

## REVIEW ARTICLE

## HOST-PLANT RESISTANCE IN PEST MANAGEMENT

Himani Chand\*

*Institute of Agriculture and Animal Science (IAAS), Paklihawa, Rupandehi, Nepal*  
\*Corresponding Author E-mail: [heemanicnd542@gmail.com](mailto:heemanicnd542@gmail.com)

*This is an open access article distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.*

## ARTICLE DETAILS

## Article History:

Received 03 June 2021  
Accepted 05 July 2021  
Available online 21 July 2021

## ABSTRACT

Host Plant Resistance (HPR) is an effective, economical and eco-friendly method introduced for pest management. The concept of HPR has been emphasized mainly in order to reduce the use of pesticides as it provides opportunities to improve research and extension documentation to assist producers. It can also be taken as an effective tool for sustainable agriculture also focusing over the creation of organic farming where very low doses of pesticides are said to be applied if we can focus over this technology. But still in Nepal, the limitation of germplasm availability and development of biotype that can overcome resistance compared to the developed and other developing countries creates disadvantageous situations to completely depend upon this technology right now. Much interest in biotechnology relative to developing insect-resistant plants is in methods known collectively as genetic transformation, rDNA methods, or genetic engineering. These methods enable transfer of a resistance gene that could not be transferred by traditional sexual hybridization. NARC and Government need to prioritize moreover to the entomological research from onwards by increasing manpower in this sector and developing improved resistant and also regarding storage and multiplication of those germplasm.

## KEYWORDS

IPM, Host-Plant Resistance, Antixenosis, Antibiosis, Tolerance.

## 1. INTRODUCTION

IPM. "Integrated Pest Management is an ecological approach in which utilization of all available techniques of pest control to reduce and maintain the pest population at levels below economic injury level". According to the Food and Agriculture Organization (FAO) of the United Nations, IPM means considering all available pest control techniques and other measures that discourage the development of pest populations, while minimizing risks to human health and the environment. It is a flexible system that makes good use of local resources i.e. harmoniously combining cultural, biological and chemical methods with the latest research, technology, knowledge and experience that's why is endorsed as the future standard for crop protection in the most cost-effective, environmentally sound and socially acceptable way (Thomas 1999; Mouden et al., 2021). This holistic concept integrates preventative and curative measures amongst which host plant resistance (HPR) plays an essential role (Mouden et al., 2021).

Snelling (1941) defined plant resistance as those characters resulting from the genetically inherited properties, enabling a plant to avoid, tolerate or recover from attacks of insects under conditions that would cause greater injury to other plants of the same species (Smith et al., 1989). In agronomic terms, a resistant crop variety yields more of a good quality than a susceptible variety at the same level of insect infestations (Fitt et al., 2008). With the domestication of plants for agricultural purposes, farmers selected the plants that were able to withstand the adverse environmental factors, including pests and diseases (Sharma et al., 2001).

### 1.1 Mechanism of Resistance

- Antixenosis (Non Preference)
- Antibiosis
- Tolerance

#### 1.1.1 Antixenosis

Host plant characters responsible for non-preference of the insects for shelter, oviposition, feeding, etc. Non-preference plants either provide stimuli that are unattractive to the pest (color, odor, texture such as downy hairs) or fail to provide stimuli that are attractive to the pest which alter insect behavior resulting in poor establishment of the insect.

e.g.

Trichomes in cotton - resistant to whitefly

Wax bloom on crucifer leaves - deter feeding by DBM

Plant shape and color also play a role in non-preference

Open panicle of sorghum - Supports less Helicoverpa

#### 1.1.2 Antibiosis

Adverse effect of the host plant on the biology (survival, development and reproduction) of the insects and their progeny due to the biochemical and biophysical factors present in it. Manifested by larval death, abnormal larval growth, reduced longevity, reduced reproduction, etc. Often both a

## Quick Response Code



## Access this article online

Website:  
[www.trab.org.my](http://www.trab.org.my)

DOI:  
10.26480/trab.02.2021.54.58

resistant and susceptible variety will have the same basic response to a pest, but the resistant variety will respond more quickly or more dramatically than the susceptible variety, reducing the amount of damage the pest causes.

