Salahaddin University_ Erbil

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Department: Plant Protection

Fourth stage

Response of wheat aphid to organic fertilizer and plant extracts

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Outline

Introduction

In temperate regions, wheat is the most common crop grown for feed for livestock and huma ns.The gluten protein fraction, which provides the viscoelastic qualities that enabl e dough to be processed into bread, pasta, noodles, and other food products, is also important to its success in addition to its versatility and high yield potential (shewry et al., 2009).

In addition, wheat provides vital amino acids, vitamins, minerals, and advantageous phytochemicals as well as dietary fibre components to the human diet. Whole grain products are especially rich in these nutrients. Concerns for the future and present include creating lines of wheat with improved quality for particular end purposes, including biofuels and human nutrition, and maintaining wheat output and quality with less agrochemical inputs (Shewry et al., 2009).Numerous variables, such as insect infestations and microbiological illnesses, are responsible for the low yield of wheat. Aphids are one type of insect pest that is frequently cited as the main obstacle to economic wheat production (Shahzad et al., 2013).

In wheat fields, aphids are a common and serious pest. Among the various species of aphids, the most common ones are often thought to be the corn leaf aphid, *Rhopalosiphum maidis,* Russian wheat aphid, *Diuraphis noxia,* green bug, *Schizaphis graminum,* and grain aphid, *Sitobion avenae* (Aphididae: Homoptera). Infested leaves turn pale and wilt as the adults and larvae feed on the plant sap, which affects crop development and spreads a variety of viral A timely acquisition of aphid density is necessary for monitoring the dynamics of the aphid population, analysing the extent of the pest infestation, and determining the economic threshold for pest control (Zhang & Swinton, 2009)(Liu et al., 2016).

One way to reduce aphid infestation is to use fertilisers to create a stronger crop that can both withstand pest infestation and yield more fruit.So, adding organic matter to the soil to incr ease its nutrient content and supply plant nutrients is one way to increase crop yield. Agricult ural wastes of all kinds and origins have been used for this purpose since ancient times (Ibrahim et al., 2008).

In the developing world, using plants and products derived from plants to control pests is very common. The only pest managing agents available to farmers worldwide before the development of synthetic pesticides were plants or plant-based products (Georges et al., 2008). On small scales, the toxic effects of different plant extracts, including eucalyptus and cypress, against wheat aphids have been investigated (Georges et al., 2008).

Hence, global tendency of producing healthy food has imposed the need of conducting further examinations especially the wheat importance has been in continuous increase as planted in large areas according to Ministry of Agriculture and water resources in Kurdistan region. Therefore, the specific aim of this study is

- To find a suitable solution that assists in the more practical use of safe natural insecticides (aqueous plant extracts) that promote sustainable agriculture

- Investigate the effect of organic fertilizers within soil amendment to minimize insect pest infestation and increase soil fertility.

- Evaluate the density of the pest after bio and chemical pesticide application under greenhouse condition.

2. Literature review

2.1The importance of wheat crop

The cereal crop known as wheat (*Triticum aestivum*) is a member of the Poaceae family.
For about 40% of the world's population, wheat is a staple source of nutrients.
Wheat has been cultivated since ancient times.
One of the earliest crops to be domesticated, wheat has been the staple diet of the major civilizations in Europe, West Asia, and North Africa for 8,000 years.
This is probably due to the versatility of wheat in terms of agronomy, its ease of storage, and its ease of conversion into flour for a wide variety of culinary applications.
With more than 218 million hectares under cultivation, wheat is currently the most widely grown crop in the world. Its global trade exceeds that of all other crops put together (Giraldo and benavente et al., 2019).

The highest percentage of lipids (11%) is found in the wheat crop; however, substantial amounts are also found in the bran, endosperm starch, and proteins. Starch content in wheat grains can range from 60% to 75% of the grain's total dry weight.
Depending on the variety, baking qualities, and growth environment, wheat can have a protein content ranging from roughly 6 to 20%.
Because wheat is the most popular cereal in the baking industry, wheat breeding and research have focused on optimising the grain for baking (high protein content, stable falling numbers, consistent baking qualities), especially with relation to carbohydrates, pentosans, protein fractions, and enzymes (Faltermaier et al., 2014).

