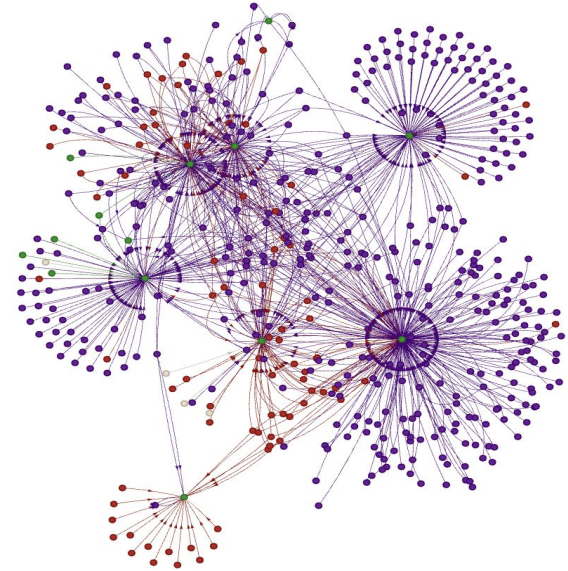




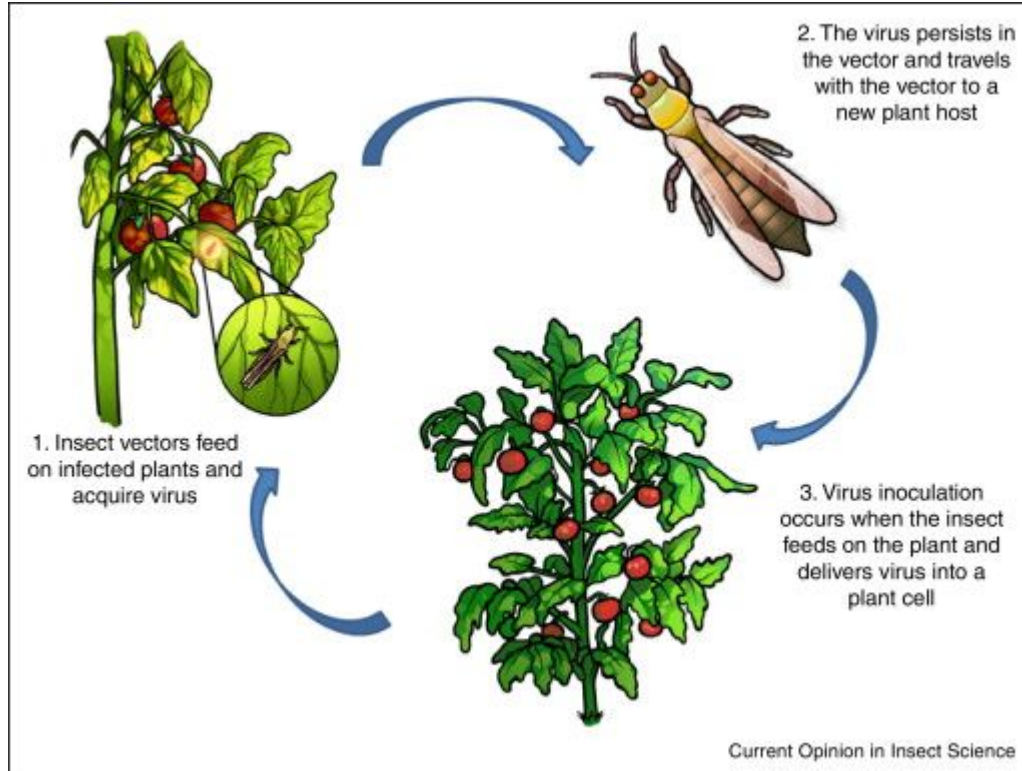
Knowledge Graph and Network Analysis for Plant Diseases Transmission based on Insect Vector and Pathogen Interaction

Yeni Herdiyeni, Moh Zulkifli Katili, Medria Kusuma
Dewi Hardhienata

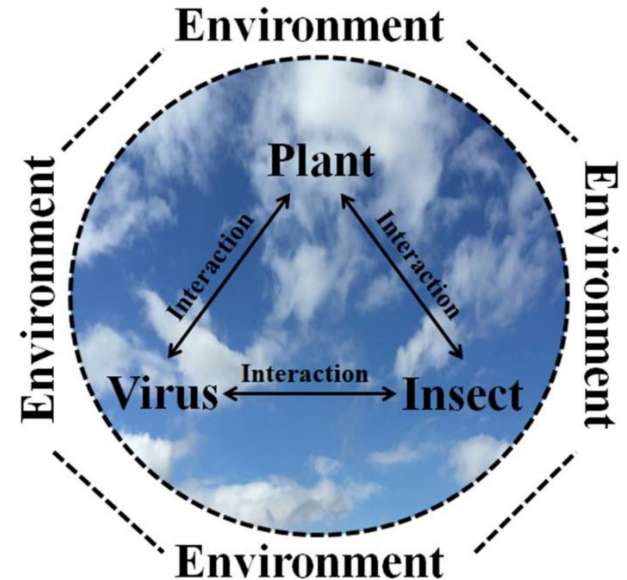
Dept of Computer Science - IPB University
Jakarta, 22 June 2023