Antibiosis may be due to

- Presence of toxic substances
- Absence of sufficient amount of essential nutrients
- Nutrient imbalance/improper utilization of nutrients

Chemical factors in Antibiosis – Examples

Chemicals present in plants Imparts resistance against

- 1. DIMBOA (Dihydroxy methyl benzoxazin) - Against European corn borer, *Ostrinia nubilalis*
- Gossypol (Polyphenol) - *Helicoverpa armigera* (American bollworm)
- Sinigrin - Aphids, *Myzus persicae*
- Cucurbitacin - Cucurbit fruit flies
- Salicylic acid - Rice stem borer

Physical factors in antibiosis

Thick cuticle, glandular hairs, silica deposits, tight leaf sheath, etc.

### 1.1.3 Tolerance

Host plants that express tolerance are resistant to pest damage because they can remain healthy and yield well despite the damage. These plants must also be able to heal wounds and fight diseases that enter through wounds. It is generally attributable to plant vigor, regrowth of damaged tissue, to produce additional branches, compensation by growth of neighboring plants.

Use of tolerance in IPM

- Tolerant varieties have high ETL - require less insecticide
- Apply less selection pressure on pests. Biotype development is less

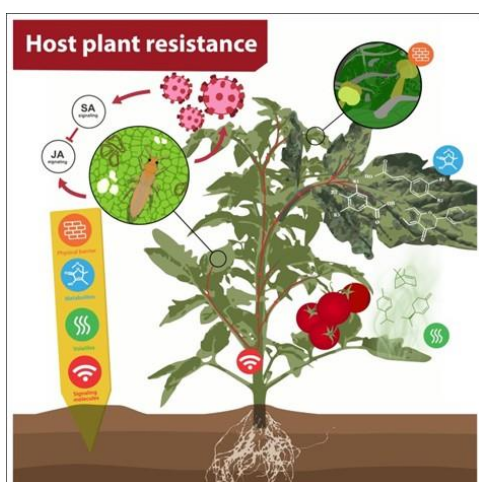


Figure 1: Host-Plant resistance of aphids

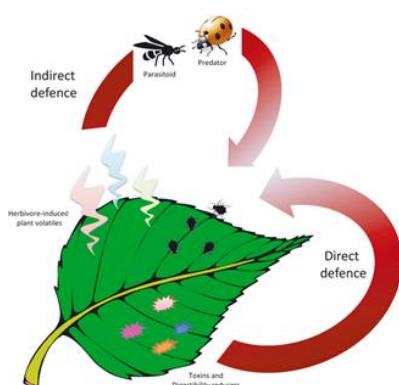


Figure 2: Resistance through leaves

## 2. MATERIALS AND METHODS

The overview in host-plant resistance in plant management has been reviewed consulting available different research papers published in articles and review articles, various news and other basic available regarding the topic was even consulted, in addition other methods of secondary data collection were also used. This review article mainly focuses over the status of host-plant resistance used under IPM mechanisms by farmers in both worldview and especially in Nepal.

## 3. RESULTS AND DISCUSSION

### 3.1 Status of Pesticides in the World

Global losses

Table 1: Estimates of food production losses due to diseases, insects and weeds.	
Actual annual losses to world crop production	\$550 billion
Losses caused by diseases only (14.1%)	\$220 billion

(Data from FAOSTATISTICS according to 2018)

Pesticides are widely used throughout the developing world, and pesticide demand is increasing due to the current system of crop production, which prioritizes high agricultural yields. Currently, herbicides are one of the most used pesticides in the world. Many farmers in developing countries mainly view pesticides as the best crop insurance against crop pests. In the past 2 years, the COVID-19 pandemic has added another factor to the situation by pushing up costs for farmers while reducing income. Although been considered as a greater to the global food security, and how it is balanced against their potential to cause harm to human health and that of the broader environment, is a subject of fierce debate, often pitting companies against consumers or non-governmental organizations (NGOs). So, IPM (especially Host-Plant resistance) has been advocated by FAO and the EU for the possible alternative solution to the given pesticides problem.

