

Plant Health for Safer and Sustainable Future
“सुरक्षित र दिगो अधिष्ठाको लागि स्वस्थ विचार”

INTERNATIONAL PLANT PROTECTION SYMPOSIUM - 2024

Jointly Organized by



Plant Protection Society Nepal
Harharbhawan, Lalitpur



Plant Quarantine and Pesticide Management Centre
Harharbhawan, Lalitpur

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International Plant Protection Symposium 2024

26-27 April, 2024
Kathmandu, Nepal

ABSTRACT BOOK



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Message from the President

The Plant Protection Society Nepal (PPSN), in collaboration with the Plant Quarantine and Pesticide Management Centre (PQPMC) and numerous esteemed national and international organizations, has curated an enriching program that encapsulates the critical challenges and innovative solutions in the realm of plant health. Our shared commitment to promoting safer and sustainable agricultural practices is reflected in the comprehensive compilation of around 100 abstracts, thoughtfully organized into four pivotal themes. These themes have been carefully chosen to address the multifaceted aspects of plant protection, ranging from the latest advancements in pest management to the implementation of cutting-edge technologies in plant quarantine. Each abstract represents a unique contribution to our understanding of plant health and its impact on global food security, environmental sustainability, and economic stability.

As you peruse this abstract book, I encourage you to engage deeply with the content, which serves as a testament to the collective expertise and dedication of our plant protection community. The insights and knowledge shared here are not only pivotal for our discussions during the symposium but will also serve as valuable resources for future research and collaboration. I am particularly proud of the collaborative spirit that characterizes this symposium. The involvement of diverse stakeholders, including academia, researchers, policymakers, industry experts, and practitioners, underscores the importance of integrated approaches to tackling the complex issues surrounding plant health. Together, we are forging pathways towards a safer and more sustainable future, guided by science and innovation.

I extend my heartfelt gratitude to Plant Quarantine and Pesticide Management Centre, chairpersons and members of all committees of IPPS 2024, contributors, and participants who have made this event possible. Your enthusiasm and commitment to advancing plant protection are what drive the success of this symposium. I look forward to the productive discussion, meaningful exchange, and innovative idea that will emerge from our gathering. Thank you for your dedication to plant health and for your participation in the International Plant Protection Symposium 2024. Let us continue to collaborate and inspire each other as we work towards a healthier, safer, and more sustainable world.

Warm regards,

Dr. Dilli Ram Sharma

President, Plant Protection Society Nepal

Editorial Message

The Plant Protection Society (PPS) Nepal and the Plant Quarantine and Pesticide Management Centre (PQPMC) in collaboration with many national and international organizations are delighted to conduct the *International Plant Protection Symposium 2024* on the theme "**Plant Health for Safer and Sustainable Future**" in Kathmandu from April 26 to 27, 2024. The gatherings of national and international experts in this symposium serves as a platform for sharing their valuable research findings and innovative ideas in the field of plant protection.

In developing countries farmers are facing severe pest problems, and confronting with their heavy crop loss in the field and even after harvest in storage. Furthermore, status of pest change scenario coupled with new invasive pests are emerging as new threats in agriculture, which can be seen as the result of misuse of pesticide, development of hybrid varieties of crops, climate change, and farmers management practices mismatching their balance in the agro-ecosystem. This seeks new interventions to solve problems in hand and face challenges in coming days. In this regards, new innovations such as protected cultivation, precision farming, nano-materials use and artificial intelligence including integrated pest management options can contribute to safeguard our agriculture production.

In this line, continuous efforts and dedication of scientists/experts in advancing knowledge and finding solutions to various problems faced by farmers in national and international geographical diversities can be truly commendable. Here, the Technical Committee and Editorial Team declares that the views and information shared in the poster/oral presentation are truly of the respective author(s) and the Committee remains neural on author(s) views to bring in this shape with just general editing of the received abstracts in this symposium.

Finally, the sponsors, organizers, experts, scientists and participants are acknowledged for their heartily support to make this symposium a grand success. We hope that the sharing of research and findings will be useful to the professionals and pave a step in further collaboration and innovation in the field of plant protection, ultimately contributing to a more sustainable and resilient agricultural future.

Thank you very much.

Editorial-in-Chief

Prof. Resham Bahadur Thapa, Ph.D.

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Key Notes / Lead Papers

**Pest Management for Sustainable and Safe Food System:
Challenges and Opportunities**

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Nepal reaches new milestone to transform its agri-food systems through a systematic and sustainable roadmap for food security (UN-OCHA 2023). For this, the Government of Nepal in May 2023 launched a series of programmatic frameworks in the food and agriculture sectors that will help the country transform its agri-food systems, making them more resilient and sustainable for the benefit of all people in Nepal. All the key Development Partners have accordingly aligned their respective country assistance strategies with those of the GoN. The upcoming GoN's 16th plan (2024/25 -2029/30) is being prepared to embrace all these initiatives to achieve the goal of transforming Nepal as the developing nation by 2030. These changes call for strategic shift in approaches and practices for pest management towards a sustainable and safe food system.

**Prospects and Emerging Issues in Biological
Control of Insect Pests - Lessons Learnt and Success Stories of India****S. N. Sushil**ICAR-National Bureau of Agricultural Insect Resources,
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India, with its vast agricultural landscape and diverse ecological regions, faces significant challenges in pest management. Insect pests threaten crop yields to the extent of 20-30 per cent loss, food security, and farmer livelihoods, while also posing risks to public health and the environment. However, amidst these challenges lie opportunities for innovation, sustainable practices, and community engagement. India's diverse agroclimatic zones support a wide variety of crops, each with its own set of pest species. From the temperate climates of the Himalayas and its foothills to the tropical regions of the south, different pests thrive in different environments, necessitating region-specific pest management strategies. India experiences pronounced seasonal variations in temperature, rainfall, and humidity, leading to fluctuations in pest populations and pest pressure. The diverse agroclimatic conditions in India provide suitable habitats for invasive pest species from other parts of the globe. Incursions of pests such as Fall armyworm, Rugose Spiralling Whitefly, South American Tomato Pinworm, Papaya Mealybug, Coconut Eriophyid Mite, Eucalyptus Gall Wasp, Coffee Berry Borer, Serpentine Leaf Miner, Cassava Mealy Bug etc., have caused severe economic losses to various crops in India. Recently, few more pest alerts have been issued on new insect pest incursions. India being a farming country cannot afford to have frequent invasion of exotic pests. Classical biological control considered to be an important approach in the management of these invasive species. International collaboration for the management of invasive species is of utmost importance as exchange of resources can help in timely control of the pest. In the recent years, several invasive insects were managed through classical biological control by introduction of natural enemies from home range. ICAR-NBAIR located at Bengaluru has played an import role in import of several biocontrol agents in timely and successful management of obnoxious insect pests. The use of biological control agents is one approach to reduce the undesirable ecological and health problems associated with overuse of chemical insecticides. Biological control is a naturally occurring phenomenon acting on the crop pests

ABSTRACT

and maintain them at certain densities, we have to supplement the activity of the naturally occurring biocontrol agents *viz.*, parasitoids, predators and entomopathogens with introduction of appropriate agents and conserve them subsequently. The present paper critically reviewed the status of invasive and native insect pest problems, various biological control options and other compatible ecofriendly technologies for their successful management, related issues, lessons learnt and way forwards to safeguard agriculture in Indian sub-continent.

Pesticide Management in Pakistan: A Comprehensive Analysis**Muhammad Tariq Khan**

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Pesticide management is vital for agricultural production in Pakistan, ensuring crop yields and food security. However, challenges such as indiscriminate use and inadequate regulation pose threats to human health, environmental sustainability, and agricultural productivity. This research paper conducts a thorough analysis of pesticide management in Pakistan, addressing key issues, challenges, lessons learned, and recommendations for future action. The paper begins with an overview of pesticides' importance in agriculture, emphasizing the need to balance benefits with associated risks. It traces the historical evolution of pesticide use in Pakistan, from initial adoption to concerns over adverse health and environmental effects. The current status of pesticide management is assessed, covering manufacture, importation, distribution, regulatory framework, and enforcement mechanisms. Challenges in pesticide management, including misuse, illegal trade, inadequate enforcement, awareness gaps, resistance, pollution, and health hazards, are identified and analyzed. Lessons learned underscore the significance of stakeholder engagement, evidence-based policymaking, education, and sustainable pest management practices. Highlighting the recent approval of Rules for Registration of Bio-Pesticides in Pakistan, the paper signifies a paradigm shift towards eco-friendly plant protection tactics. This development is set to revolutionize pesticide management by promoting safer bio-based alternatives. Moreover, suggestions for regional collaboration in South Asia are proposed, encompassing information sharing, capacity building, joint research, policy harmonization, and cross-border monitoring programs. These efforts aim to address pesticide-related challenges effectively and promote sustainable agriculture across the region. In conclusion, this paper offers valuable insights into pesticide management complexities in Pakistan, advocating for safe, sustainable practices. By fostering regional collaboration in South Asia, it aims for collective progress towards a future where pesticide use ensures the well-being of farmers, consumers, and the environment.

ABSTRACT

*IPPS_2024_Key Note***Pesticide Residue in Agrifood Commodities in Pakistan****Ashiq Mohammad**

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The analysis of pesticide residues in agricultural products is of paramount importance not only for minimizing human health risk and environmental concerns but also for international trade and regulatory control. Except for a few sporadic studies, no planned study reflects the true extent of pesticide contamination in Pakistan's agricultural products. In order to cope with this challenge, the Pakistan Agricultural Research Council (PARC), under the Ministry of National Food Security and Research, Government of Pakistan, has established six Pesticide Residue Testing Laboratories (PRTLs), five at the provincial level and one at the federal level, as part of the "National Pesticide Residues Monitoring System in Pakistan" project. PRTL has validated analytical methods on state-of-the-art analytical research equipment with reporting limits below EU-Maximum Residue Levels (MRLs) for the testing of pesticide residues in different food commodities (rice, wheat, citrus fruits, peach, date palm, grapes, cherry guava, tomato, brinjal, cauliflower, okra, chili, lettuce, honey, water, tea, cottonseed oil, and soyabean meal). Targeted and suspect surveillance of pesticide residues has been conducted in different regions of Pakistan, including Swat, Peshawar, Sargodha, Rawalpindi, Lahore, Tandojam, Umerkot, Mirpurkhas Hyderabad, Karachi, Barkhan, Harnai, Jaffarabad, Khuzdar, Panjgur, and Quetta, to assess pesticide use and educate farmers. The results demonstrated that 20–77% of the analyzed samples were found to be contaminated with multiple pesticides, while 8–66% of samples were found to be noncompliant with Codex Alimentarius and EU-MRL. Consumer dietary health risks associated with pesticide-contaminated fruits and vegetables have been assessed. Problematic pesticides in chili from Pakistan's agro-climatic conditions have been identified, and supervised field trials have been conducted to study their dissipation in chilies.

Study on Determining Banning of Alternative Use of Pesticides and Effects on Productions: A Case Study**Dilli Ram Sharma^{1,*}, Leah Utyasheva² and Michael Eddleston³**¹National Consultant, Centre for Pesticide Suicide Prevention (CPSP)²Policy Director, Centre for Pesticide Suicide Prevention (CPSP)

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The regulatory body aims to implement the Pesticides Management Act, 2019 and Pesticide Rules 1994, to prepare necessary procedures/ guidelines/ standards and protocols for carrying out the tasks specified in the Act and Regulation regarding the import, distribution, use, and management of pesticides and implement them as approved. Pesticides were responsible for an estimated 200,000 acute poisoning deaths each year- UN News - 7 March 2017. In 2012 Nepal had 7th highest suicide rate in the world, with an age-standardized suicide rate of 24.9 per 100,000 population- World Health Organization (WHO, 2013)- Similar to other agricultural communities in the world, pesticide poisoning is responsible for a large proportion of all suicides in Nepal. A study on determining the banning of alternative use of pesticides and the implementation status of banning was carried out in four districts of Nepal and revealed that pesticide regulation is playing a key role in minimizing pesticide suicide cases in Nepal. A Study also showed that banning pesticides in Nepal has no effects on the production of cereal and vegetable crops. Farmers are not able to easily get alternate pesticides in their localities and if available in any big city, the cost of the alternative pesticides is higher than the banned ones. Banning of pesticides implementation is very weak and urgent implement the banned pesticides by coordinating Province and Local Governments and the study of pesticide poisoning cases should be continuously done.