2.2 . Aphid lifecycle

Hemiptera: Aphididae, or aphids, are a group of ancient insects that feed on sap and have a variety of rather complex life cycles. Every life cycle has several stages, each of which is distinguished by one or more specialised morphs. Every one of these morphs has a distinct role that must be fulfilled for the life cycle to progress through each stage. Aphid life cycles are typified by morphs that are specialised in reproduction, dispersal, and enduring harsh or unfavourable environmental or dietary circumstances (Loxdale and Balog et al., 2018).

The effects that aphids can have on crops can vary greatly depending on their life cycle. For instance, a species' likelihood of coming into contact with crops and the variety of crops it is likely to come across in a given year can be predicted by its life cycle. Additionally, an aphid species' population density is influenced by variables like temperature and natural enemies in any given year, but the relative significance of these variables varies depending on the life cycle of the aphid. The degree of damage inflicted by a particular species of aphid on a crop is also determined by its morphology. For instance, compared to their winged counterparts, wingless parthenogenetic morphs reproduce at a rate that can reach 70% higher (Dixon and Wratten, 1971).

Based on how they use their host plants, aphids have two main life cycles: non-host alternating (monoecious or autoecious) and host alternating (heteroecious). Aphids that host-switch spend the winter on a single plant species (primary host), migrate in the summer to a different plant species (secondary host), and return to the primary host in the autumn. Once males and sexual females have mated, eggs are laid on the main host. Holocyclic aphids are those that halt parthenogenesis in order to reproduce sexually.

In other words, non-host-alternating aphids can lay their eggs on the same group of host plant species that all parthenogenetic generations feed on, or they can migrate between closely related species throughout the year. Aphid species classified as anholocyclic are those that never lay eggs. While monoecy and heteroecy are uncommon, certain species exhibit both holocycly and anholocycly. This chapter elaborates on these life cycle types and discusses their significance in identifying a species' pest status. Every major category has notable crop pests (Williams and Dixon et al., 2007).

2.3.Aphid damage

While the distal tip of the labium acts as a guide and aids in stylet penetration from the outside, aphids typically feed passively on the contents of plant vascular tissues (usually the phloem) through the use of high pressure within the sieve elements. Their mouth appendages are elongated into a stylet bundle that pierces the plant tissues to reach the feeding site in the phloem (Miles 1999). The first type is dense and proteinaceous; it forms a jelly around the stylets (stylet sheaths) and provides the piercing stylets with an intercellular pathway towards the phloem. This keeps the plant tissues isolated from the mouthparts and inhibits plant reaction at the feeding site (Felton and Eichenseer 1999).

The second type of saliva, known as "watery," is produced by aphids once they reach the phloem flow. This saliva is injected directly into the plant's vascular system and contains digestive lytic enzymes that cause wilting when the adults and larvae suck the plant sap (1), ultimately leading to a low wheat crop yield (Wiliams and Dixon et al., 2007).

Aphids can produce lipids and amino acids from dietary sugars, according to research conducted on artificial diets that contain sucrose (Febvay et al. 1999). However, they are dependent on the bacterial symbiont *Buchnera aphidicola* Munson Baumann & Kinsey, which is housed in the cytoplasm of specialised cells (bacteriocytes) in the aphid body cavity, in order to obtain essential amino acids. The well-known honeydew is used to excrete dietary sugars that exceed nutritional requirements. This lowers the osmotic pressure of the sap that is consumed, which would otherwise be fatal to aphids (Douglas 2006).

As one of the most serious insect pests in the world, honeydew can cause discoloration, leaf curling, yellowing, and stunted growth. Ants actively search for honeydew and frequently visit aphid colonies to protect them from natural enemies (such as parasitic wasps and ladybird predators), further damaging crops (Loxdale and Balog et al.,2018).

Figure1: Ahid damage to wheat crop

2.4. Prevention method

2.4.1. Organic fertilizers to minimize pest infestation

Carbon based substances known as organic fertilisers improve plant growth and productivity. Rather than being chemicals that have been refined and simplified, organic fertilisers are intricate mixtures that provide a variety of secondary and micronutrients. Compost, wood ash, plant leaves, and animal and poultry manures are examples of organic materials that contain valuable micronutrients and whose texture would enhance soil quality rather than worsen it.