The figures of pesticides application is increasing rapidly which shows on how the investment on breeding for greater insects resistance. Although identifying sources and studying the complexity of mechanisms of resistance to insects receives much attention, one should remember that the ultimate goal is less insect damage in the varieties of the future. These are still to be developed and it is in the developmental process (selection and breeding) where resistance must be incorporated, judged accurately, and selected among other criteria of the variety-to-be.

### 3.2 Historical Aspects of Host-Plant resistance

Until 1960, the host plant resistance as a method of insect control received very little attention except in few cases. However, the growing awareness of the limitations of pesticides in recent years has caused an upsurge of interest in this approach in insect control through developing a resistant variety involves faculties of different department and requires several years of research and experimentation.

- Earliest documentation of an insect resistant variety was a wheat variety "Underhill" which was found to resist the attack of the Hessian fly, *Mayetiola destructor* in New York in 1782.
- Grape phylloxera (1860) leaf galls caused by *Viteus vitifoliae* (Hemiptera: Sternorrhyncha) causing french wine production fell by 70% between 1863- 1875. In 1890, European grape vines were successfully grafted on to resistant rootstock to save the French wine industry from *Viteus vitifoliae* (Fitch).
- Apple variety "Winter Majetin" found to be resistant to the woolly aphid, *Eriosoma lanigerum* (Hausmann) in England.

The role of host plant resistance in pest management has been discussed earlier by Painter (1951), Maxwell and Jennings (1980), Smith (1989), Sharma and Kalode (1995), Smith et al., (1994) and Sharma et al., (1999). The most attractive feature of HPR is that farmers virtually do not need any skill in application techniques, and there is no cash investment by the resource poor farmers. There is a need to transfer resistance genes into high-yielding cultivars with adaptation to different agro-ecosystems. Resistance to insects should form one of the criteria to release varieties and hybrids for cultivation by the farmers (Ortiz et al., 2002).

### 3.3 Methods of developing Resistant Varieties

In order to develop resistant varieties the most popular method is to follow the breeding techniques by following Plant-Pathogen Interaction models that is genetic engineering, biotechnological techniques, transgenic approaches, etc. As these technologies ensure the development of elite varieties through the selective screening of many varieties under natural farm conditions to extreme research trials resulting the production of highly species-specified and broad spectrum varieties for pests' resistance (Dzhavakhiya et al., 2007).

Apart from breeding approaches, ecological basis are also considered for the resistant varieties development. The development of many resistant varieties also revolve around the evolution of crops to produce improved varieties than those susceptible landraces (Muimba-Kankolongo et al., 2018). The continuous subsistence farming of wild and improved resistant varieties by farmers can also be taken as fast alternative solution regarding pest problems where biotechnological pathway can take many years of toil and expertise. Genes from the wild relatives of crops, and novel genes, such as those from *Bacillus thuringiensis* can be deployed in different crops to make HPR an effective defense against insect pests.

### 3.4 Identification and Some Case Studies of Host-Plant Resistance In The World

Newly developed cultivars can fail to cope up with the heterogenous pest populations present in the farmer's field, so they are rejected. While developing pest resistant crops, all examinations should be done under the subsistence farming environment as the "Development and standardization of resistance screening techniques is the key for an effective resistance-breeding programs" (Sharma et al., 2002). With continuous efforts for past many years in order to develop multi insect resistant cultivars for many crops ranging from tropical to temperate ones either it be cereal, vegetable, fruits, considerable progresses have been made in HPR (Host-Plant Resistant) programs till the date. Accountable numbers of HPR crops have been introduced either some from wild species or from breeding techniques.