Plant Diseases Epidemics: **Plant-Vector-Pathogen System**



Many viral and bacterial pathogens that cause plant disease epidemics rely on herbivorous **insect vectors for transmission**





Research Background


**Production losses
issue due to the
insect vector**

- Garlic 14-32% (Pauzi 2017)
- Chilli 12-65% (Marianah 2020)
- Tomato 24,70% (Wahyudin 2022)



Challenges in direct vector identification

- Wide host range (Lee et al. 2022),
- Limited detection methods (Rubio et al. 2020),
- PCR costs and require experts in its implementation (Yasin 2006; Rubio et al. 2020).



Challenges in vector identification by literature study

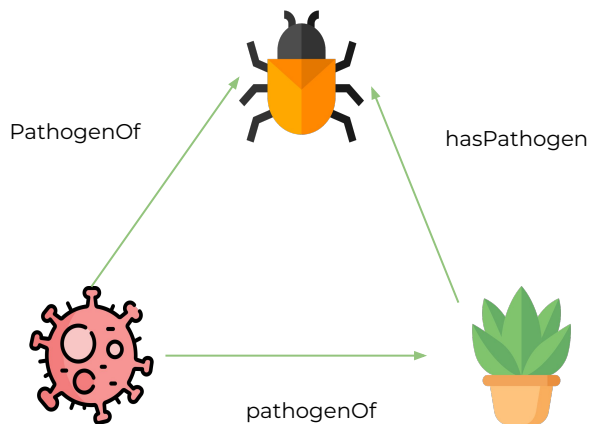
Reading and concluding previous literature studies, requires more time and effort.

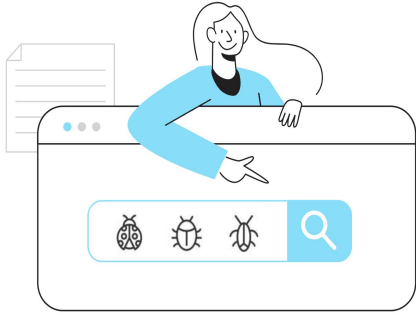
Insect Vector & Plant Pathogen Interaction

Viruses: Pathogens that carry disease

Insects Vector: Insects that carry pathogens

Host plant: The plant that will be affected





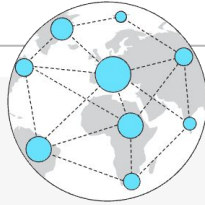
What we do:

- Using biotic interaction data already available in GloBI
- Build an specific graph of insect-virus-plant interaction from the data
- Apply a suitable graph analysis method to find insects that act as vectors of a virus

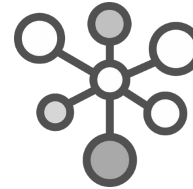
Insect Vector Search Engine

Existing Knowledge Graph:

- **Substance Information :**
Global Biotic Interaction (Poelen et al. 2014)
- **Complementary Information :**
 - **Wikidata** (Farda-Sarbas dan Mueller-Birn 2019)
 - **DBPedia** (Lehmann et al. 2015)
 - **NCBI Taxonomy Ontology** (Schulz et al. 2008; Arnaud et al. 2020)