The Value of Natural Fertiliser In contrast to chemical fertilisers, organic fertilisers contained materials that were leftovers from plants, animals, or minerals. These sources of decomposing matter break down organically and replenish the soil with nutrients and minerals. In order to maintain a healthy lawn, it is important to ensure that the garden or lawn receives all the nutrients required for growth. Even though regular soil contains nutrients, fertilisers can supply and guarantee that the plant has an adequate and balanced supply of nutrients. Proper lawn care also takes into account the lawn and garden's overall health. The fact that the nutrients in organic fertiliser related to one another more slowly than in chemical fertilisers was one of its advantages . This more gradual process prevents overfertilization, which could harm the plant, and enables the plant to absorb the fertiliser in a more organic manner. It is also possible to enhance the soil's air circulation and drainage (Rahman et al., 2004).

Manure has a variable effect on the pH of the soil. While organic matter added as manure can help buffer the soil against a decrease in pH, manure that is low in organic matter and high in ammonium nitrogen may result in a decrease in pH due to acidity produced when the ammonium is oxidised to nitrate in the soil . Repeated applications of nitrogen fertiliser may cause soil acidification due to acidity produced in the nitrification process. (Assefa and Tadesse et al.,2019).

Numerous studies have shown that organic fertilisers, such as composted or uncomposted organic matters, can increase the density of parasitoids and predators while suppressing insect pest attacks and population decline. Through modifying the nutrient levels in plant tissue, cultural practises like crop fertilisation can change a plant's susceptibility to insect pests. Research indicates that ideal physical, chemical, and mostly biological properties of soils are linked to a crop plant's capacity to withstand or tolerate insect pests and diseases. Good soil fertility is typically found in soils with high organic matter content and active soil biology.

Due to a lower nitrogen content in organically farmed crops, crops grown in such soils typically show lower abundances of a number of insect herbivores. However, certain farming techniques, like overusing inorganic fertilisers, can lead to nutrient imbalances and a reduction in pest resistance. It is necessary to conduct more research comparing pest populations on plants treated with synthetic versus organic fertilisers. New and improved integrated pest management and integrated soil fertility management designs may result from our understanding of the underlying mechanisms behind the apparent improvement in plant health that organic fertilisation brings. (Altieri and Nicholls et al., 2003). Interactions between plants, microbes, and insects are also influenced by environmental factors, such as soil fertility, since interactions between an aboveground aphid, a crop plant, and a pathogenic soil fungus are influenced by mineral fertiliser and soil organic matter (SOM) (van Gils et al., 2017).

2.5.Control method

2.5.1. Plant extracts to minimize pest infestation

The use of a combination of natural products to treat disease has a number of intriguing outcomes, most notably their synergistic effects and polypharmacological action. Plant extracts are gaining popularity as possible therapeutic agents. Plant-based insecticides are regarded as some of the most affordable and environmentally friendly chemicals available for plant protection. Botanical formulations have demonstrated their potential in integrated pest management as semi-chemicals by demonstrating efficacy in changing behaviour against bruchids. This has helped to mitigate the issue of induced pest resistance that is often associated with synthetic pesticides (Gibbons et al., 2003).

2.5.2. Eucalyptus extract as biopesticide

Because of its many intriguing biological activities, which are mostly ascribed to the variety of phytochemical constituents found in the plant parts, Eucalyptus globulus is one of the most commonly used medicinal plants in the world. There is an urgent need to investigate new antimicrobial ingredients from botanical sources, with medicinal plants being one of the most promising sources, due to the growing crisis of pathogen resistance for conventional antibiotics, which is thought to be a global concern for the declining effectiveness of antibiotics. Furthermore, the worldwide scientific community has been driven to discover antioxidants and antimicrobials derived from plants due to the increasing restrictions placed on synthetic antioxidants. Furthermore, the worldwide scientific community has been driven to discover antioxidants and antimicrobials derived from plants due to the increasing restrictions placed on synthetic antioxidants. Because natural compounds are safer alternatives and public health awareness is rising, this is a major worldwide challenge (Mossi et al., 2011).

Additionally, plant extracts and their oil could be utilised to reduce reliance on synthetic chemicals by controlling insects, weeds, and plant pathogens with environmentally friendly plant-based products. In light of this, the purpose of this review is to showcase the abundance of the E. globulus plant, which possesses valuable bioactive components, antioxidants, antimicrobials, phytoremediation, and herbicidal properties. These properties will open the door for the creation of novel medications, agrochemicals, and food preservatives. In addition, they might offer potential commercial uses to mitigate the drawbacks of synthetic antioxidants (Shala and Gururani et al., 2021).