Some of the examples have been discussed below:

- Sorghum:
  - Sorghum midge and Sorghum greenbugs are one of the key pests of sorghum.
  - Sorghum shoot fly (*Atherigona soccata* Rond.): M 35-1\*, Swati\*, Phule Yashoda\*, IS 18551
  - Sorghum midge (*Stenodiplosis sorghicola*): ICSV 197, ICSV 735, ICSV 88032
  - Greenbug, *Schizaphis graminum* (Rondani): Tolerance is the primary resistance mechanism of greenbug-resistant sorghums.
- Ber, *Ziziphus mauritiana*
  - The fruit fly causes yield losses of up to 80 per cent under severe infestation. Cultivars: Tikadi, Katha and Illaichi are found to be resistant.
- Musk Melon, *Cucumis melo*
  - Musk melon (*Cucumis melo* L.) is one of the important horticultural crops worldwide and plays an important role in international trade. The genotypes, AHMM/BR-1, RM-50 and AHMM/BR-8 were the most resistant.
- Brinjal
  - Leafhopper: Varieties like H-4, Pusa purple round were found resistant
  - Brinjal Fruit and shoot borer: Varieties like SM-202, SM-17-4 were found resistant
- Groundnut
  - Leaf miner, *Aproaerema modicella* Duv. ICGV 86031, FDRS 10\*, ICG 57,156,541
  - Tobacco Leaf Caterpillar, *Spodoptera litura*: ICGV 86031, FDRS 10\*
- Cotton
  - Pink bollworm, *Pectinophora gossypiella*: G 27, LD 135\*, Lohit, Abadhita
  - Cotton Jassid, *A. biguttula biguttula*: Khandwa 2, Badnawar, Krishna\*, Mahalaxmi\*

- Tomato
  - Fruit borer, *H. armigera*: Punjab Kesari, BT 1, T 32\*, T 27\*

These are only few of the crops on which HPR research has been done. In order to list out, there are numbers of crops like rice, chickpea, chillies, watermelon, okra, cruciferous vegetables, rapeseed and mustard, soyabean, onion, cowpea, greengram, sugarcane, etc. where many resistant varieties have been created through many breeding programs worldwide. These researches are not only based on insects attacking them but also against arthropods, abiotic (environmental) factors too. Emphasis of HPR is major in the tropics in recent days than in North America and Europe. Although some breeding programs existed in tropical countries prior to 1940, it was not until the 1950's that major programs were initiated (by the Rockefeller Foundation) to improve tropical food crops such as maize (*Zea mays* L.), potatoes (*Solanum tuberosum* L.), and rice (*Oryza sativa* L.). Host plant resistance in perennial crops can be hard to keep up with, since the decision to implement this tactic takes place before planting and can't be changed unless you are willing to tear out and replant a crop block. Of course, that's easier to do with something like strawberries or raspberries than with apples or cherries. For that reason, using HPR in your IPM program requires a good deal of research into the susceptibilities of various cultivars to the insects and diseases most prevalent in your area PRIOR to planting a new block.

In present context, where climate change has become one of the major worldwide issues, its impact is really huge including the biophysical environment under agricultural fields too. Climate change can influence the environment on micro- to macro-scales influencing both hosts plants and pathogens, their dominance factors; even likely to diminish effectiveness of some control measures (Jones et al., 2016). Furthermore, sustainable and stable researches are going on to develop resources that can successfully suppress not only pest but also reduce diversification and dissemination of viruses.

## 4. FINDINGS IN NEPAL

The field of agriculture entomology is one of the most essential components for overall agricultural development. Ever changing cultivation practices and new environmental issues have evolved emergence of new pest threat to many agricultural commodities. Since long time, Entomology Division and other research stations under NARC has been involved in entomological research and developmental work. In the developed countries, IPM emerged to be in practice since 1960 whereas in Nepal, the word IPM was heard since 1997 and has been in practice for more than a decade.

