granivory and omnivory. Ants perform an essential role in structuring the diversity and abundance of other taxa in many ecological communities due to their several associations with several taxa ranging from plants to insects to vertebrates (Folgarait, 1998)[8]. Ants are effectively present in all categories of habitats, but there are some exception viz., Iceland, Greenland and Antarctica (Holldobler and Wilson, 1990)[4]. Soil health is essential For proper ecosystem functioning or to increase agriculture production and it provides supportive ecosystem services (Mc Bratney et al., 2014)[5]. The quality of nutrient cycling and soil nutrients are regulated by soil fauna.(Brussaard et al.,2007[6],Bender and van der Heijden, 2014) [7]. Understanding the role of soil organisms as an ecosystem engineer is an essential challenge for agro-ecosystem researchers (Folgarait, 1998)[8]. Ants perform an important role in agroecosystems like plant pollination, soil turbation, bioindication and the regulation of crop-damaging insects. Predatory ants affect the behavior of the prey and decreased the size of the pest population (Green & Sullivan, 1950) [9]. Ants regulate insect population by chemical control program and are important not only because of their diversity but also because their functional part in the ecosystem, turning forest soil, dispersing seeds and helping with decomposition (Agosti et al., 2000[10]; Maryati, 1996) [11]. Patkar and Chavan (2014)[47] studied ant diversity in undisturbed and disturbed habitats of Great Indian Bustard Wildlife sanctuary and concludes that ants show a quick response to environmental changes for that reason they are good indicators of disturbance. Therefore, this review article intends to focus all the significant aspects of ants and their role in agriculture habitat and general ecology.

Role As A Biological Control Agent

Ants have established strong ecological associations with diverse organisms in the environment, and most of the time they show mutualistic interaction and correlation with some plants (Quinlan et al., 1979) [12]. Ant-plant mutualism show variation as per the time, habitat type, ant species, rate of ant visitation, as well as with the capacity of herbivores to overcome ant predation (Koptur & Bernays, 1992[43]; Bronstein, 1998[44], De la Fuente& Marquis, 1999[45]; Whitford, 1996) [46]. In the tropics, a great number of ant species foliage, where they search for arthropod prey, plant-derived food products as well as liquid rewards secreted by insect herbivores (Carroll & Janzen, 1973[34]; Oliveira & Marquis, 2002[35]). Ants are ideal predators in agroecosystems because of their capability of to quickly consume large numbers of prey (Risch and Carroll,1982) [13]. Naturally occurring ant species in citrus and cotton control many pest insects. The first recorded example of biological control was the manipulation of ants throughout citrus orchids in Asia (Choate and Drummond, 2011) [14]. Ant regulates crop-damaging insects, particularly in horticulture and controls the carbohydrate and nitrate ratio in their nest environment began to do masticate fungi (Holldobler and Wilson, 1990) [4]. Ants decrease herbivore damage to leaves, buds or flowers and seeds (Koptur, 1979[36]; Smiley, 1985[37]; Rico-Gray & Thien, 1989[38]; Oliveira, 1997[39]; Inouye & Taylor Jr., 1979[40]; Keeler, 1981[41]; Whalen & Mackay, 1988) [42]. Some ants feed on disturb plants and may act as vectors of plant diseases, benefit from damaging Homoptera and attack or irritate humans, domestic animals and other beneficial organisms (Vander meer, 1990[49], Vinson and Greenberg, 1986) [50]. Predator ants that are recognized as important in pest management are mostly omnivorous and rely also on plant foods e.g. one of the ant species, *Formica rufa* diet comprised 62% honeydew, 5% resin, fungi, carrion, seeds and 33 % insect prey (Wallenstein, 1952) [51]. Ants show a great impact on the terrestrial ecosystem. In most terrestrial habitats, they are among the leading predators, feeding on other insects and small invertebrates, so that can be manipulated for pest biocontrol (Suryanto, 1993)[53].

For integrated pest management and natural pest control, the potential of ants to control pest species can be utilized. It will be helpful to reduce chemical pesticides in the agricultural system.