ABSTRACT

IPPS_2024_Lead Presentation_Th1_01

Fruit Piercing Moths and their Management Options in Nepal**Rangaswamy Muniappan**

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Fruit piercing moths are distributed all over the world, however, the species of the common genus *Eudocima* (Lepidoptera: Erebidae) are distributed mostly in the subtropical and tropical regions of the world. So far, 29 species of fruit piercing moths have been recorded from Nepal. They are distributed from Terai up to 3750 m in high hills. Menispermaceae plants are the major host plants of *Eudocima* species. However, *Eudocima phalonia* (Linnaeus) uses *Leea indica* (Vitaceae) in Malaysia and Thailand and *Erythrina* spp. (Fabaceae) in the Pacific Islands as alternate hosts. Bänziger, Swiss scientist, who visited Nepal in 1984 and 1985, collected fruit piercing moths and recorded them. These moths are known to attack most fruits like banana, carambola, citrus, guava, lychee, mango, peaches, plums, pomegranate, soursop, and others. In 2023, there was a report of severe sweet orange fruit drop due to the attack of fruit piercing moths in the Sindhuli district. There is an urgent need to address this fruit piercing moth problem in Nepal. To start with 1) a survey of different species of fruit piercing moths causing sweet orange fruit drop in Sindhuli district, 2) documentation of spatial and temporal distribution of these moths in Nepal, 3) determination of their host plants, 4) recording of their natural enemies, and, 5) investigation of different methods of their management. This presentation highlights the difference between fruit piercing and fruit sucking moths, distribution of different fruit piercing moths in Asia and the Pacific, their biology, host plants, ecology, and management techniques.

ABSTRACT

IPPS_2024_Lead Presentation_Th2_01

Pest Risk Analysis of Mango Seed Borer, *Deanolis albizonalis* (Hampson, 1903) (Lepidoptera: Pyralidae) in Mango Commodity in Nepal

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Mango seed borer, *Deanolis albizonalis* (Hampson, 1903) (Lepidoptera: Pyralidae) in mango commodity was reported in Sarlahi district in mango orchards in 2011. Long time awaited Pest Risk Analysis of *D. albizonalis* in the important mango commodity area of Nepal was conducted. A pea size to mature mango fruit is the suitable host food to its caterpillar resulting fruit losses averaging 55 percent (ranging from 0 to 100 percent). Its pest risk assessment revealed the mango seed borer, *D. albizonalis* being a quarantine insect pest in the endangered mango area of Nepal. Immediately, a wider scale mango seed borer detection survey in the endangered mango orchards is required and the infested area should be delimited for regulatory action. Along with the pest risk assessment, pest risk management has been also developed to mitigate the pest risk of this mango insect pest of a quarantine status.

ABSTRACT

IPPS_2024_Lead Presentation_Th3_01

Improving Livelihood of Rural People through Beneficial Insects and Mushroom Farming in Nepal

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Honeybees, silkworms, lac insects rearing and mushroom farming are practiced in different agro-ecological domains of Nepal and handling of these beneficial products have greatly assisted to increase the income of the rural people with opportunity for employment. However, their development endeavors of the country are hampered by a number of constraints, such as shortage of flora, quality silkworm eggs, lac plantation, mushroom spawn, and advanced technological promotion scheme including skilled human resources. Therefore, the research needs to focus to solve the problems especially on quality silkworm egg production, mulberry varietal development, agronomic and management studies, bee floral diversity, bee pasture and disease management, lac culture and mushroom farming. This paper reviews achievements, and outlines challenges and future directions of their research and development program.

ABSTRACT

*IPPS_2024_Lead Presentation_Th4_01***Strategy and Vision for Integrating Digital Tools for Farmer Advisory****Malvika Chaudhary**

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Public and private-sector extension services play a key role in providing essential services to small holder farmer including agricultural information. Though it is known that the poor access to extension services by farmers is mainly due to understaffing, lack of institutional capacity, limited operational funds, recent advancement in technology has pinned high hopes on digital farm advisory to overcome these recognised limitations. Digital products (knowledge, digital learning, or decision support tools) provide the opportunity to collect, store and share data along the agricultural value chain that can be used to facilitate enhancement in knowledge, better decision making, providing services and products for smallholder farmers, enabling them to increase their efficiency, productivity, and profitability. The use of the digital products requires a basic level of in-country ICT, and an approach to mitigate the vast inequalities that exist in terms of internet accessibility, availability, and affordability, based on gender, geography, and income. Women, especially rural women, remain excluded from the 'digital revolution'. In this paper actions to accelerate the approaches of digital tool and integrate into Extension Advisory System are discussed. Recently there has been an increasing effort from both private and public sector to develop agricultural digital tools. This is proving to be overwhelming for the stakeholders, leading to inconsistency of their use. Alignment to the nine principles of digital development advocates tools which are context specific, with open access localised content, that is co-created with the users and designed to scale. Considering such tools would benefit the farmers and lead to the ultimate sustainability towards their usage for bridging the information gap.

Thematic Session I

Plant Health Management

(Insect pest, diseases and weed management)

Management of Mealybug (*Planococcus citri*) of Japanese Pear (*Pyrus pyrifolia*) in Field and Laboratory Condition**Punam Khadka^{1,®}, Bhola Gautam² and Lekh Raj Dhakal³**¹ Faculty of Agriculture, Agriculture and Forestry University, Chitwan, Nepal² Department of Entomology, Agriculture and Forestry University, Chitwan, Nepal³ Warm Temperate Horticulture Centre, Kritipur, Kathmandu, Nepal

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Pear is an important deciduous fruit crop in Nepal. Mealybug is one of the most serious pests of pear because it reduces the plant vigor by sucking the sap from the tender shoots and fruits. A field experiment was conducted in Warm Temperate Horticulture Centre (WTHC), Kirtipur, Kathmandu from March to July, 2023 for the management of mealybug in Japanese pear. This experiment was designed with eight treatments replicated four times in RCBD. Eight different banding practices were tested and mealybug infestations were recorded. Data was recorded every fifteen days and banding was changed after fifteen days. Another, experiment was conducted to evaluate the effect of different insecticides against mealybugs in Japanese Pear in the laboratory. The experiment had nine botanicals and chemical insecticides including control and each treatment was replicated four times in Complete Randomized Design (CRD). Leaf dip bioassay was performed to assess the toxicity of different insecticides using the 1st instar nymph of mealybugs. Data regarding the mortality of insects were recorded after 1,2,3,4 and 24 hours of treatment. Under the laboratory conditions, the study findings revealed that (Chlorpyrifos 50% + Cypermethrin 5% EC) and Emamectin benzoate were most effective and consistent in controlling mealybugs nymphs. The result showed that (Chlorpyrifos 50% + Cypermethrin 5% EC) proved to be most toxic and superior to other treatments due to maximum percentage mortality of 87.5% one day post treatment followed by Emamectin benzoate(73.75%). Dimethoate 30% EC (52.5%) and Imidacloprid (36.25%) showed intermediate toxicity. The least effective insecticides was found to be vermicompost liquid with mortality of 17.5% one day post treatment. Similarly, in the field experiment black plastic band was the best compared to all other banding practices as it showed highest percentage control at 15, 30, 45 and 60 days after banding. The no. of mealybug found in above the band in black plastic was least. Grease and white plastic were also effective and consistent in controlling the no. of mealybugs. White plastic

ABSTRACT

showed highest percentage control of 83.33% after 4th banding whereas grease showed highest percentage control after 1st banding. Double sticky tape, muslin cloth and jute bag were not much effective in controlling mealybugs in Japanese Pear. Cow dung banding was least preferred and found most ineffective in controlling mealybugs as it had more mealybugs infestation.

Application of Balanced Fertilizers Reduces the Incidence of Fall Armyworm in Maize Crop

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Fall armyworm (FAW) has become the global threat for maize industry. FAW-damaging parameters; percent infestation, percent damage for maize plant leaves, leaf damage score and maize grain yield (t/ha) were evaluated under a long-term fertility assessment plots at Lumle, Nepal in 2020 and 2021. The significantly lowest infestation (41.02 ± 2.97 and $12.45 \pm 2.40\%$, respectively in 2020 and 2021), percent damage ($20.04 \pm 4.35\%$ in 2020 and 18.07 ± 3.22 in 2021) and the score (1.62 ± 0.84 in 2020 and 1.10 ± 0.06 in 2021) were recorded in plots receiving balanced fertilizers (NPK @ 120:60:40 Kg and 20 t FYM /ha). Ultimately, the maize grain yield (3.04 ± 0.30 in 2020 and 3.72 ± 0.19 in 2021) was also the significantly highest in balanced fertilizer applied plots followed by the FYM only applied plot (2.18 ± 0.22 t/ha in 2020 and 2.64 ± 0.84 t/ha in 2021). This study suggests to consider the incorporation of organic sources of fertilizer to reduce the incidence of FAW in maize crop.

Life Cycle of *Liriomyza huidobrensis* (Blanchard, 1926) (Diptera: Agromyzidae) on Potato in Nepal**Binu Bhat[@] and Ajaya Shree Ratna Bajracharya**

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Liriomyza. huidobrensis (Blanchard, 1926), a leaf miner is the key pest of potato cultivation in mid hills of Nepal causing up to 90% foliar damage. The taxonomic identification of the insect and determination of its life cycle is basic requirement for development of integrated management technology. Considering the fact, life cycle of *L. huidobrensis* was studied at $27\pm 2^{\circ}\text{C}$ temperature and $70\pm 5\%$ relative humidity on potato plant (var. Khumal Seto) in the laboratory of National Entomology Research Center, Lalitpur, Nepal during March to April, 2023. The insect was confirmed as *L. huidobrensis* on the basis of morphological studies of bristles, male genitalia and wing venation. The average duration of pre-oviposition, egg, larval and pupal periods were recorded 2.35, 3.18, 4.47 and 7.88 days, respectively. Adult male and female longevity was recorded 3 days without feeding and 6 and 10 days, respectively with honey water feeding. The male and female adult emergence ratio from pupae was found 1:1.41. Eggs are oval in shape and white in color measuring 0.30 mm long and 0.10 wide and generally laid into the leaf tissue just beneath the epidermis. Pupae were coarctate measuring about 2.10 mm in length and 0.90 mm in breadth. Wing span of adult female and male fly measured 1.92 mm and 1.70 mm in length, while width measured 0.78 mm and 0.67 mm, respectively.

Laboratory Study on the Settlement Response of Fall Armyworm, *Spodoptera frugiperda* (J.E. Smith) on a Range of Potential Host Crops**Sheela Devi Sharma^{1,2,*}, Resham Bahadur Thapa², Suroj Pokhrel², Saraswati Neupane³ and Chiran Adhikari⁴**¹ National Entomology Research Centre, Nepal Agricultural Research Council, Khumaltar, Lalitpur² Department of Entomology, Agriculture and Forestry University, Rampur, Chitwan³ National Maize Research Program, Nepal Agricultural Research Council, Rampur, Chitwan⁴ College of Natural Resource Management, Kapilakot, Sindhuli
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Fall armyworm (FAW), *Spodoptera frugiperda* (Noctuidae: Lepidoptera) is an invasive pest in almost all maize growing countries. More than 353 plant species are recorded as the host crops of fall armyworm with maize being the most preferred crops followed by sweetcorn, sorghum, rice, wheat, and many other cultivated crops. The information on the preferences level of *S. frugiperda* on various crops can provide the information on the pest manipulation by clearing or maintaining such host crops in- and off- the main field. Hence, a host preference study was carried out using first to fourth stages *S. frugiperda* larvae to observe the host selection behavior on a wide host range such as maize (cv. Rampur Composite), Cowpea (cv. Surya), Wheat (cv. Vijay), Soybean (cv. Puja), Napier (cv. Super Napier), Rice (cv. Sabitri) and Buckwheat (cv. Mithe phapar) in a laboratory experiments. The laboratory design used was Completely Randomized Design (CRD) with six replications. The study showed that initially the selection of host crops by *S. frugiperda* larva was random. But at the end of the 24 h, the larvae settled on the host plant of their preference. The highest preference was towards wheat followed by maize whereas lowest preference was observed towards cowpea, soybean, and buckwheat, respectively. Here, highly preferred crops can be used as trap crops and less preferred crops can be used as intercrops in agro-ecological pest management strategy.

**Distribution and Management of Root-Knot Nematodes
(*Meloidogyne* Spp.) in Kiwifruit Orchards of Dolakha, Nepal**

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Root-knot nematodes pose a severe threat to kiwifruit cultivation. A comprehensive survey of kiwifruit farms in Dolakha district was conducted to assess the distribution of root-knot nematodes and their association with soil properties. Field trials were carried out in a naturally-infested orchard and nursery to evaluate the efficacy of various chemicals (Cartap hydrochloride and Emamectin benzoate) and biological nematicides (neem cake, mustard cake and *Verticillium chlamydosporium*). Results showed an incidence and prevalence of root-knot nematodes 55.71% and 78.57%, respectively. Soil moisture, sand content, and available potassium in the soil showed a positive association with root-knot nematodes, while organic matter content showed a negative correlation. Cartap hydrochloride and neem cake demonstrated the highest efficacy in reducing root galls. This study concludes that Dolakha's kiwifruit farms are infested with root-knot nematodes and are influenced by soil properties. Neem cake can be a promising environmentally friendly alternative to chemical nematicides for nematode management in kiwifruit cultivation.