The two keys most important in the case of pest management are Prevention and Intervention. The most attractive feature of HPR is that farmers need virtually no skill in applying the technique, and there is no cash investment required from resource poor farmers. Due to these reasons, HPR have become popular choice among Nepal's farmers too. Furthermore, here in Nepal, we have a number of other options in integrating such resistant plants in **Pest Prevention Plantation Practices** (P4 plantation techniques), which also reduces the need of spray.

## 5. PRIORITY LISTS

- Chickpea pod borer, *Helicoverpa armigera* Hubner
- Red ant, *Dorylus orientalis* Westwood
- Cutworm, *Agrotis* sp.
- Whiter Grub
- Army worm, *Mythimna* sp.
- Tobacco caterpillar, *Spodoptera* sp.
- Fruit fly complex
- Insect vector
  - Aphid, *Myzus persicae* (Sulzer);
  - Whitefly, *Bemisia tabaci* (Gennadius);
  - Citrus psylla, *Diphornia citiri* Kuwayama;
  - Green leafhopper, *Nephotettix virescens* (Distant); brown planthopper, *Nilaparvata lugens* (Stal.)
- Mite complex
- Ginger rhizome fly
- Cereal borer complex (Rice, maize and wheat)
- Coffee white stem borer
- Sugarcane pests
  - Plassey borer management

- Early shoot borer management
- Seed bed beetle, *Heteronychus* sp.
- Storage pests

NARC is the apex research and technology generating body of Nepal to address various problems including entomological related problems too. Out of many management ideas in research areas for pest problems, HPR by all Physical, biological, Genetic means are given priority. Although it received little priority in early days, but now it is important to implement breeding program considering quality adaptability and pest resistance rather than considering only one yield of variety. Some of the current works under HPR in Nepal are given below:

- Potato tuber moth, *Phthorimea operculella* is a notorious pest of potato under farmer's field and storage condition. National Potato research Program, Khumaltar, has developed some potato varieties (Q-115.6, Q-1156 and NY-323) that are found to be tolerant against potato tuber moth and late blight disease as well.
- Maize weevil (*Sitophilus zeamais* Mostchulsky) is the most destructive insect pest of maize storage in Nepal. Among 42 different maize genotypes on study, RL-14 and RL-26 were observed the least damaged inbred lines.
- Among 24 maize genotypes on which HPR program performed nationwide on maize till 2012, Rampur composite and Hill Pool yellow were observed to be least damaged by maize weevil. In the case of armyworm, Manakamana-1 caused relatively high larval and pupal mortality.
- Host plant resistant study: Cowpea aphid (GLRP, Nepaljung); Potato aphid (ED, NARC)
- Plant-Incorporated-Protectants (PIPs)
- Pesticidal substances that plants produce from genetic material that has been added to the plant.
- For example, scientists can take the gene for the Bt pesticidal protein and introduce the gene into the plant's own genetic material. Then the plant, instead of the Bt bacterium, manufactures the substance that destroys the pest. The protein and its genetic material, but not the plant itself, are regulated by EPA.
- Varietal screening of 46 genotypes of potato against red ant was done, 22 were rated to be less damaged ones, 18 were rated to be moderately damaged ones, and 6 were rated to be highly damaged ones.
- Tarahara-1 and NR-601-9 varieties of cowpea were found to be moderately tolerant against BPH

