MARTIN JOHN:

Martin John is one of ACE IRPM&BTD Staff who successfully defended his PHD Thesis in Agricultural Entomology and pest control at the university of Northwest Agriculture and Forest University (NWAFU), China, on the 2th may 2021. His study focused on the Variations in growth, life table characteristics, and defense responses of the pea aphid (*Acyrthosiphon pisum*) in broad beans (*Vicia faba*) and alfalfa (*Medicago sativa*). His research area was insect Physiology and Biochemistry. Let's join hands to congratulate him.

A short summary of his work

The pea aphid (*Acyrthosiphon pisum*) (Hemiptera: Aphididae) is a pest of leguminous crops. It damages crops directly by causing injuries and indirectly by transmitting plant pathogens. The insect has drawn the interest of many researchers globally because of its incomplete immune system but can mount strong immune responses against invaders. Although most defensive responses are known, there is a lack of knowledge of host plants' effects on these responses. Also, the impact of plants on growth rates and life table parameters of the insect have received insufficient attention. Therefore, the major aim of this research was to understand the disparities in growth, life table parameters, and defensive responses of the pea aphid reared separately on two different host plants (*Broad beans* and *alfalfa*). The specific objectives were (1) to investigate the nutritional differences in alfalfa (*Medicago sativa*) and broad bean, (*Vicia faba*) phloem saps and assess their influence on growth rates, body weights, and life table parameters; (2) to determine the variations in immune responses when pea aphids are feeding on the two host plants; (3) to evaluate plants' impact on the alternative defense responses of pea aphid against microbial infections. The results are summarized as follows:

1. Potential nutritional variation in the phloem sap of *V. faba* and *M. sativa* influences the growth and life table parameters of the *A. pisum*

The mean concentrations of eight amino acids differed considerably between the two plants: arginine, histidine, lysine, proline, asparagine, glutamine, tyrosine, and phenylalanine. All of these amino acids were significantly higher in *V. faba* leaf samples than in *M. sativa* samples. Similarly, the total concentration of all free amino acids was significantly higher in *V. faba* than in *M. sativa*. The most abundant amino acids in *M. sativa* were all non-essential amino acids, i.e., asparagine (36.03%), glutamic acid (17.37%), and serine (11.92%). Similarly, the most abundant amino acids in *V. faba* were all non-essential amino acids: asparagine (60%), tyrosine (7.08%), and glutamic acid (3.91%). The total concentration of essential amino acids was significantly higher in *V. faba* than in *M. sativa*. The most abundant essential amino acids in *M. sativa* were threonine (31.28%), leucine (16.1%), and valine (15.72%), while in the *V. faba*, the most abundant essential amino acids were histidine (48.4%), lysine (14.04%) and valine (9.7%). The contribution of the essential amino acids to the total amount of amino acids was 9.65% for *M. sativa* and 12. 35% for *V. faba*. The most varied essential amino acids in the two plants were histidine, lysine, and phenylalanine.

Fructose, glucose, and sucrose were detected in the phloem sap of both plants. The total concentration of sugars differed significantly between the two plants. Individual sugars in *V. faba* were all significantly higher than those in *M. sativa*. Correspondingly, the total amount of all sugars were significantly higher in *V. faba* than in *M. sativa*. More importantly, the analysis revealed that both total amino acids and total sugars were significantly higher in *V. faba* than in *M. sativa*. Considering the amount of amino acids, especially the essential amino acids, are used as an index of phloem sap quality. In this regard, broad beans are of higher quality than alfalfa.

Aphids reared on *M. sativa* (the low-quality plant) had lower growth rates, body weights, intrinsic rate of natural increase, and finite rate of increase than the aphids feeding on *V. faba* (the higher quality plant). The generation time, pre-reproductive period, and the doubling time were more extended in the aphids reared on *M. sativa* than in the aphid reared on *V. faba*. This may indicate that broad beans are more suitable host plants for pea aphids, and the suitability of *V. faba* may be due to its higher nutritional quality.

2. Host plants affect the immune defense of A. pisum in response to pathogen

The survival of aphid after exposure to different pathogens was not affected by the host plants. However, *A. pisum* reared on *M. sativa* generally harboured fewer microbial loads than those reared on *V. faba*. Furthermore, infection of the aphid with Escherichia coli and Staphylococcus aureus induced hydrogen peroxide production (H_2O_2) and significantly increased phenoloxidase (PO) activity in both aphid groups. Interestingly, the aphid group feeding on *V. faba* showed higher H_2O_2 levels but lower PO activity than those on *M. sativa*. This could be because the aphids allocate different amounts of resources to each immune response. Also, these two immune responses may have trade-offs between each other. Both in infection and un-infection conditions, *A. pisum* reared on *M. sativa* had higher PO activity than their counterparts reared on *V. faba*, indicating that the host plant influences the activity of this critical enzyme. Aphids from both plant species were able to phagocytize *E. coli* and *S. aureus* cells, but there were no significant differences in the ability to engulf bacterial cells.

These observations suggest that *A. pisum* reacts differently to infections on different plants. The host plant moderates interactions between the *A. pisum* and their pathogens by influencing the aphid's immune responses.

3. Host plants affect the alternative defense of A. pisum in response to pathogens

Rearing pea aphid on different host plants, *M. sativa* and *V. faba*, did not change the composition of the secondary symbionts. Aphids raised on *V. faba* invested more in terminal reproduction in response to bacterial and fungal infections. Aphids raised on *M. sativa*, on the other hand, responded to *Staphylococcus aureus* and *Beauveria bassiana* by producing significantly more winged offspring. This may mean that when food quality or supply is low, aphids will produce winged offspring that can fly away and seek out new plants, while when food quality is high, aphids will respond to infection by increasing reproductive output. This indicates the role of the host plant in these responses.

In conclusion, in this study, I found a significant difference in the pea aphid’s growth rate, body weights, life table parameters, and defenses when fed on diets with potential variations in the nutritional quality. The most important aspect of the research is how aphids react to pathogens while feeding on diets that differ in nutritional qualities. More specifically, diets influence

defensive strategies between terminal reproduction and the production of winged offspring. This information is essential in designing ecological pest management programs for managing aphids with microbial pathogens.

Keywords: Host plant, *Acyrthosiphon pisum*, life table parameters, immune response, alternative defense, microbial pathogen.