Farmers' Education – An Effective Tool for Plant Protection**Pankaj Raj Dhital¹ and Pratishtha Adhikari^{1,*}**¹Agriculture and Forestry University, Rampur Chitwan
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Educating the farmers is the foremost strategy for ensuring the application of effective plant protection measures in the field. In the face of evolving agricultural challenges, empowering farmers with knowledge emerges as an essential for sustainable and resilient farming practices. Educating farmers has a multifaceted impact on various aspects of plant protection, emphasizing its pivotal role in early detection, integrated pest management, and pesticide use, playing a central role in enabling early identification of potential threats to crops. Equipped with knowledge about the signs and symptoms of pests and diseases, educated farmers can promptly respond to mitigate risks and prevent widespread crop damage. Such knowledge empowers farmers to make informed decisions that contribute to the overall health and sustainability of agricultural ecosystems. In conclusion, this abstract advocates for the recognition and prioritization of farmer education, its contents, and teaching methods as the cornerstone of comprehensive plant protection. It emphasizes the transformative impact of informed agricultural practices on the resilience of farming systems, environmental conservation, and the well-being of farming communities.

**Field Screening of Potato Genotypes for
Red Ant (*Dorylus orientalis* Westwood) Infestation**

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Host-plant resistance could be an alternative approach to combat an ever-increasing threat of red ant, *Dorylus orientalis* Westwood infestation in potato cultivation of mid- and high-hills of Nepal. A total of 36 released and promising potato genotypes were evaluated for the ant infestation in rod-row method under natural field condition at Hattiban, Lalitpur during 2021 to 2022. The infestation was based on Tuber Damage Indices (TDI) (0.00 to 1.00 scale); negligible (≤ 0.18), low (0.19-0.35), medium (0.36-0.52), high (0.53-0.69) and severe (≥ 0.70). High TDIs were recorded in four and medium TDIs in 23 genotypes. Low TDIs were recorded in nine genotypes (PRP 447173.44, PRP 017173.169, PRP 017173.64, PRP 017173.5, PRP 017173.38, PRP 397173.1, PRP 437274.112, Desiree, Kufri Jyoti) which could be recommended for cultivation in the ant-prone areas of the country.

**Unveiling the Impact of Green-Synthesized Silver Nanoparticles on
Tomato Growth and Early Blight Disease Resistance:
Exploring Plant Physiology Insights**

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Tomatoes (*Solanum lycopersicum*) are vital in global agriculture but face challenges from early blight disease caused by *Alternaria solani*, leading to significant yield losses. Silver nanoparticles (AgNPs) show promise as antifungal agents against plant pathogens. This study examined the effects of biogenic AgNPs on tomato plant defenses, using biochemical markers to assess plant responses. Histochemical analysis revealed activation of defense mechanisms, with increased accumulation of secondary metabolites in plants treated with 20 ppm AgNPs. Combined AgNPs and plant treatment enhanced plant resilience against biotic stress, reducing stress parameters and enzyme activity. Variation in antioxidant enzyme levels indicated AgNPs' role in maintaining ROS balance within plant cells. These findings highlight nanotechnology's potential in sustainable agriculture, enhancing food production. Integrating biochemical markers offers insight into plant defense mechanisms, optimizing agricultural practices. Overall, silver nanoparticles effectively enhance tomato plant resistance against early blight disease, promoting sustainability in agriculture.

New Pathogens for Dragon Fruit: Way Forward for their Management in Nepal

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Dragon fruit (*Hylocereus* spp.) is native to South and Central America and is a new crop to Nepal. The area of this vine cactus fruit is increasing rapidly in Nepal due to its higher water use efficiency, and potential for dry and marginal land. Dragon fruit is considered a nutrient-dense fruit and has high medical properties, particularly due to the presence of high betalains and antioxidants. The crop is established as a major source of rural income in Nepal, therefore, accelerated expansion in area and production has been observed in the last decade. However, the emerging dragon fruit industry in Nepal is facing significant challenges of fruit diseases. We conducted a random survey, discussed with growers, isolated and characterized pathogens, and conducted a pathogenicity test and confirmed several new pathogens for the first time in Nepal. We used both morphological and molecular tools to detect the pathogen, sequence the gene to maintain species identity and conducted detached leaf/fruit assays to confirm the pathogenicity of several dragon fruit pathogens. Among them, major pathogens were *Neoscytalidium dimidiatum* (stem canker), *Colletotrichum* spp. (anthracnose), *Botryosphaeria dothidea* (stem spot) and *Epicoccum sorghinum* (leaf spot). We conducted the fungicide sensitivity test for *N. dimidiatum* and *E. sorghinum* in *in-plate* and *in-planta* and found propiconazole an effective fungicide for both pathogens. The stem cracking during branching, wounding caused by insect damage, and pruning, and flowering during the rainy season lead the pathogen penetration and colonization. Therefore, management of cull piles, deep burying of the pruned infected parts, fungicide spray after pruning, are always recommended in managing dragon fruit diseases. The current study provides some useful information and insight into pathogens associated with dragon fruit and their management in Nepal. However effective, pragmatic and sustainable management strategies for dragon fruit diseases in Nepal are yet to be developed.

Evaluation of Low-Cost Carbon Sources in Anaerobic Soil Disinfestation in Suppression of *Rhizoctonia* Root Rot in Bean

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Anaerobic soil disinfestation (ASD) is a pre-plant soil rehabilitation method to control soil borne diseases. High costs associated with the use of the carbon source is a major concern for the wider applicability of ASD in commercial fields. Therefore the current study was done to pursue low-cost carbon source alternatives for ASD to control *Rhizoctonia* root rot (RRR) in green beans in Nepal. Experiments were conducted in randomized complete block design with eight replications of ten carbon source treatments. Treatments include two non-amended (covered and uncovered) controls, two oil cakes (butter tree and neem), four plant biomasses (water hyacinth, nettle leaves, banana pseudo-stem, and *Eupatorium* sp.), and two standard checks (rice bran and molasses). *Rhizoctonia solani* inoculant and carbon sources were mixed with soil, placed in pots, followed by irrigation up to saturation and the pots were sealed with plastic bags and electric tape for three weeks. After that plastic bags were removed leaving the soils open for 7 days in which bean seeds were seeded. Two weeks after planting, plants were uprooted and washed into tap water and RRR severities were recorded. *Rhizoctonia* root rot severity was significantly lower in the seedlings grown in all ASD-treated soils compared to the seedling grown in both non-amended controls, except in bean plants grown in water hyacinth biomass amended ASD-treated soils. ASD treatments reduced RRR severity by 19.2 to 38.6% compared to non-covered control. The results indicate plant biomasses could be an alternative carbon source for the successful management of soil borne diseases in Nepal.

Agroecological Interventions for the Sustainable Management of Fall Armyworm, *Spodoptera frugiperda* (J.E Smith): A Systematic Review**Sundar Tiwari**

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The fall armyworm (FAW), *Spodoptera frugiperda* (Lepidoptera: Noctuidae), is a worldwide invasive insect pest of maize and damages sweet corn, rice, sorghum, and many cultivated crops. This pest originates from tropical and subtropical regions of the Americas and spread across sub-Saharan Africa, Asia, parts of the Near East and Northern Africa, Australia, and Europe with a total of more than 80 countries. As of now, more than 353 host plants are reported belonging to the 76 crop families, with the major crop families being Poaceae, Asteraceae, and Fabaceae. Pesticidal management practices always get a priority for the immediate intervention of this pest. These practices are against the environment, biodiversity, and human health. Hence efforts are interestingly growing to develop agroecological strategies for fall armyworm management. This review is focused on diagnosing the various agroecological practices that apply to the sustainable management of fall armyworms. These practices are soil fertility management, mulching practices, intercropping with appropriately selected intercrops, diversification of field margins and farm environment, improving conservation biological control activities, promoting cultural practices, use of local pesticidal plants, push-push management systems, and many more. Providing balanced nutrients with organic manure increases the level of soil organic carbon, and soil biological activities that improve the health of plants and increase resistance to pest damage. Mulching with spreading the non-crop residues on the soil ameliorates soil microclimate improves plant growth and provides shelter to the natural enemies. Intercropping the leguminous crops in rows or between the main crop reduces the number of FAW eggs on the crop, inhibits the movement of pest larvae, and increases biocontrol activities. Diversification of the farm provides shelter, nectar, alternative food, and pollen (SNAP) to the pest's natural enemies. Conservation biological control activities such as providing nesting sites, multiple cropping, and insectary plants provide shelter and food to the pest-beneficial insects in adverse situations. Cultural practices include adjustment of planting time, spraying with sugar solution, coconut milk, and fish soup that increase the

ABSTRACT

abundance of ants, spiders, and parasitoids. Similarly, using local pesticidal plants such as *Azadirachta indica*, *Jatropha gossypifolia*, *Calotropis gigantean*, etc. could be a popular sustainable alternative to FAW management to synthetic pesticides. Finally, the push-pull system is a very popular strategy to keep the fall armyworm away from the main crop. Hence, adopting such agroecological practices for pest management improves a balanced environment, increases yields, regulates natural pests, reduces inputs, diversifies the agroecosystem, improves biologically mediated soil fertility, and finally improves ecosystem services. These practices need to be promoted to replace agricultural intensification with sustainable intensification in maize fields.

ABSTRACT

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Efficacy of Chemical Insecticides on *Nilaparvata lugens* (Stål) and Their Impact in *Lycosa pseudoannulata* in Laboratory**Naresh Dangi^{1,*}, Kapil Paudel¹, Pawan Dhakal², Indu Regmi², Surata Kafle², Smriti Poudel², Bikash Bhusal¹ and Ajaya Shree Ratna Bajracharya¹**¹National Entomology Research Center, National Agriculture Research Institute, Nepal
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Brown plant hopper *Nilaparvata lugens* (Stål) is serious pest of paddy in Nepal. Ten different insecticides in two sets were tested against 3rd and 5th (n =300) instar BPH in laboratory. Mortality of 3rd (1st set: $F_{5,35} = 387.41$, $P < 0.001$; 2nd set: $F_{7,47} = 255.01$, $P < 0.001$) and 5th (1st set: $F_{5,35} = 416.73$, $P < 0.001$; 2nd set: $F_{7,47} = 259.70$, $P < 0.001$) instar BPH was found significantly different in 96 h after insecticide application. Similarly, toxicity ratio of tested insecticides observed more in nitenpyram (10.9 and 7.1), thiamethoxam (2.6 and 1.9), emamectin benzoate (2.6 and 2.4) and fipronil (2.6 and 1.7) than that of imidachlorpid to 3rd and 5th instar BPH respectively. According to IOBC/WPRS recommendation nitenpyram, emamectin benzoate and imidacloprid were found harmless to *Lycosa pseudoannulata*. Thus, the insecticides nitenpyram, thiamethoxam and fipronil could be useful to manage BPH in paddy.

Integrated Management of Rice Insect Pests in Nepal**Resham Bahadur Thapa¹ and Dilli Ram Sharma²**¹Institute of Agriculture and Animal Science, Tribhuvan University²Plant Protection Society, Nepal

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Rice is a principal source of food for more than half of the world population, and its cultivation assist in food security, provides income and employment to the farmers. Rice farming *is* practiced in different agro-ecological domains of Nepal and insect pests are considered as major constraints for increasing productivity. Integrated Pest Management (IPM) was initiated in Nepal after the incidence of brown plant hopper (BPH) through Farmer's Field School (FFS) in rice. After the grand success of BPH management in the rice field, the IPM-FFS model has been widely adopted in various crops in Nepal because of its multi-dimensional benefits over traditional pest management practices, such as trained technicians and farmers, increased production and productivity, reduced use of pesticide and polluting environment, and promoted healthy agro-ecosystem with conservation of natural enemies of the pest species. This paper reviews achievements, and outlines challenges and future directions of rice research and development program in Nepal.