## 6. CONCLUSION

Host-Plant Resistance (HPR) represents diverse and expanding field of study in the world of IPM tools. Studies of the biochemical and biophysical mechanisms of insect resistance have added a new dimension to HPR work. Knowledge of specific factors that contribute to insect resistance can be extremely useful to plant breeders and entomologists. The ability to identify and select for one specific plant component or group of components can speed the development of resistant varieties. Significant effort has been made in recognition of sources of resistance to insect pests, but the origins of resistance have not been utilized extensively in the crop breeding programs, as it is the subject matter of great interest with few limitations also in the context of Nepal. Although there are very limited researches going-on in the field of HPR in Nepal due to the lack of prioritization of the problem of entomological issues and responsibility sharing, along with low economic investment in breeding programs. Great compatibility with other IPM methods and consumer demands, HPR components need to be up-scaled to hold large potential for future success in agriculture extension system as well as entomological subject mainly focusing in pest management. However, regardless of the technology used to develop insect-resistant plants, the technology will have to be used as a component of IPM in the same way traditionally developed insect-resistant plants are used today.

## REFERENCES

- Aryal, S. 2012. Review on entomological research and development works on commercial crops.
- Bhandari, G.S., Thakur, P., Achhami, B.B., Mainali, R.P. & Sharma, P.N. 2016. Review and finding, existing problems and future strategies of maize

entomological research of Nepal. Proceedings of Workshop on Review and Strategy Development of Entomological Research Work in Nepal. <https://www.researchgate.net/publication/291329128>

- Bhusal, D. & Thakuri, S. 2019. Spatial Relation of Bumblebees (Hymenoptera-Apidae) with Host-Plant and their Conservation Issues: An Outlook from Urban Ecosystem of Kathmandu Valley, Nepal. *European Journal of Ecology*. 5. 1-7. DOI: 10.2478/eje-2019-0008.
- Bista, S., Ansari, A., Aryal, S., Mainali, R.P., Giri, Y. 2015. Issues, prioritization and responsibility sharing of entomological research in Nepal. ISBN: NARC PUBLICATION NO.: 00241-151/2014/2015
- Cartea, M., Soengas, P., Sotelo, T., Abilleira, R., Velasco, P. 2014. Determining the host-plant resistance mechanisms for Mamestra brassicae (Lepidoptera: Noctuidae) pest in cabbage. *Annals of Applied Biology*. 164. 10.1111/aab.12100.
- Ciesla, W.M. 2001. Protecting Plantations from Pests and Diseases. Forest Resources Development Service Working Paper FP/10. <http://www.fao.org/3/ac130e/ac130e.pdf>
- Dzhavakhiya V. & Shcherbakova, L. 2007. Creation of disease-resistant plants by gene engineering. Pages 439-466, ISSN 09283420, ISBN 9780444521323, <https://doi.org/10.1016/B978-044452132-3/50021-3>.
- Dzhavakhiya, V. & Shcherbakova, L. 2007. Creation of disease-resistant plants by gene engineering, In *Studies in Plant Science, Comprehensive and Molecular Phytopathology*, Pages 439-466, ISSN 09283420, ISBN 9780444521323, <https://doi.org/10.1016/B978-044452132-3/50021-3>.
- Eigenbrode, S. & Trumble, J. 1994. Host plant resistance to arthropods in vegetables: Potential in integrated pest management. *J. Agric. Entomol.*, vol. 11, no. 3, pp. 201-224
- Gu, H., Edwards, O., Hardy, A.T., Fitt, G. 2008. Host plant resistance in grain crops and prospects for invertebrate pest management in Australia: An overview. *Australian Journal of Experimental Agriculture*. 48. 10.1071/EA08027.
- Haldhar, S.M., Sarolia, D.K., Reddy, V.R., Berwal, M.K. 2021. Role of Host Plant Resistance (HPR) in Pests Management of Dryland Horticultural Crops. ISBN 978-81-7622-491-8
- Harris, M., Frederiksen, R. 1984. Concepts and Methods Regarding Host Plant Resistance to Arthropods and Pathogens. Departments of Entomology and Plant Pathology and Microbiology, College of Agriculture and Texas Agricultural Experiment Station, Texas A & M University, College Station, Texas 77843. *Ann. Rev. Phytopathol.*, vol. 22, pp. 247-72
- Jones, R. 2016. Future Scenarios for Plant Virus Pathogens as Climate Change Progresses, *Advances in Virus Research*, Academic Press, vol. 95, pp. 87-147, ISSN 0065-3527, ISBN 9780128048207, <https://doi.org/10.1016/bs.aivir.2016.02.004>.
- Maxwell, F. 1985. Utilization of host plant resistance in pest management. *Insect Science and Its Application*, vol. 6, no. 3, pp. 437-442. Doi: 10.1017/S1742758400004768
- Menken, S.B.J., Visser, J.H. & Harrewijn, P. Proceedings of the 8<sup>th</sup> International Symposium on Insect-Plant Relationships, vol. 49, ISBN 0-7923-2099-9
- Mouden, S. & Leiss, K. 2021. Host plant resistance to thrips (Thysanoptera: Thripidae) – current state of art and future research avenues, *Current Opinion in Insect Science*, vol. 45, pp. 28-34, ISSN 2214-5745, <https://doi.org/10.1016/j.cois.2020.11.011>.
- Muimba-Kankolongo, A. 2018. Crops Diseases and Pests. Food Crop Production by Smallholder Farmers in Southern Africa, Academic Press, pp. 23-39, ISBN 9780128143834, <https://doi.org/10.1016/B978-0-12-814383-4.00004-9>.
- Pelletier, Y., Horgan, F. & Pompon, J. 2013. Potato Resistance against Insect Herbivores: Resources and Opportunities. *Insect Pests of Potato*, Academic Press, pp. 439-462, ISBN 9780123868954, <https://doi.org/10.1016/B978-0-12-386895-4.00015-6>.
- Varshney, R.R., Romila, R., Akoijam, T.J.G. Host Plant Resistance as a Component to Organic Pest Management in Vegetable Crops