Get spesific
data



**Subgraph:
Virus-Insect-Plant
Interaction**



Network
Analytic

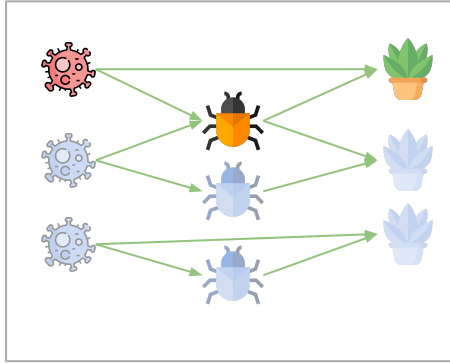


**Insect vector
Identification**

Knowledge Graph & Network Analysis: Insect Vector & Plant Pathogen

In searching for insect vectors, we will use two pieces of information

(1) Network interactions of viruses, insects, plants

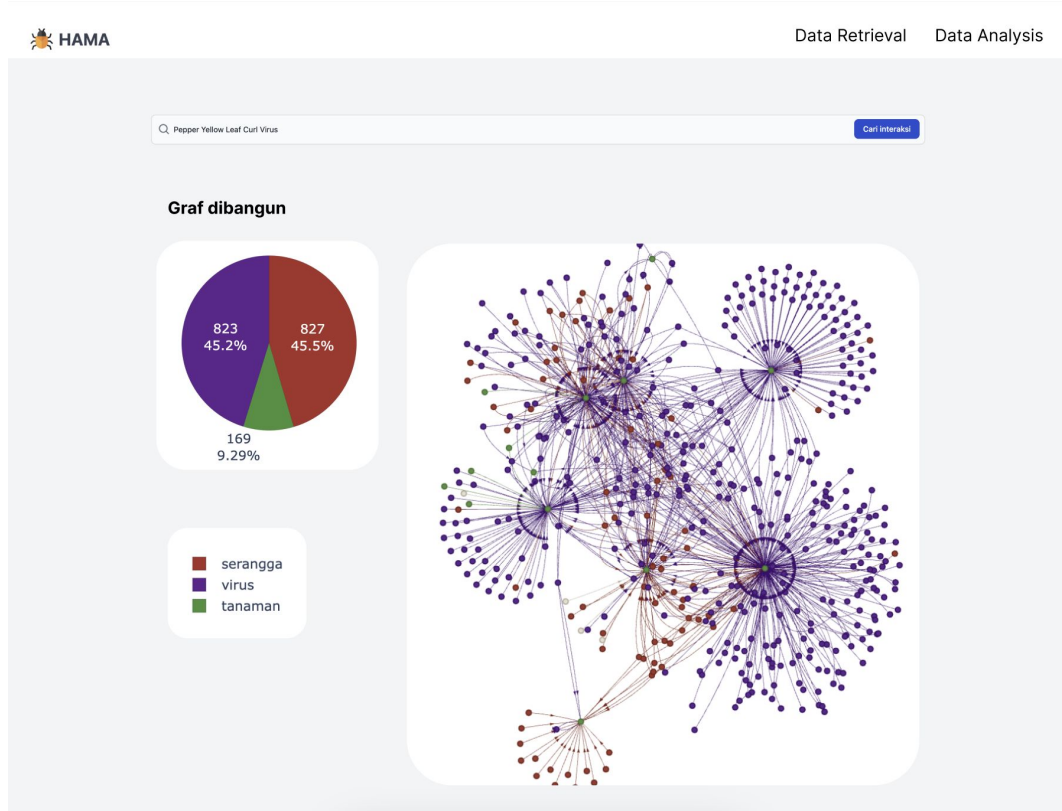


- **Data:** Insect-virus-plant Interaction
- **Technique :** Degree Centrality (DC)
- **Objective :** Find insects that have an important (central) role in the graph. It can be interpreted as insects that often appear in many viruses and plants.

(2) Insect and virus taxonomic association pattern

Insect Family	Virus Family
<i>Aphididae</i>	<i>Bromoviridae</i>
<i>Aleyrodidae</i>	<i>Closteroviridae</i>
<i>Aleyrodidae</i>	<i>Geminiviridae</i>
<i>Thripidae</i>	<i>Tospoviridae</i>
...

- **Data:** Relevant Insect Taxonomy
- **Technique :** Entity Embedding and Euclidean Distance (ED)
- **Objective :** Entity embedding measures the taxonomic similarity of insects with relevant taxonomic patterns (an insect taxonomy with known virus vectors based on the literature).



KNOWLEDGE FUSION

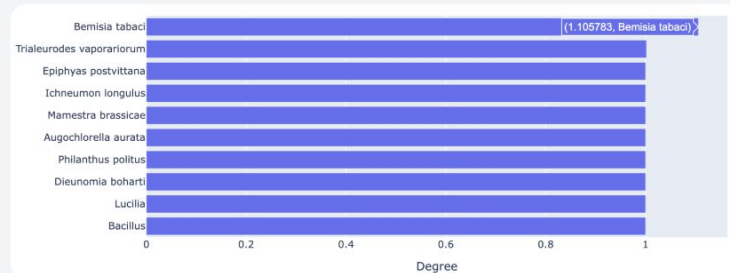
In the example, we type virus “*Pepper Yellow Curl Virus*” and obtain the insect-virus-plant interaction graph