**Efficacy of Essential Oils against Rice Weevil (*Sitophilus oryzae*)
(Coleoptera: Curculionidae) in Stored Wheat****Amrit Sharma¹*, Min Raj Pokhrel², Vinita Sharma³, Shaurav Sharma¹,
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Rice weevil (*Sitophilus oryzae*) is a notorious stored grain pest that causes significant losses, especially in cereals. The pest has become resistant to many chemical insecticides and has raised food safety and the cost-of-protection issues. Eleven plant essential oils (EOs) were tested for their contact, fumigation and repellence tests against the weevil at the Entomology Unit of National Wheat Research Program (NWRP), Bhairahawa, Nepal during April to August 2023. The order (higher-lower) of fumigant toxicity of the EOS against the weevil was: ginger > timur > clove > mint > turmeric > geranium > lemon > lemon grass > guava > eucalyptus > French basil within three weeks of fumigation. The lowest weevil emergence (3.67) was observed with eucalyptus EO followed by ginger (4.33) and clove (5.67), whereas the greatest adult emergence was noted with timur (39.70), lemon (39.70), and lemon grass EO (15) after 16 weeks of fumigation. The order of contact toxicity was: clove > ginger > geranium > turmeric > French basil > mint > lemon grass > lemon > guava > eucalyptus > timur. At 5% concentration, strong repellence (>70%) was shown by clove and timur while ginger, lemon grass, geranium, mint, turmeric, and lemon EOs showed moderate repellence (40-70%). Clove and ginger EOs were the most effective fumigants against rice weevils at low concentrations (15 µL/L). Similarly, French basil, clove, geranium, and ginger EOs showed high contact toxicity within 72 h of treatment. Clove, ginger, and French basil EOs were the most promising against rice weevils in stored wheat. Further study is necessary to include this component in the integrated management of rice weevils and to minimize the post-harvest losses in wheat.

Management of Root-Knot Nematodes with Chemical and Non-Chemical Pesticides for Sustainable Production of Tomato under Protected Cultivation

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Protected (plastic house) cultivation offers numerous advantages for vegetable production in Nepal. Continuous cropping cycle within soil-based closed structures has led to a rise in soil borne pathogens, notably in the mid-hills of Nepal, posing challenges to sustainable crop production. Root-knot nematodes (RKNs) particularly threaten protected cultivation, demanding significant time and financial investments for effective management. This study has investigated the efficacy of chemical (fosthiazate) and non-chemical (biogas slurry, *Trichoderma* sp., neem cake, and root care hormone) pesticides with a control for RKN management in tomato grown under plastic greenhouses. A randomized block trial was conducted to compare the effectiveness of these non-chemical treatments along with a nematicide against RKNs in tomato. Results from the three-block trial revealed significant differences in the galling index (GI), demonstrating that Fosthiazate, neem cake, and biogas slurry outperformed the control treatment. On pairwise mean comparison, Fosthiazate, Neem cake, and Biogas Slurry were superior to that of the control treatment with GI of 2.23, 2.67, and 3.23%, respectively, where the control had an average GI of 4.45%. Furthermore, there was no significant disparity between the GI of neem cake and Fosthiazate, while the performance of *Trichoderma* and root care showed no significant difference compared to the control in remediating RKN-induced root galling in tomatoes. All other treatments gave significantly lower disease incidence than the control. Lowest mean disease incidence was found to be $12.23 \pm (4.10)$ % and lowest galling index, at $2.23 \pm (0.74)$ % with the application of chemical pesticide i.e. Fosthiazate. Additionally, Neem cake as non-chemical pesticide having non-significant difference with fosthiazate at $16.67 \pm (5.56)$, mean disease incidence and $(2.67 \pm (0.89))$ %, galling index (give data). However, control has significant

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difference in mean disease incidence with $80.0 \pm (26.67)\%$ and galling index, at $4.45 \pm (1.48) \%$. These findings suggest promising prospects for environmentally friendly management of RKN in protected tomato cultivation, offering the added benefit of improved soil health.

Fruit Fly Species (Diptera:Tephritidae:Dacinae:Dacini) Diversity in Field Infested Fruits/flowers of Cucurbits during Summer-rainy and Autumn-winter Seasons in Nepal

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Fruit flies (Diptera:Tephritidae:Dacinae:Dacini) are widely distributed in the world. Their diversity is prevalent in cucurbitaceous fruits. To date, 26 species have been reported from agricultural system of Nepal largely from field monitoring and collected specimens. Their management is effective if the control measures are specific to the damage causing species. Therefore, damaged fruits of zucchini, pumpkin, cucumber, sponge gourd, bitter gourd and bottle gourd were collected from eastern-western terai and mid-hills of Nepal from 7 July to 27 November in 2022. In total, 365 sampled fruits were cultured each in separate plastic jar till the adult emergence. The adult fruit flies were collected from each jar and identified based on morphological features and standard keys under trinocular microscope. Four fruit fly species: *Zeugodacus cucurbitae* (Coq.), *Z. tau* (Walker), *Z. scutellaris* (Bezzi) and *Z. diversus* (Coq.) were recorded from the field infested fruits and flowers. At least one fruit fly species emerged as adult fly from 75% samples. Of the total successful samples (n=273), 55%, 43%, 25% and 9% samples consisted of *Z. tau*, *Z. cucurbitae*, *Z. scutellaris* and *Z. diversus*, respectively. Fruit/flower infested with one, two and three species of fruit flies were 70.3%, 28% and 1.7%, respectively. *Z. tau* was the most abundant species and accounted for 82.2% while the second most abundant species *Z. cucurbitae* accounted 15.6% of the total emerged adults (7799). *Z. tau* and *Z. cucurbitae* were found throughout the study period in fruits while *Z. scutellaris* and *Z. diversus* largely emerged as adult flies from flowers. Considering the species diversity from sampled fruits, the management strategies should be targeted to the most abundant species- *Zeugodacus* spp. in cucurbit fields.

ABSTRACT

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The Role of Plant Doctors in Hungary

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Hungarian plant protection system is unique in the world in the sense it is the first country to introduce university level education of plant doctors (MSc) and plant protection prescription. In 2007, the higher education in Plant Doctor MSc course has started. Act XLVI of 2008 on the Food Chain (act of plant protection in Hungary) codified the name of the profession as Plant Doctor. In 2011, statistical number of plant doctors was officially introduced in the State Register of Occupations. In Hungary, strict legislations regulate the plant protection activity. End-users are only entitled to purchase and use pesticides with marketing category I if they have a plant protection prescription. Only plant doctors who are members of the Plant Protection Chamber are entitled to issue prescriptions. Hungarian Plant Protection Chamber is also unique in the world. Plant protection prescription guarantees the expert use of pesticides with category I supervised by plant doctors.

Area-Wide Control Program of Chinese Citrus Fly, *Bactrocera minax* (Enderlein, 1920) (Diptera: Tephritidae) in Nepal**Debraj Adhikari**

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The Chinese citrus fly, *Bactrocera minax* (Enderlein, 1920) (Tephritidae: Diptera), poses a significant threat to citrus fruits, particularly those with tight skins, causing substantial losses ranging from 5 to 100% in mid-mountain citrus orchards of Nepal. Its geographic distribution includes Nepal, India (Sikkim and West Bengal), Bhutan, and China. Recently, *B. minax* infestations have been observed in lemon, sweet orange, and mandarin fruits across many citrus-growing districts in Nepal. An Area-Wide Control Program (AWCP) against *B. minax* in the orchards was initiated for the first time in Nepal. This program involved organized spot applications of a lethal protein hydrolysate bait in productive sweet orange trees, along with orchard sanitation measures, in community level. This approach successfully managed fruit fly populations, reducing sweet orange losses from 56.7% in 2017 (prior to AWCP) to 10.9% during AWCP implementation in 2018, and further down to 4.5% in 2019 with the subsequent AWCP approach.

**Plant Clinic as Agro-Advisory Service in Nepal:
Assessment of Tomato Pest Management**

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Agriculture, forestry and fishing, as a major sector of Nepalese economy, contribute about 24.12 percent in gross domestic product (GDP). Plant clinic is one of the extensions approaches that deliver field level services to farmers. Insect pests and diseases are major constraints in agricultural production. Plantwise Online Management System (POMS) data from September 2013 to July 2022 were retrieved to determine the major vegetable crops and their problems diagnosed in plant clinics and assess performance of this plant clinic approach as agro advisory services in Nepal. Tomato (*Solanum lycopersicum*) crop was ranked first (17 percent) among crops registered in plant clinic sessions. Late blight (*Phytophthora infestans*) was diagnosed as a major problem in tomato followed by tomato leaf miner (*Tuta absoluta*). Similarly, around 60 percent recommendation provided by plant doctors involved management through cultural practices. In this study, it is suggested that Nepalese plant doctors provide pertinent and useful advice on plant health issues faced by farmers, who recommend integrated pest management-based techniques for managing insect pests and diseases of their crops.

The First Report of an Entomopathogenic Fungus, *Metarhizium rileyi* (Farlow) Samson in the Maize Fields of Chitwan, Nepal**Nisha Subedi¹*, Sundar Tiwari², Min Raj Pokhrel² and Rangaswamy Muniappan³**¹Faculty of Agriculture, Agriculture and Forestry University, Chitwan, Nepal²Department of Entomology, Agriculture and Forestry University, Nepal³Center for International Research, Education, and Development, Virginia Tech, Blacksburg, VA 24061, USA

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Metarhizium rileyi is an entomopathogenic fungus with a potential to cause diseases in several noctuid (Lepidoptera: Noctuidae) pests of agricultural importance. The fungus has received great attention as a potential microbial agent to control fall armyworm (FAW), (*Spodoptera frugiperda*), an invasive notorious pest that damages both vegetative and reproductive parts of many crops, particularly belonging to the family, Poaceae. Chemical control methods for the management of this pest pose risk to human, environment, and the pest has gained resistance to a broad range of synthetic pesticides. Hence, a study was proposed to confirm entomopathogenic *M. rileyi* from the Nepalese FAW population using three-step technique. First, the fungus infected FAW larvae were collected from the pesticide-free maize fields and the green spores of the cadavers were isolated and inoculated on Sabouraud Dextrose Agar media to obtain pure culture of the fungal colony. Morphologically, the fungal growth in the petri dish was observed white to malachite green in color and the conidia were ellipsoid, hyaline, and aseptate. Second, the identification of fungal isolate (FAMF01) being *M. rileyi* which was confirmed through molecular identification. The sequence data information obtained was deposited in NCBI GenBank database and obtained with accession number, PP091973. Third, pure culture of identified fungus was produced and the bioassay experiment was carried out using conidial suspension (1×10^8 conidia/ml) and a control 0.1% Tween-80 to test its pathogenicity against the third instar larvae of FAW. The result showed that the *M. rileyi* is highly virulent to FAW larvae causing 100% mortality within ten days of treatment. This is the first report of *M. rileyi* isolation from maize fields of Chitwan, Nepal and the preliminary bioassay results showed its potential use in the management of FAW.

Determinants of Farmers' Adoption of Sustainable Management Practices of Citrus Fruit Fly in Myagdi District, Nepal

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A study was conducted in three municipalities of Myagdi district, Nepal to investigate the factors influencing the adoption of sustainable management practices for citrus fruit fly infestation. Using pre-tested questionnaire, a household survey was employed with 100 households to collect the primary data. The data were processed using MS-Excel and analyzed using STATA version 15. The binary logistic regression model shows that extension support and income were statistically positively significant but household's distance from the nearest market was statistically negatively significant. While other variables age, gender, training, knowledge index, education, and member involvement in organization were statistically insignificant. Any programs or policies targeted for farmers' efficient adoption of sustainable management practices need to focus on the extension support, distance, and income of the household.

Assessment of Damage and Abundance of Banana Leaf and Fruit Scarring Beetle (*Basilepta subcostatum*) in Chitwan**Susma Shrestha¹ and Min Raj Pokhrel^{2, @}**¹College of Natural Resource Management, Bardibas Mahottari, Nepal²Agriculture and Forestry University, Rampur, Chitwan, Nepal

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Banana leaf and fruit scarring beetle (*Basilepta subcostatum*) is one of the major challenges of commercial banana production in Nepal. With a view to estimating the existence of *B. subcostatum* in banana crops and the damage done by the beetles in commercial farmer's fields, the study was conducted in Khairahani Municipality-10, Kathar of Chitwan district from April to July, 2023. Random sampling of the 50 plants from different locations within the banana field was done, and the average population of the beetle per plant and the number of scars per 10 cm² of leaves were calculated. Fruit damage was estimated by the number of scars per finger, the number of fingers infested per hand, and the percentage of fruit damage. Fifty bunches of bananas were sampled in each observation at 10-day intervals. The highest mean beetle population per plant was recorded 17.22 during the study period. The maximum mean scars per 10cm² of leaf and mean number of scars per finger was recorded up to 33.28 and 6.8, respectively. The maximum mean number of fingers infested per hand was 3.92 and the highest mean percentage fruit damage was recorded as high as 32.7 during the study period. It was found that the beetle population and extent of damage increased gradually from April to July which could be considered for its management in the field.