Ants And Soil Relation

Some organisms are no longer considered to play a role only as elements of the food web, but they are studied from the point of view of being responsible for altering ecosystem dynamics through the modifications (Jen and Jouquet, 2006)[15]. According to Holldobler & Wilson(1990)[4], Folgarait (1998)[8], ant frequently clear the soil surface of vegetation and mobilize a large amount of underground soil to superficial layers to construct and maintain their nests. They also focus on organic matter and generate large quantities of organic waste that are deposited inside the nest in specific chambers or on the soil surface because of these activities ant nest soil show particular properties affecting surrounding vegetation. Ants greatly affect the physical, biological and chemical properties of soil, ants, therefore, improve the mineral quality of soil through their effects particularly improving the availability of resources to another organism as microorganisms or plants. Ants also help to increase microbial activities and the release of mineral nutrients similar to ammonium and nitrate (Abbadie & Lepage, 1989)[16]. Ant nests have a reached amount of organic matter, phosphorous, nitrogen, and potassium as compared to the surrounding soil (Salem, M. Z., & Hole, F. D. 1968[18], Petal, J.O.A.N.N.A., 1978[19], Mandel, R. D., & Sorenson, C. J. 1982[20], Choate. Ouellette, et al.,

2010) [21]. When soil pH is near neutral then most of the mineral nutrients are readily available to plants (Kumari et al, 2016) [54]. Ant activity may also neutralize soil pH by increasing the pH in acidic soils and decreasing the pH in basic soils (Frouz & Jilková, 2008[22]; Petal, 1980) [23]. Ants improve the mineral quality of soil by dissolving mineral elements (Diame et al.,2017) [24]. Some of the common and abundant ant species which increased nutrition amount ultimately help the enhancement of agroecological productivity (Agarwal & Rastogi, 2008)[25]. Chate (2022)[52] studied the correlation between the diversity of ants in the agriculture field and concludes that all other parameters which showed a significant positive correlation with ants, except potassium, phosphorus, water holding capacity and temperature this was due to bioturbation, nesting habitat and foraging activity of ants in the agriculture field. The contribution of active ants mounds to the surrounding soil ecosystems involves long-term nutrient release into the system (Chate & Chavan, 2021)[59].

Act As An Ecosystem Engineer

Ants act as ecosystem engineers; they mark on physical, chemical and biological properties of the soil. An increased soil porosity and separation of the soil particles according to their size. Ants mainly carried out two changes in the chemical properties of soil, they shift pH toward neutral and an increased nutrient content (Frouz & Jilkova, 2008)[22]. Ants play a significant role in the diversity and stability of the ecosystem. Ants maintain microclimate and habitat which aids in biodiversity conservation. Ants are very much sensitive to the environment. Hence Species composition in an area acts as an indicator of its health (Kumar et al, 2014)[58]. According to Jones et al., (1994) [26] role of organisms is influenced by ecosystem functioning is called ecosystem engineering. Ecosystem engineers are organisms that directly or indirectly modulate the availability of resources to other species, through their building activities. They have an impact on soil aggregation and porosity and hence associated hydraulic properties and soil organic matter (SOM) availability for microorganisms (Lavelle P. 1997[27], Vivian-smith, 1997)[28]. Soil engineers like ants and termites could play a key role in increasing plant species richness or modifying the plant community structure of ecosystems. Soils handled by their (ant, termites) engineers are often enriched in fine particles as well as in soil organic matter and exchangeable Ca, Mg, K and Na cations as compared to the surrounding soil (Folgarait, 1998[8]; Bruyn and Conacher,1990) [29]. A direct positive effect of the engineering activity lies in the development of the mutualistic relationship between the ants and the epiphytes, whereby the ants profit from the roots forming an integral part of the nest and increasing its structural stability and an abundant food source close to the nest such as extrafloral nectar (Buckley, R. C. 1982) [30]. Through the collection of dead organic material, ants take it to their nests and in the process reallocate nutrients around the ecosystem. Ants are responsible for resource removal and for scavenging along with other invertebrates. In the absence of ants, no other animals compensated to maintain levels of food removal (Kumar, 2017) [55]. As compared to surrounding parent soils, ant-processed mound soils are often well-aerated and bulky with very stable parameters of temperature, humidity etc. Moreover, these mound soils contain higher amounts of organic matter, particularly C and N (Risch, et. al., 2005[31]; Cammeraat & Risch, 2008) [32]. Ants were found as pioneers and subsequent colonizers of this industrial waste deposit from the viewpoint of their functioning in plant seed dispersal. So ants play the role in primary vegetation succession (Kovar et al, 2013)[56].

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