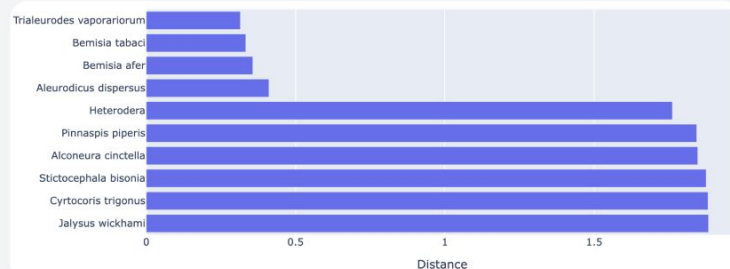
Analysis Graf

Interaction Analysis : Centrality Measurement



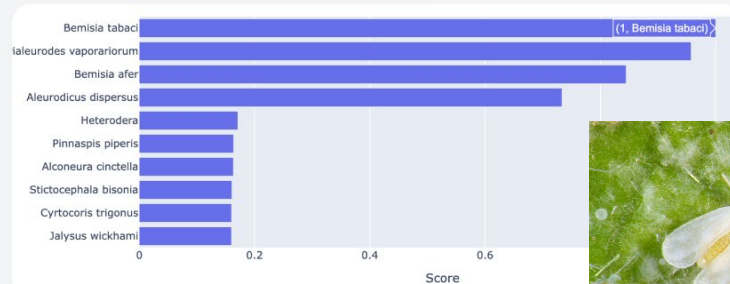
*the bigger the value the better

Taxonomy Analysis : Euclidean Distance



*the smaller the value the better

Final score



*the bigger



GRAPH ANALYSIS:

In the interaction analysis / Centrality measurement the best is Bemisia Tabaci.

In the taxonomic analysis / Euclidean Distance, the best is Trialeurodes vaporariorum.

In the final score that represents the best of both is **Bemisia Tabaci**

Detail Page



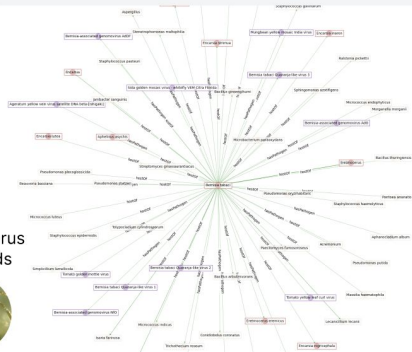
Dari Wikidata and DBPedia :
Binomial Name : Bemisia Tabaci
Nama : Kutu kebul, Silver whitefly
Location : -

Diambil dari NCBI : Klasifikasi Saintifik

- Superkingdom : NCBI:2759_Eukaryota
- Kingdom : NCBI:33208_Metazoa
- Filum : NCBI:6656_Arthropoda
- Kelas : NCBI:50557_Insecta
- Ordo : NCBI:7524_Hemiptera
- Famili : NCBI:7036_Aleyrodidae
- Genus : NCBI:7037_Bemisia
- Spesies: NCBI:7038_Bemisia tabaci

Diambil dari GloBI :

Interaksi serangga Bemisia Tabaci : NCBI7038



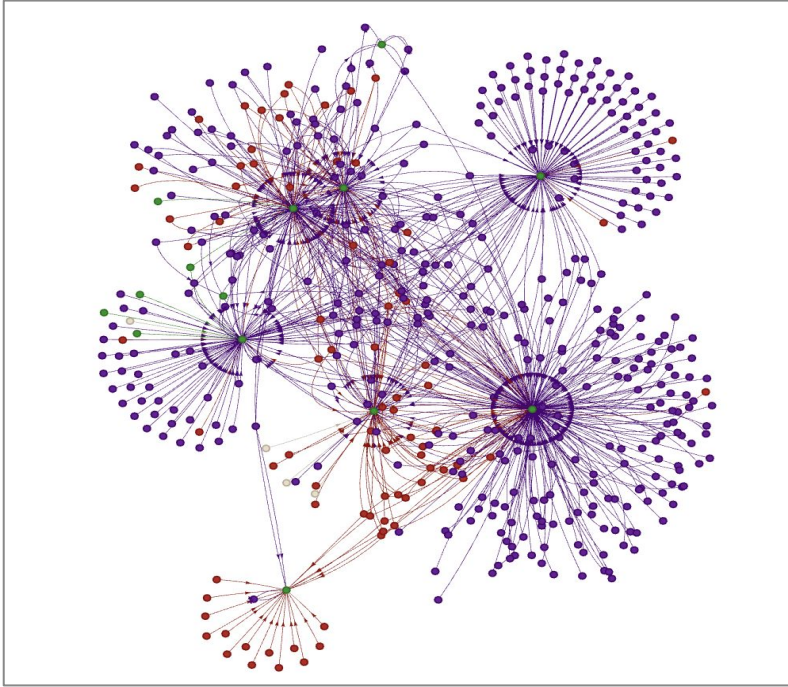
Eretmocerus
parasitoids



TAXONOMY INFORMATION & GRAPH INTERACTION

The interaction Bemisia tabaci insect with Eretmocerus, the natural enemy of Bemisia Tabaci.

This information can be used for **biological control**



Thank You

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