Bunch Covering for Management of Banana Leaf and Fruit Scarring Beetle**Pushpa Roka¹ and Min Raj Pokhrel^{2,*}**¹College of Natural Resource Management, Bardibas, Mahottari, Nepal²Agriculture and Forestry University, Rampur, Chitwan, Nepal

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Banana leaf and fruit scarring beetle (BLFSB) is an emerging pest of banana plantation. Farmers are using synthetic chemical pesticides to control the beetle population and reduce their damage in banana crops in the field. A randomized complete block design field experiment was conducted in a 3.5 ha banana farm (variety Grand Nain, tissue-cultured) located at Madhavpur, Ratnanagar Municipality, 15, Chitwan during 6th April - 12th June 2023 to determine the effect of different bunch-covering materials on BFLSB management and the resultant fruit quality. Among the treatments (red polybag, green polybag, blue polybag, fiber net and a non-covering control) applied after the fall of bracts when the fingers were curled upwards and the floral remnants were hard, insect infestation on fruit was recorded minimum under covered bunches; red bag (3.06%), green bags (3.33%), blue bag (3.87%) and fiber net (4.8%) as compared to control bunches which experienced a maximum of 95.87% infestation. However, the treatments had no significant effects in regard to bunch weight, finger weight, finger length, finger diameter, pulp weight, peel weight, pulp to peel ratio and total soluble solid that determine the fruit quality. The covering materials had no significant effect on fruit maturity harvested 68 days after flowering. Therefore, either of the tested bunch covering materials are effective in scarring beetle management practices. However, further year-round tests are required before its commercialization.

ABSTRACT

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**Screening of Rice Genotypes for Resistance to Leaf Blast
(*Pyricularia oryzae*) Disease under Field Conditions at
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Rice (*Oryza sativa* L.) ranks the top position among the cereal crops in Nepal in both area coverage and production. However, its production is frequently hampered by devastating blast (*Pyricularia oryzae* Cav.) disease. Host resistance is convenient, preferable, cost effective, safe and practical means of its management. Experiments, encompassing 112 rice genotypes, including resistant (Sabitri) and susceptible check (Shankharika) were conducted at Directorate of Agricultural Research (DoAR) Khajura, Banke, Nepal during the years 2020 and 2021. The field experiment was conducted in augmented row design. Leaf blast disease scoring was done from the 25th days after sowing by using the disease rating scale 0-9. The significant differences for resistance to leaf blast disease indicate the adequate genetic variability among the genotypes. Susceptible check Shankharika recorded the highest AUDPC value (472.76 and 550.93) in 2020 and 2021, respectively, that indicate the conducive conditions for screening of genotypes. The experiment revealed that sixty-six genotypes were resistant in 2020, whereas only the resistant check Sabitri maintained its resistance in 2021. Amongst the tested genotypes, 10 were recorded as moderately resistant and 7 moderately susceptible in both years of testing. The current study aims to identify resistant rice genotypes against blast disease, which could be further utilized as a genetic source for developing leaf blast resistant rice varieties.

Citrus Decline Management Tools: Agricultural Technician's Preference in Nepal

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Citrus greening caused by *Candidatus liberibacter asiaticus* (CLAs) is considered one of the important diseases responsible for citrus decline in Nepal. After an orientation of 16 available decline management technologies to the agriculture technicians from the Department of Agriculture, Nepal Agricultural Research Council, and citrus related zone and super zones of the Prime Minister Agricultural Modernization Project, a semi-structured questionnaire was provided to these technicians in April 2023. These technicians marked their choices, and the results were analyzed to identify their perception of available technologies' applicability in the Nepalese context. Among sixteen technologies assessed soil health management, the use of clean planting materials; root rot management, and destruction of infected trees were mostly agreed on technologies by the development workers (>68%) to manage citrus decline. The technicians partly agreed (>61%) that the use of Kaolin spray and natural enemies, quarantine measures, individual protective covers (IPC), and plant nutrient management were better alternatives to manage the citrus greening disease. On the contrary, agricultural technicians were mostly reluctant to use citrus under a protective screen (CUPS) as unconvincing ideas to control greening disease. Based on this study, we can say that there are a few readily available technologies that technicians can take and for others, we need to convince our technicians before sending them to the farmers' field.

Field Evaluation of Soybean Genotypes against Soybean Yellow Mosaic Disease

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Two years field experiments were conducted at Grain Legumes Research Program, Khajura, Banke with an objective to identify the sources of resistant against soybean yellow mosaic virus disease among the selected set of seventy-five soybean genotypes in the cropping seasons 2020 and 2021. Experiments were carried out in rod row design with Puja as a check variety. Soybean yellow mosaic disease scoring was done in 1-6 scale. In cropping season 2020, none of the genotypes were found highly resistant and resistant. Out of seventy-five genotypes, nineteen were moderately resistant, forty were moderately susceptible, fifteen were susceptible and one was highly susceptible. Similarly, in cropping season 2021, none of the genotypes were found highly resistant, susceptible and highly susceptible. Out of seventy-five genotypes, thirty-three were resistant, nineteen moderately resistant and twenty-three moderately susceptible. Eight genotypes; CO#165 (White), TGX 1989-20F, TGX1990-47F, TGX1990-5F, C2016, TGX1889-75FN, TGX1990-21F, and Puja were consistently moderately resistant in both years of testing. The current study provides profile of soybean genotypes response against soybean yellow mosaic disease in Nepal which will be useful for Nepal's soybean improvement programs.

Habitat Management: An Agro-Ecology Based Innovative Option to Enhance Natural Enemies of Crop Pests in Agriculture**Ram Prasad Mainali^{1, @}, Toya Nath Joshi², Sudeep Subedi³**¹National Agriculture Genetic Resources Center, Nepal Agricultural Research Council (NARC), Khumaltar, Lalitpur, Nepal²Ministry of Agriculture and Livestock Development, Kathmandu, Nepal³National Plant Breeding and Genetics Research Centre, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal
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The green revolution has increased global agricultural production through high agricultural inputs including higher use of pesticides to manage insect pests for higher yields. These practices cause negative impacts on human health, the environment and biodiversity. Habitat management is the most potent strategy for conserving natural enemies where the farm agroecosystem, its adjacent semi-natural habitats, or the entire landscape are manipulated in such a way that it encourages the presence of natural enemies. This system relies on optimal plant resources such as non-crop vegetation that provides shelter, nectar, alternative food and pollen (SNAP) for natural enemies, especially during the time of insufficient pest residue. These resources then increase the growth, fecundity, survival and longevity of the natural enemies. Plant characteristics such as blooming, the adjacent landscape and semi-natural habitat are imperative to provide necessary resources that finally aid in the conservation of biological control. As a result, conserved biological control agents possibly reduce the pest population. This review suggested that the spatial and temporal availability of ecological infrastructure provides the optimum exploitation of natural enemies and hence growers could get multiple benefits. It further gives innovative solutions to pest management without the use of pesticides. Besides, it stimulates the future possibilities of shifting pesticide-dominated agriculture to integrated pest management and finally towards organic agriculture. The natural enemies, their requirements for living, and a comprehensive overview of different levels of habitat management are discussed in this review paper. We recommend a few research questions that could be an academic capsule for an immediate researcher in Nepal to make biological control more practical.

Black Pit of Banana: An Emerging Challenge and Its Potential Management

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Depressed dark-colored spots were reported in Cavendish banana cultivar Grand Nain in the autumn season of 2021 at Bardiya and Kailali districts. A detailed investigation was done to detect the pathogen. Microscopic observation after 2–5 days of incubation in a moist chamber revealed the association of *Pyricularia angulata* and the disease was declared black pit. The same year blast-like symptoms were observed in tissue-cultured banana seedlings at the Directorate of Agricultural Research, Khajura. Microscopic observation in tape mounting indicated the association of the same species. After repeated requests from growers, an initiative was taken to evaluate the efficacy of available fungicides in 2022 and 2023 in farmers' fields at disease-infested fields of Bardiya district. Experiments were conducted in a randomized complete block design where seven plants from seven rows having black pit symptoms in banana fruit cultivar Grand Nain were selected and six fungicides: hexaconazole, iprodione + hexaconazole, tebuconazole + trifloxystrobin, propiconazole, and tebuconazole + sulfur were sprayed at seven days interval until 35 days. The control plants were sprayed with tap water. The number of infected fruits before each spray were counted and the incidence percentage was calculated. The results indicated consistent reduction of disease incidence in propiconazole, tebuconazole, and tebuconazole + trifloxystrobin sprayed plants in both years of testing. The propiconazole was recommended based on the first year of testing to growers and growers responded to the satisfactory suppression of disease after spraying the propiconazole once the disease was onset. The black pit and blast diseases are becoming intensively challenging in Cavendish banana in the western terai of Nepal and significantly impacting the postharvest life and marketability. The current study provides management options to growers to tackle the newly emerged banana disease in Nepal.

Population Dynamics and Sex Expression of Fruit Fly Species in Cucurbits from Sindhuli and Mahottari Districts

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Fruit flies are polyphagous pests causing severe damage to cucurbitaceous vegetables. A study was conducted to identify the potential species of fruit flies affecting cucurbits in Sindhuli and Mahottari districts during early summer of 2019. Infested fruit samples of zucchini, sponge gourd and cucumber were collected from four farmers from different locations in each district and brought to the Entomology Laboratory, Institute of Agriculture and Animal Science, Lamjung Campus for further analysis. Treatment was set as single infested fruit sample from each type of cucurbit, and each farmer representing a replication. Morphological identification revealed *Zeugodacus tau* and *Zeugodacus cucurbitae* as the major fruit fly species infesting cucurbits. Two factorial analysis was conducted considering locations and cucurbit crops as factors. *Z. tau* being the prominent species compared to *Z. cucurbitae* regardless of location. In laboratory experiment, a consistently higher female population was observed across all crops studied and in both locations. Additionally, in crop-wise infestation from sampled cucurbits, zucchini was highly infested in Mahottari, while sponge gourd was predominant in Sindhuli district. This research suggests that during early summer season, two species of fruit flies are responsible for a higher level of infestation in cucurbit crops, and they prefer variety of hosts available at that time.

Effect of Indigenous Plant Materials on Control of Rice Weevil (*Sitophilus oryzae* L.) in Stored Wheat Grains**Rajendra Yadav¹,^{*} Resham Bahadur Thapa²,
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Rice weevil (*Sitophilus oryzae* L.) causes significant losses on stored wheat grains and farmers generally use various chemical pesticides to control it which is not safe for human health. Therefore, this study was conducted to evaluate the efficacy of indigenous plant materials against rice weevil on stored wheat grains. The experiments were conducted in a completely randomized design with three replications at the National Wheat Research Program, Bhairahawa from June to October, 2019. A total of three indigenous plant material powders (neem leaf, castor leaf and sweet flag stolon) each of three concentrations (1.0, 2.0 and 3.0% w/w), along with Aluminium Phosphide @ 9 g/mt seed as a standard check and untreated control were included in the experiment. The effect of indigenous plant materials on adult weevil emergence was found significantly different among the treatments. The lowest number of adult weevil emergence was recorded in neem leaf powder @ 3.0% treated wheat grains followed by sweet flag stolon powder and castor leaf powder each @ 3.0%. The highest adult weevil emergence inhibition (80.7%) was recorded in neem leaf powder @ 3.0% followed by sweet flag stolon powder @ 3.0% (74.3%) at 90 days after treatment. Neem leaf powder and sweet flag stolon powder treated grains also showed a significant effect on the reduction of grain loss compared to other treatments over different observation periods. Therefore, the present study indicated that neem leaf powder and sweet flag stolon powder each @ 3.0% w/w could be used to control rice weevil in stored wheat grains for up to four months.

An Overview of Store Grain Pests of Cereal Crops in Nepal**Kapil Kafle^{1, @}, Resham Bahadur Thapa¹, Keshab Dahal¹ and Sunil Aryal²**¹Institute of Agriculture and Animal Science, Tribhuvan University, Nepal²Horticultural Research Station, Malepatan, Pokhara

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Crop production and grain storage plays a vital role in food security and economic stability. However, the presence of pests in stored grain poses a significant challenge, resulting in substantial post-harvest losses. In Nepal, the most common store grain insect pests of cereal are weevils and moths- rice weevil (*Sitophilus oryzae*), maize weevil (*Sitophilus zeamais*), red flour beetles (*Tribolium castaneum*), confused flour beetle (*Tribolium confusum*), rice moth (*Corcyra cephalonica*) and angoumois grain moth (*Sitotroga cerealella*). This paper reviews various management strategies to control store grain pests. It discusses preventive measures, such as proper storage facilities, hygiene practices, and effective grain handling techniques. Additionally, it explores the use of chemical controls, including fumigation and insecticides, as well as non-chemical alternatives like biological control agents and hermetic storage methods and emphasizes the importance of integrated pest management approaches in mitigating store grain pest infestations. The findings of study serves as a valuable resource for researchers, extension workers, and policymakers in developing targeted interventions to minimize post-harvest losses and ensure the quality and safety of stored grain in Nepal.