In Israel, eucalyptus stands were planted for the first time successfully in 1884. Currently, this tree genus—especially E. camaldulensis—covers about 11,000 hectares and accounts for about 4% of all planted ornamental trees. Here, we go over and talk about the information that is currently available regarding native and alien insect species that grow on eucalyptus trees in Israel, as well as the natural enemies of particular exotic insects that attack this tree. On this tree, sixty-two phytophagous species have been identified, of which about 60% are native.Mostly found in wetlands or on irrigated trees, the largest group of insects are sap feeders, which include both invasive and native species. Wood feeders, a polyphagous group of insects that make up the majority native group, are the second largest group. They develop on dead or dying wood. Classical biological control projects introduced most of the seventeen parasitoids linked to the ten invasive species specific to Eucalyptus as biocontrol agents. This tree is unaffected by any of the polyphagous species known to feed on eucalyptus. Invasive parasitoids have successfully managed to suppress the most harmful invasive species of pests, namely the bronze bug (*Thaumastocoris peregrinus*) and gall wasps (Eulophidae).) state that the Australian insect fauna is the most likely source of potential entomological hazards associated with eucalyptus in Israel(Mendel and Protasov et al.,2019).

2.5.3. Cypress extract as biopesticide

The Cupressaceae family of plants, which includes the Mediterranean cypress (*Cupressus sempervirens)*, is the first whose comprehensive evolutionary history traces the break-up of the supercontinent Pangaea approximately 150 million years ago (Weick et al.,2023).

The oil has been used medicinally for hundreds of years as an astringent and skin tonic, cosmetically to treat broken capillaries and varicose veins, and as an immune system stimulant. It also demonstrated great deterrent and larvicidal activity towards mosquitoes. The ancient Greeks used the mashed and steeped Cypress cones to treat coughs, dysentery, and asthma (Ali et al., 2013).

Pinto et al. (2020) found that administering cypress and eucalyptus essential oils via inhalation highlighted their adulticidal effect on T.absoluta. Thus, whereas 10% mortality was found in the control experiment, the death rate increased dramatically to 100% at the highest concentration after 24 hours of treatment.

Tests were done on insect pests found on white cabbage using cypress water extracts. The number of cabbage aphids (*Brevicoryne brassicae* L.) on the treated plants was significantly decreased. At the height of their occurrence, aphids were almost twice as common on unsprayed plants as they were on spurge extract-sprayed plants (Jankowska and Wilk., 2011).

3. Material and Methods

Laboratory experiment

3.1. Germination rate

Ten seeds of wheat were placed inside petri-dish with a total of five petri-dish and filter aper inside and the germination rate was calculated and monitored with %100 germination rate were recorded after 5 days.

3.2. Preparation of aqueous plant extracts

Fresh leaves of cypress, *Cupressus sempervirens* and eucalyptus, *Eucalyptus camaldulensis* were collected from Erbil.

Leaves of these plants were washed carefully with water, air dried in the shade, and afterwards ground into a fine powder using an electric grinder. Later the plant powder will be admixed with water to prepare aqueous plant extracts and will be used to control aphid o wheat crop.

3.3. Plastic house experiment

The procedure started from November as the soil has been sterilized with formalin %5 as for 2-3 days the soil covered to eliminate any soil-borne pathogens.

The sterilized soil has been used to prepare 30 plastic pots with a capacity of 2 Kg for each pot that have been placed inside the plastic house.

Wheat seeds of Hawler 4 variety was selected for the experiment which is a local product and three grains were cultivated in each pot. Animal organic fertilizers from local market were admixed with the soil in 3 levels (0,20,40)g/pot to the soil with three replications. The level (0)g is the untreated control group in which no management with any kind of fertilizers were applied to the soil.

Later in Spring will leave the pots to be infested with aphid naturally if not they will be artificially infested with wheat. Wheat inside pots will be treated with the aqueous plant extracts and water will be used as negative control and a chemical pesticide as a positive control.

The population of aphid and percentage of wheat infection will be calculated as following:

Percentage of infection = Number of infected leaves X 100 / Total number of leaves.

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