- Sharma, H.C. & Crouch, J.H. 2021. Molecular Marker-Assisted Selection: A Novel Approach for Host Plant Resistance to Insects in Grain Legumes. International Crops Research for Institute the Semi-Arid Tropics Patancheru, 502 324 AP
- Sharma H.C. & Ortiz R. 2002. Host plant resistance to insects: An eco-friendly approach for pest management and environment conservation. Journal of Environmental Biology, vol. 23, no. 2, pp. 111-35.
- Sharma, H.C., Jaba, J., Vashisth, S. 2018. Breeding Insect Resistant Crops for Sustainable Agriculture. Doi: 10.1007/978-981-10-6056-4\_5
- Sharma, H.C., Ortiz, R. 2002. Host plant resistance to insects: an eco-friendly approach for pest management and environment conservation. J Environ Biol., vol. 23, no. 2, pp. 111-35. PMID: 12602847.
- Sharma, H.C. 2016. Host plant resistance to insect pests in Pigeonpea: Potential and limitations. Legume Perspectives. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India, vol. 11. <https://hdl.handle.net/20.500.11766/6760>
- Stoner, K.A. 1996. Plant Resistance to Insects: A Resource Available for Sustainable Agriculture. Biological Agriculture & Horticulture, vol. 13, no. 1, pp. 7-38.
- Sulistyo, A. & Inayati, A. 2016. Mechanisms of antixenosis, Antibiosis, and tolerance of fourteen soybean genotypes in response to whiteflies (*Bemisia tabaci*). Biodiversitas, vol. 17, pp. 447-453. 10.13057/biodiv/d170207.
- Teetes, G.L. Plant Resistance to Insects: A Fundamental Component of IPM. Department of Entomology, Texas A&M University. <https://ipmworld.umn.edu/teetes>
- The use of pesticides in developing countries and their impact on health and the right to food. Policy Department for External Relations, Directorate General for External Policies of the Union, PE 653.622 - January 2021
- Zoeren, J. & Guédo, C. 2017. IPM Tools: Host Plant Resistance. UW Extension. <https://fruit.wisc.edu/2017/06/23/ipm-tools-host-plant-resistance/>.