**First Report of Chilli Thrips, *Scirtothrips dorsalis* Hood, 1919
(Thysanoptera: Thripidae) on Strawberry, *Fragaria x ananassa* in
Nepal**

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Scirtothrips dorsalis Hood, 1919 (Thysanoptera: Thripidae) commonly known as chilli thrips, were observed for the first time at Nepal Agrovine Pvt. Ltd. Farm, Bharatpur, Chitwan, Nepal in March 2021 on strawberries (*Fragaria X ananassa*). Its established population was detected on the vegetative as well as reproductive parts of the strawberries. Only 1% of plants had thrips populations and showed leaf, and fruit bronzing while the damaged leaves appeared with scrapped epidermis and exhibited characteristic upward curl and reduced size which resembled symptoms reported on strawberries worldwide. The morphological characteristics were compared utilizing the keys given by Zur Strassen (2003) and Kumar et al. (2017) and species identification of thrips was made by the senior author with a dissecting microscope at a minimum of 10X magnification. According to the result of identification, it was confirmed that all collected thrips individuals belonged to *S. dorsalis* Hood, 1919 (Thysanoptera: Thripidae) adults and larvae. The same species of thrips have been observed in 2022/23 season with an increased number of plants with thrips population. In this article, a summary of identification features, damage symptoms, and its economic importance and need for further research is highlighted.

Field Evaluation of Finger millet Genotypes for Blast Resistance Caused by *Pyricularia grisea* in Midhill of Nepal**Subash Subedi¹*, ²Saraswati Neupane, Bandhu Raj Baral²,
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Finger millet (*Eleusine coracana* L.) is Nepal's fourth significant cereal, facing biotic stresses like blast caused by *Pyricularia grisea* Sacc. Field disease screening nurseries at Hill Crops Research Program, Kavre and Dolakha established and evaluated 156 finger millet genotypes including Okhle Kodo-1 and ACC#422 as checks for blast resistance during 2020 and 2021. Only 3% genotypes exhibited resistance to leaf and finger blast, with 7% resistant to neck blast. None of the genotypes were marked as immune and highly susceptible. The maximum genotypes 75% for leaf blast, 83% for neck blast and 40% for finger blast showed moderately resistant (MR) reaction. A strong significant ($P \leq 0.05$) positive correlation was found between neck and finger blast ($r=0.87$), and moderate correlations between leaf and neck blast ($r=0.60$), and leaf and finger blast ($r=0.52$). Genotypes ACC#6408, Coll#DR-6, ACC#2707, ACC#6375, and ACC#2811 showed high yield (>5 t/ha) and combined resistance to leaf, neck and finger blast. These findings offer prospects for developing high-yielding, blast-resistant finger millet varieties.

Post-Harvest Storage Technology for Mandarin Fruit**Madhav Prasad Lamsal**

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A review study was carried out to find out the recent relevant technologies to be followed while storing mandarin in the cold stores. Published scientific report, articles, books, websites and some unpublished data, fieldwork reports, author's field trials, and experiences were consulted for the study. Nepal had started storing mandarin in cellar stores without use of external energy since 1977/78. Till date, cellar stores are used in modified version for small scale volume. Fruits should be harvested, handled, pre-cooled and treated carefully before storing in the cold store. Cold store sanitation and cleaning and grading of fruits also found to be important factors. Commercial and large volume of mandarin required automated larger structure of cold stores. The study revealed that mandarin is a type of citrus fruit that is commonly stored in cold storage to extend the shelf life and maintain the quality. External bruises, physiological disorder, mishandling, improper maturity stage and the microbial attack (fungi and bacteria) are the major causes of cold storage decay of mandarin. The most important factor is fungal decay. Microbial decaying is managed by pre-treatment of the fruits with antimicrobial chemical like 1-4% of calcium chloride. Gaseous concentration and oxygen and carbon dioxide ratio is also found crucial in cold store, and this should further be tested in case of Nepalese local variety of mandarin. The physical weight loss in cold store found similar while the pre-storage treatment with 4% calcium chloride has minimum decay as compared to untreated after 15 days of storage. Cushioning materials help to minimize the loss by 5% in cold storage. The ideal storage temperature for mandarins is reported between 0°C to 5°C with a relative humidity of 90-95%. This review and author's experience show that this range of temperature and humidity is not working in Nepalese local variety and further research is needed.

ABSTRACT

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Evaluation of Sweet Corn Genotypes for Northern Leaf Blight Resistance in Field Condition at NMRP, Rampur**Suk Bahadur Gurung^{1,@}, Shiva Prasad Adhikari²,
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Sweet corn cultivation is new for Nepalese farming community. National Maize Research Program has limited number of sweet corn germplasms. None of the sweet corn varieties are registered or released till now for general cultivation. Maize for human consumption can be enhanced with sweet corn and can contribute largely for food and nutrition security. This experiment aimed to characterize sweet corn genotypes in response to northern leaf blight (*Exserohilum turcicum*) in winter season in terai condition. Altogether 13 genotypes were laid out in randomized complete block design. Planting was done in first week of Kartik. Disease incidence was evaluated in natural epiphytotic condition and scoring was done in 1-5 rating scale for three times as guided by CIMMYT protocol. Disease evaluation was started after silking to dough stage at 10 days interval. Most of the evaluated sweet corn genotypes were susceptible to disease. Analysis of variance revealed that only one genotype Sweet corn-1 followed by ID-8007-R, was tolerant to northern leaf blight in all disease scoring days. Based upon its response to northern leaf blight, it can be promoted to multi-locational and multi-year yield trials verification. Being most of the tested genotypes susceptible to disease, development of new sweet corn lines and their evaluation from multiple discipline is necessary.

Understanding the Interaction of *OsWRKYs* with Blast-resistant Genes using the Computational Approach

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The translation of genetic data into biological implications depends heavily on protein-DNA interactions and the complexes they form. Molecular docking was done using computational tools to study the interactions between five *OsWRKY* proteins (expressed differentially in blast caused by *Magnaporthe oryzae* and drought stresses applied individually and overlapped) with the promoter region of two blast resistance genes (*Pi2* and *Pi54*). Differential binding patterns were observed with different *OsWRKY* proteins. The *WRKY* proteins (*OsWRKY88* and *OsWRKY102*), whose transcript levels decrease when drought and blast stress overlap, interact with the two resistance genes mostly involving the residues of the zinc finger structure. On the other hand, the *WRKY* proteins (*OsWRKY53-1* and *OsWRKY113*), whose transcript levels did not reduce significantly when challenged by drought and blast overlapped conditions compared to individual treatment of blast, interact mostly involving the residues of the conserved *WRKYGQK* heptapeptide sequence. Interestingly, the *OsWRKY74* whose transcript levels are unaffected in both individual and combined stresses, interacts with both the blast resistance genes involving few residues of both *WRKYGQK* heptapeptide and the zinc finger structure. The findings thus indicate that the interaction of *OsWRKY* proteins involving the conserved *WRKYGQK* heptapeptide sequence with the blast resistance genes *Pi2* and *Pi54* is important to mitigate the blast challenge in rice even during overlapping challenges of drought.

Toxicity of the *Acorus calamus* (Acorales:Acoraceae) from High Hills of Nepal to *Sitophilus zeamais* (Coleoptera: Curculionidae)**Sunil Aryal¹*, Kashinath Chiluwal² and Ashmita Poudel³**¹ Horticulture Research Station, Malepatan, Kaski, Nepal²National Entomology Research Center, Khumaltar, Lalitpur, Nepal³Entomology Department, Tribhuvan University, Kirtipur, Kathmandu, Nepal

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Essential oil of *Acorus calamus* L. rhizome from Daman, Makwanpur, Nepal was extracted using Clevenger-type hydro-distillation apparatus and analyzed by GC-mass spectrometer. The major chemical constituents identified were of β -asarone (79.7%), Methyl isoeugenol (4.08%), Dehydroxy-isocalmendiol (4.03%), Shyobunone (3.27%), (0.93%), δ -Cadinene (0.85%), Epishyobunone (0.68%), and Isoshyobunone (0.47%). For the weevils, when released in methanol diluted essential oil of sweet flag treated scintillating vial, LC₅₀ at 24, 48, and 72 hrs. were estimated to be 1.23 ($y=2.21x-0.22$), 0.45 ($y=1.68x+0.58$) and 0.17 ($y=2.98x+2.29$) percent concentration of oil respectively. Hundred percent weevil mortality was obtained within 24 hours with 10% concentration while it took 380 hrs. with 0.16 % concentration. Essential oil of potential plant could be one of the good alternative to chemical pesticides in managing storage pests. Essential oil of sweet flag rhizome can be further tested in field and storage pests. MRL should be ascertained to allowable limits as β -asarone has carcinogenic effect at certain level.

Effectiveness of *Zanthoxylum armatum* (Sapindales: Rutaceae) Essential Oil on Mortality and Repellency of *Sitophilus zeamais* (Coleoptera: Curculionidae)

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Zanthoxylum armatum (Sichuan pepper) essential oil was tested against *Sitophilus zeamais* with different concentration (10, 5, 2.5, 1.25, 0.62, 0.31 and 0.15%) in scintillating vial bioassay and in oil treated maize grain. Repellency effect of the oil was also evaluated in filter paper test. LC₅₀ at 96 and 144 hours was estimated as 11.6 ($y=0.97x-1.03$) and 4.5 ($y=1.10x-0.721.03$) percent oil whereas LT₅₀ with the highest 10 % concentration was calculated as 13.84 hrs. but it took 197 hrs. to cause 50 percent mortality by the lowest concentration in scintillating vial bioassay. It was estimated that 0.01% ($y=0.56x+0.41$) oil was enough to kill 50 % of tested maize weevil in treated maize bioassay at 10 days. *S. zeamais* also showed strong repellency effect with presence of 98.75 (± 2.5) percent ($t=39$, $p\leq 0.01$) of weevil population in untreated area with 10% oil however the lowest concentration could repel around 77.5 (± 2.87) % ($t=19.75$, $p\leq 0.01$) of weevil after 24 hours of test. Essential oil of *Z. armatum* could be utilized in managing weevils in grain storage.

Detection of UG99 (TTKTT) Pathotype of Stem Rust Pathogen (*Puccinia graminis* f. sp. *tritici*) of Wheat in Nepal

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Wheat stem rust disease has historically been a major threat to global wheat growing areas, including South Asia. Stem rust (*P. graminis* f. sp. *tritici* (*Pgt*)) is currently considered as a minor disease and occurs infrequently in Nepal. Given the re-emergence of stem rust Ug99 in East Africa, global efforts to ensure monitoring, early warning and pre-emptive breeding of resistant cultivars have been undertaken. Nepal has actively implemented effective surveillance and resistance breeding. Regular rust disease monitoring was carried out in off-season (summer wheat) crops cultivated as a fodder crop in Dolkha district in November, 2023. Rust infected leaves' samples were collected from Dhandunge (27.7195N; 85.9491E; 2726masl) and Kharidhunga (27.4300N; 85.5600E; 2635masl), Dolkha district. Air dried samples were sent under permit to the Global Rust Reference Center (GRRC), Department of Agroecology, University of Aarhus, Denmark for pathotype analysis. Two viable samples were multiplied on susceptible wheat cultivars Morocco and McNair at GRRC laboratory and single pustules inoculated on 5-7 days old seedlings of the 20 internationally agreed stem rust differential lines using standard procedure and 14 supplementary wheat lines providing additional confirmation of pathogen virulence. Based on infection types of differential lines, the pathotype was diagnosed as TTKTT (Ug99 race group) in repeated experiments. Samples were also independently tested using SSR genotyping according to standard procedures. SSR genotype assays conclusively showed the confirmation of Pgt Clade 1 (Ug99). Risk of contamination for the Nepal samples was ruled out as no work on pathotype TTKTT had been undertaken at GRRC in the previous 6 months and no other stem rust pathotyping

ABSTRACT

was on-going in the lab at the time of analysis. The first detection of UG 99 in Nepal, highlights the success of surveillance activities in the country. Current risk is considered to be low, due to early detection, deployment of resistant cultivars and absence of any main season wheat crops in the sampling area. However, there is a need for continued and increased surveillance in both summer and main season wheat crops across the country. Varietal diversification and deployment of different resistant gene/s in different environments are also needed for the management of year round epidemic of rust pathotypes in the country.

Curbing Greenhouse Gas (GHG) Emissions through Biodiversity-Driven Crop Protection: Bright Prospects for the Asia-Pacific

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Synthetic pesticides are extensively utilized in Asian agriculture for the control of various crop pests, diseases, and weeds. However, the excessive reliance on these harmful substances has adverse effects on human health, biodiversity, and farm profitability, while also contributing to climate change. The process of pesticide-based crop protection consumes significant amounts of energy, resulting in the release of substantial greenhouse gas (GHG) emissions during product synthesis, distribution, and field application. In countries like China, Malaysia, or Japan, the use of chemical pesticides leads to carbon emissions equivalent to those produced by approximately 1.7 million, 381,000, or 300,000 passenger vehicles respectively. Whereas in another hand countries like Nepal, Maldives and several other Pacific countries have negligible contribution of GHG emissions. Based on the review of the literatures and available information, principal discoveries regarding biodiversity-based crop protection and our proposition includes (1) *Effective Pest Management Biodiversity*-based crop protection methods, such as integrated pest management (IPM), utilize natural predators, parasites, and pathogens to control pests, offering an effective alternative to synthetic pesticides (2) *Reduced Environmental Impact*: These methods minimize negative environmental impacts, including reduced chemical pollution and preservation of biodiversity, leading to healthier ecosystems. Despite the significant scientific progress made in non-chemical pest management in various Asian countries over the past decades, these advancements are often not implemented in practice. (3) *Enhanced Resilience*: Biodiversity-based crop protection enhances the resilience of agricultural systems to pest outbreaks and environmental stressors by promoting natural pest control mechanisms. (4) *Cost-effectiveness*: Implementing biodiversity-based approaches can be cost-effective in the long term, as they reduce the need for expensive synthetic pesticides and associated inputs (5) *Sustainable Agriculture*: By promoting sustainable agricultural practices, biodiversity-based crop protection contributes to long-term food security and agricultural sustainability. (6)

ABSTRACT

Technological Advancements: Ongoing research and technological advancements continue to improve the efficacy and scalability of biodiversity-based crop protection methods, making them increasingly viable options for farmers worldwide. (7) *Policy Implications:* We propose a range of policy options, such as carbon financing, to facilitate the widespread adoption of biodiversity-driven pest management across the Asia-Pacific region. There is a need for supportive policies and incentives to encourage the adoption of biodiversity-based crop protection practices on a larger scale, which can contribute to global efforts to mitigate climate change and promote sustainable agriculture.

Empirical Evidence of *Zeugodacus tau* Dominance in Cucurbit Cropping System

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Yet to be clarified issue of cucurbit fruit fly dominance in Nepalese cucurbit farming system is addressed through this study carried out in seven districts of Bagmati and Gandaki Provinces of Nepal. Traps baited either with cue lure, methyl eugenol or their mixtures were installed at nine cucurbit pockets during 2022-2023. A total of 25,957 specimens belonging to *Bactrocera* falling under six species were collected. *Zeugodacus tau* was determined to be the most dominant followed by *Zeugodacus scutellaris*, *Bactrocera dorsalis*, *Bactrocera diversus* and *Zeugodacus cucurbitae*, respectively with the Berger-Parker dominance indices of 0.55, 0.17, 0.12, 0.11, 0.01 and 0.004. Comparing the emerged adults from *Bactrocera*-infested cucurbits, only two species; *Z. tau* and *Z. cucurbitae* were recorded, and the *Z. tau* significantly outnumbered ($\chi^2 = 38.754$, $p \leq 0.001$) to the *Z. cucurbitae*. This study suggests to consider the dominance of *Z. tau* while conducting cucurbit fruit fly management activities.

Assessing the Emerging Havoc of Snails and Slugs in the Rupandehi and Nawalparasi Districts of Nepal: Occurrence, Management Practices and Economic Impact

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Among 100 terrestrial snails and slugs found in Nepal spanning 42 genera and 24 families, the giant African land snail (GALS) stands out as the most destructive pest of vegetable crops in tropical and subtropical regions. A comprehensive study, involving direct observations and a questionnaire survey was conducted from 12th June to 2nd July 2023. The findings, based on responses from 141 participants, reveal a significant surge in snail and slug populations over the past 4-8 years in two districts. Based on these informants the most preferred habitats in the study area include gardens followed by bari (small field), roadside, riverside, and water sources. The survey study in Rupandehi and Nawalparasi indicates that the majority of respondents do not observe snails and slugs throughout the year. However, their prevalence notably increases during the rainy season, from June to September. The GALS was reported to be more prominent than slugs and horntail snails in both districts. These pests were found in various habitats, including gardens, bari, walls, roads, and paddy fields, with the highest number of sightings in gardens and bari. Respondents reported that they feed on a range of vegetable crops, including cucurbits, cole, brinjal, okra, and taro, and cause 50% damage to nursery seedlings. The most common management practices reported include collecting and disposing of them in garbage-carrying vehicles, nearby rivers, and roads as well as crushing live individuals, spreading salt on them, and spraying alcohol and detergents. Regarding predators, respondents from Rupandehi identified the greater coucal as the most prominent predator of GALS and slugs, while in Nawalparasi, the great egret was reported to be the most common predator of snails and slugs. Only a few respondents from both districts (22% from Rupandehi and 31% from Nawalparasi) used molluscicides such as metaldehyde and pesticides like permethrin to manage the snail and slug populations.

Assessment of Citrus Greening Disease and Monitoring of Asian Citrus Psyllid (*Diaphorina citri* Kuwayama) in Sweet Orange Orchards of Sindhuli, Nepal

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This study was conducted to evaluate farmers' perceptions of citrus greening disease and to monitor the presence of the Asian Citrus Psyllid (ACP) in the major sweet orange growing regions of Sindhuli in 2022. The study consisted of two major parts: farmers' survey and monitoring of the vector ACP. According to the survey, 73.77% of the orchards exhibited symptoms indicative of citrus greening disease, 83.3% of the farmers were found to be aware of the disease, and 66.67% were aware of the symptoms it produced but only 43.14% of farmers were aware of the vector ACP. Cutting off the diseased tree ($I=0.63$) was the most followed strategy after the occurrence of the disease. The use of chemical pesticides ($I=0.85$) was ranked 1st among the strategies being applied to control the vector. The total ACP count was found to be the highest in July (Mean population=33.2). Its emergence in the orchard started after the end of winter (March), and gradually increased its population in spring (April), attained maximum population in the rainy season (July), and started declining again in fall (August).

Plant Clinic and its Impact in Agricultural Production in Three Districts of Bagmati Province

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A study entitled “Plant Clinic and Its Impact in Nepal” was conducted from March to August 2023 and assessed the effectiveness of plant clinics in three districts, namely Kavre, Lalitpur, and Bhaktapur, with a total sample size of 100 individuals (10 agricultural officers and 90 farmers). Data collection primarily involved direct interviews with farmers and agricultural officers, through a simple random method. The study revealed that 60% of male participants in plant clinics were from Kavre, while Lalitpur (53%) and Bhaktapur (60%) had higher female participation. Farmers above 40 years of age were actively engaged in the plant clinic session. Agricultural officers played a crucial role in disseminating plant clinic information (Kavre 60%, Lalitpur 53%, and Bhaktapur 49%). The media had a minimal impact. Kavre showed better access, awareness, and availability of experts. Respondents in Kavre attended clinics more frequently (60%), while Lalitpur (50%) and Bhaktapur (70%) had more first-time attendees. Furthermore, the study also revealed that the maximum number of respondents did not visit plant clinics due to lack of awareness in Kavre (57%), Lalitpur (77%), and Bhaktapur (63%). They faced a distance problem in reaching plant clinic spots. The farmers who applied suggestions from plant doctors got a positive impact from the plant clinic on plant health, such as improved crop yield and pest management. The greatest percentage of agricultural officers (70%) used follow-up, 20% training sessions and workshops, and 10% surveying plants to measure the impact of the plant clinic on plant health. Plant doctors faced challenges due to limited resources, such as financial and technical assistance.

IPM Adoption and its Economic Benefits for Tomato Growers in Kathmandu and Bhaktapur District

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A field survey was conducted from June to August, 2023 in Kathmandu and Bhaktapur Districts. A total of 100 tomato farmers were selected using the purposive random sampling method for the survey. The respondents were interviewed using a structured questionnaire. The results from this study revealed that the majority of farmers (68%) had participated in IPM training organized by Agro-vets in the study area. Additionally, 54% of the respondents reported that IPM practices had a significant impact on reducing post-harvest losses and enhancing the product quality. The economic benefits of adopting IPM practices in tomato cultivation under plastic tunnels varied across different municipalities. In Chagunarayan Municipality, 48% of farmers reported benefits, while in Suryabinayak Municipality, the percentage was 41%. In Chandragiri Municipality, the percentage was 32%, and in Kirtipur Municipality, it was only 17%. The study also revealed 62% reduction in input costs and 32% saving in labor costs for IPM in tomato cultivation under plastic tunnels. In terms of satisfaction, more than 50% of the respondents were in the satisfied group, while only 25% were in the highly satisfied group, and 20% were neutral. Dissatisfaction with IPM practices in the Kathmandu and Bhaktapur districts was found among only 2.5% of the respondents. In conclusion, the study highlights the positive impact of adopting IPM practices on tomato crops in the Kathmandu and Bhaktapur districts. The findings emphasize the economic benefits, reduction in costs, and overall satisfaction among the majority of the farmers who participated in the study.

Ethyl Formate Fumigation against Life Stages of Potato Tuber Moth Infesting Stored Potato Tubers**Dharma Raj Katuwal¹, Kapil Kafle¹ and Kashinath Chiluwal^{2,*}**¹Institute of Agriculture and Animal Science, Kirtipur, Kathmandu, Nepal²National Entomology Research Center, Khumal Complex, Lalitpur, Nepal

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A series of experiments were carried out to assess the appropriate ethyl formate (EF) doses against potato tuber moth (PTM) and to assess its phyto-toxicity on potato tubers. The EF doses for the bioassay in 6-L capacity desiccators against eggs (0, 2, 4, 6, 8 $\mu\text{l}\times\text{L}^{-1}$), larvae (0, 1, 2, 3, 4 $\mu\text{l}\times\text{L}^{-1}$), pupae (0, 2.5, 5, 7.5, 10, 12.5 $\mu\text{l}\times\text{L}^{-1}$) and adults (0, 1, 2, 3, 4 $\mu\text{l}\times\text{L}^{-1}$) were established through preliminary tests in 250 mL flasks. EF lethal concentrations to completely disinfest PTM eggs, larvae, pupae, and adults were 8, 4, 12.5, and 4 $\mu\text{l}\times\text{L}^{-1}$, respectively proving pupae to be the most EF-tolerant (50% lethal concentration, $\text{LC}_{50}=4.40 \mu\text{l}\times\text{L}^{-1}$) stage. Until two months of storage after EF (threshold limit value = 100 $\mu\text{l}\times\text{L}^{-1}$) treatment, no phyto-toxic symptoms were seen on potato tubers exhibiting a good prospect for EF as an effective fumigant against PTM infesting potato in storage.

ABSTRACT

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**Monitoring of Adult Coffee White Stem Borer (*Xylotrechus quadripes*)
Flight Period through Cross Vane Trap at
Coffee Research Program, Gulmi**

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Coffee white stem borer (CWSB) *Xylotrechus quadripes* is a serious pest of coffee. Cross vane traps with xylolure were used to monitor seasonal abundance of CWSB at Coffee Research Program, Gulmi in 2021/22. Daily adult catch in morning and afternoon were recorded at 9 am and 5 pm to identify the flight activity of CWSB adult. The adult CSWB catches in morning and afternoon was found significantly different in October ($\chi^2=7.0$, $P=0.008$), November ($\chi^2=9.0$, $P=0.002$), June ($\chi^2=5.06$, $P=0.024$) and July ($\chi^2=4.0$, $P=0.045$). Similarly, CWSB adult catches in morning and afternoon was not significantly different in March, April and May. The CWSB adult flight was not observed in August, September, December, January and February. The CSWB peak flight activity was found in June (67.36%) during May 2021 to April 2022. Thus, flight activity result will be useful for the development of integrated management strategies of CSWB.

Morphometrics and Management of Chinese Citrus Fly, *Bactrocera minax* (Enderlein) (Diptera: Tephritidae) in Kathmandu**Bidhika Basnet^{1,*}, Debraj Adhikari², Ashmit Thapa¹ and Subeksha Shrestha¹**¹Himalayan College of Agricultural Sciences and Technology, Kritipur, Nepal²Plant Quarantine and Pesticide Management Centre, Hariharbhawan, Lalitpur

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The study performed at citrus orchard of Chhahari Retreat in Budhanilkantha, Kathmandu, meticulously scrutinized the morphological dimensions of both pupal and adult specimens of *B. minax*, with a focused investigation spanning from March to July 2023. The average pupal length of the Chinese citrus fly was determined to be 9.44 ± 0.10 mm, with a corresponding breadth of 4.33 ± 0.09 mm and weight of 0.051 ± 0.002 gm. Notably, the body length of adult female *B. minax* surpassed that of males, measuring at 13.9 ± 0.20 mm compared to 11.93 ± 0.33 mm for males, while females exhibited broader bodies (3.92 ± 0.06 mm) in contrast to males (3.18 ± 0.05 mm). Furthermore, adult females displayed a wider wingspan (22.21 ± 0.23 mm) relative to adult males (21.36 ± 0.30 mm), along with longer wings (9.22 ± 0.16 mm) compared to males (8.86 ± 0.16 mm). The ovipositor length was determined to be 4.62 ± 0.62 mm. The average adult female and male weight were 0.0228 ± 0.001 and 0.0141 ± 0.002 , respectively. This research underscores significant morphological disparities between male and females. Furthermore, an attempt was made to mitigate this pest through the implementation of an Area-wide Control Program (AWCP), involving the application of a lethal protein bait comprising 25% protein hydrolysate and 0.1% abamectin (Great fruit fly bait), diluted in two parts water and administered through spot application at weekly intervals for 12 consecutive occurrences, spanning from 8th May to 24th July 2023, aimed at safeguarding citrus crops from the ravages of the Chinese citrus fly. Subsequent to the execution of the AWCP, a notable decline in fruit loss was observed, decreasing to a mere 1.24% from the previously recorded 27.68% during the 2023 harvest season. This substantial reduction in overall fruit loss, amounting to a noteworthy 26.44% decrease in comparison to 2022 ($p \leq 0.001$), was effectively attained through the application of targeted protein bait.

Evaluation of Different Weed Management Strategies in Spring Maize in Gauradaha, Jhapa

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Maize is more sensitive to weed infestation during early growth stages as it has steady initial growth rate, no tillering and extensive row spacing, which causes loss of the applied nutrients and decreased crop yield. Eight different weed management strategies (control, cover crops, hand weeding at 15-day intervals, biopesticides, chemical weedicides, black plastic mulch, straw mulch, and small interrow cropping) were evaluated in randomized complete block design with three replications at Gauradaha, Jhapa, Nepal during spring of 2022 with an objective to determine an innovative, efficient, less labor-intensive and most suitable weed management strategy in context of Jhapa. Use of black plastic mulch was recorded to be most effective to reduce weed density throughout growth period. Weed control efficiency (WCE) was significantly higher in black plastic mulching (92%, 90.5%, 97.2%) at 45, 60 and 75 DAS whereas straw mulching recorded significantly higher WCE (80.4%) at 30 DAS. Similarly, significantly lowest weed dry weight of 1.45gm, 1.26gm, 4.60gm and 1.82gm at 30, 45, 60 and 75 DAS were recorded in black plastic mulch treated plot indicating that plastic mulching proved to be the most efficient in controlling weed population and their further growth throughout the growth period of maize.

Weeds Affect the Productivity and Sustainability of Dry Direct Seeded Rice (*Ghaiya Dhan*) in Hilly Districts of Nepal

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Dry direct seeded rice, which is commonly known as upland rice and locally *Ghaiya dhan* in Nepal, was the potential crop for food security in the hills of Nepal. The area and production under this upland rice had reduced drastically in the present decade. Survey study was carried out during 2023 at different locations of Sindhupalchowk, Dhading, Tanahun and Gorkha districts. The average field size ranges from 0.05 to 0.4 hectares. Common varieties used by farmers were local land races viz., *Chhote*, *Thatar*, *Tauli*, *Chobo*, *Gorkhali*, *Himali*, *Makwanpure*, *Aapjhute* and one improved variety Sukha dhan -2. The rice is sown during Chaitra -Baisakh with seed rate of 80 –100 kg/ha. Mostly organic manures are used for plant nutrition with rarely synthetic fertilizers. Weeds are managed by carrying out 3 weeding and one hoeing by *daade*. Weed is the major constraints and common weeds are *Cyperus rotundus*, *Ageratum conyzoides*, *Eleusine indica*, *Commelina sp.*, *Digiteria sp.*, *Bracharia sp.*, *Spilanthus sp.*

**Biology of Cowpea Aphid *Aphis craccivora* (Koch)
Under Protected Condition****Samikshya Khanal¹@ and Resham Bahadur Thapa²**¹Ministry of Agriculture and Livestock Development, Bagmati Province, Nepal²Institute of Agriculture and Animal Science, Tribhuvan University, Kirtipur

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Protected cultivation of high value vegetables has shown good potential in Nepal. This technology benefits the growers with the smaller landholdings giving higher productivity and income. However, aphids are the polyphagous pests causing heavy loss even in protected cultivation of crops. Their biology and behavioral studies are necessary before applying any control measures. Therefore, biology of *Aphis craccivora* Koch (Aphididae: Hemiptera) was studied under protection condition. *A. craccivora* were reared on cowpea plants grown on plastic pots of dimension diameter 15" inches × 20" inches. Individual *A. craccivora* were placed on each plant on pot for their colony development. They were reared on a total of 55 pots during the study period. Nymphal period was found 4.88 ± 0.53 days with duration of 32.3 ± 7.54 , 25.6 ± 4.11 , 26.0 ± 2.61 , and 32.8 ± 2.20 hours for the development of Ist, IInd, IIIrd, and IVth nymphal instars, respectively under protected condition in a temperature range of 26.7°C to 29.2°C . Regression analysis revealed that temperature and relative humidity explained 78.9% of change in nymphal period of *A. craccivora*. Hence, biological and behavioral studies are useful to understand growth, development and population buildup of aphids and follow up their eco-friendly management under protected conditions.

ABSTRACT

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Efficacy of Different Treatments against Fruit Fly (*Zeugodacus cucurbitae* Coquillett) on Summer Squash in Rampur, Chitwan, Nepal**Nanda Kishor Singh^{1,*}, Resham Bahadur Thapa²,
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Summer squash is a vegetable with huge nutritive and economic benefits. However, it is vulnerable to economic damage by many insects. Cucurbit fruit fly (*Zeugodacus cucurbitae* Coquillett) is one of them. The irrational use of chemical pesticides for control of pests has become a threat to human health as well as the ecosystem. An alternative method is felt necessary. Therefore, a two factorial experiment was designed to determine the efficacy of various pesticides against cucurbit fruit fly on two different varieties (Black Beauty and Sunny House) of summer squash. Five treatments consisted of i) *Trichoderma* (10ml/l) ii) Neemix (2ml/l) iii) Emamectin benzoate (5g/151), iv) Malathion (0.5%) + Mollasses (5gm/l) and v) control (water). The results revealed that Emamectin benzoate treated plots showed the highest reduction of fruit flies followed by Malathion, Neemix and *Trichoderma* spp. The infestation of cucurbit fruit fly was lower in Black Beauty as compared to Sunny House. While, Malathion resulted in lower damage of fruits in Black Beauty. The lower damage of unopened flower and higher total number of marketable fruits was obtained with Multineem followed by Emamectin benzoate and Malathion sprays. Neemix also showed as a promising treatment against cucurbits fruit flies. Hence, this study elucidates that Emamectin benzoate followed by Malathion (0.5%) + molasses 5gm/l could be suggested for effective control of cucurbits fruit flies under Chitwan condition.

Thematic Session II

SPS and Pesticide Management

(Invasive and trans-boundary pests, SPS, quarantine issues,
pesticide, toxicology, biological pesticides)

Leaf-dip Bioassay of Insecticides for the Fall Armyworm, *Spodoptera frugiperda* J. E. Smith Larva Management in Laboratory Condition, Chitwan, Nepal

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Fall armyworm (*Spodoptera frugiperda* J. E. Smith, 1797) is a polyphagous and voracious agricultural pest and is a major production threat to maize and sweetcorn worldwide including Nepal. This pest has more than 353 plant hosts with a particular crop family of Poaceae, Fabaceae and Asteraceae. In Nepal, this pest has been noticed for the first time in Gaidakot, Nawalpur district on 9th May 2019, which causes a loss of 20-35 % in maize crops. The late stages larva feed voraciously to almost all plant stages of maize. Insecticides are commonly used to manage this pest. Several synthetic chemicals are recommended to control this pest but their level of efficiency varies according to season, crop stage, and geographical location. Hence, the laboratory study was performed to evaluate the efficacy of common chemicals such as Chlorantraniliprole 18.5% SC, Emamectin benzoate 5% SC, Spinetoram 11.7% SC, Spinosad 45% SC, Neem-based pesticide (Azadirachtin 1500 ppm), Malathion 50% EC, Chlorantraniliprole+ lambda-cyhalothrin 0.15% ZC and control (water spray). This laboratory experiment was carried out in a completely randomized design with eight treatments and four replications. Cohorts of second-instar larvae were used for laboratory bioassay. The number of dead larvae was counted at 12-h, 24-h, and 48-h after leaf-dip bioassay. Population reduction over control (PROC %) was then calculated from the obtained data. Greater population reduction over control was recorded by Spinetoram 11.7% SC (90%) followed by the treatment Chlorantraniliprole+ lambda-cyhalothrin 0.15% ZC (86%) in 12 hours of treatment application. Chlorantraniliprole 18.5% SC was less effective since larval mortality was only 10% in 12 hours of treatment application. Spinetoram 11.7% SC and Chlorantraniliprole+ lambda-cyhalothrin 0.15% ZC were found effective for the FAW larval population reduction over control (>90%) in 24 hours followed by Emamectin benzoate (70%). Lower population reduction over control was

ABSTRACT

recorded on Azadirachtin 1500 ppm (< 45%) within 24 hours of application. But within 48 hours of treatment application, all chemicals except Azadirachtin 1500 ppm and Malathion show 100% mortality of FAW. Such information is important to the maize growers to select the right insecticides for the control of FAW in maize crops.

Tomato Varietal and Insecticidal Screening against Whitefly (*Bemisia tabaci* Genn) Under Polyhouse Condition**Sudeep Kumar Upadhyay^{1,*}, Kashinath Chiluwal¹ and Bikash Bhusal²**¹National Entomology Research Centre, Khumaltar, Lalitpur, Nepal²National Agriculture Genetic Resource Centre, Khumaltar, Lalitpur, Nepal

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Whitefly (*Bemisia tabaci* Genn) is a serious vector pest of tomato viral diseases. Eight commercial varieties including Pusa Ruby as a check were subjected to varietal screening tests and insecticidal screening taking the most susceptible variety, Pusa Ruby were carried out in 2020 and 2021 under polyhouse condition at Khumaltar, Lalitpur, Nepal. Pusa Ruby was again proved to be the most susceptible variety for *B. tabaci* as it harbored the highest number of both nymphs ($F_{7, 16} = 7.81$, $p \leq 0.01$) and adults ($F_{7, 16} = 10.77$, $p \leq 0.01$). In insecticidal screening tests, all the potential insecticides such as Neemex, *Verticillium leucanii*, Imidacloprid, Spiromecifen, Nitanpyram and Thiomethoxame were found equally and highly significantly effective as compared to the control during both the study years. This study suggested to consider the tested insecticides of their commercial formulation and claimed application doses for the management of *B. tabaci* in tomato plants.

Suitability of Plant Species in Tailored Flower Strips for Development of Pest Insect, Alternative Hosts and Natural Enemies

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A banker plant system with the parasitoid *Encarsia tricolor* provided with *Trialeurodes vaporariorum* as alternative host on *Cucurbita maxima* (Hokkaido squash) was found promising in biological control of cabbage whitefly *Aleyrodes proletella* in Germany. Flower strips are another important conservation biological control strategy in the field. A tailored flower strip “Hannover-Mix” was specifically developed to promote natural enemies against cabbage pests. Combining the tailored flower strip with the banker plant system could be a sustainable strategy to control multiple pests of *Brassica* crops. This study investigated ability of the three whitefly species, *A. proletella* and two alternative *E. tricolor* hosts, *T. vaporariorum* and *Aleyrodes lonicerarum* to colonize plant species of “Hannover-Mix” and ability of *E. tricolor* to parasitize *A. proletella* and *T. vaporariorum* on selected plant species of “Hannover-Mix” under laboratory condition. The ability of *A. proletella* and *T. vaporariorum* to colonize selected plant species of “Hannover-Mix” was further investigated under field conditions. Results showed that many of the tested flowering plant species were potential hosts to the tested whitefly species. The evaluation of the *E. tricolor* performance on seven whitefly-plant combinations revealed that *E. tricolor* can parasitize the whitefly nymphs (*A. proletella* and *T. vaporariorum*) irrespective of the host plants. But, the number of adults *E. tricolor* developed from *A. proletella* nymphs were higher and larger than those developed on *T. vaporariorum* nymphs. Under field condition, *T. vaporariorum* and *A. proletella* both colonized the respective main host plant kept in flower strip plot far more compared to the tested two plant species (Coriander and Persian clover). In conclusion, the plant species of “Hannover-Mix” might be the potential host for the alternative host whitefly and *E. tricolor* of the banker plant system.

Pesticide Use and Development of Pesticide Resistance in Nepal**Pratishtha Adhikari**Agriculture and Forestry University, Chitwan, Nepal
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In the context of Nepal's expanding vegetable production prompted by the development of local market centers and road corridors, the surge in agrochemical use, particularly fertilizers and pesticides, is noteworthy. In the fiscal year 2021/22, Nepal imported 1135.50 tons of pesticides, with fungicides comprising 46.63%, insecticides 32.60%, herbicides 19.90%, and others 0.86%. Despite pesticides being widely acknowledged for their ease of use and immediate effectiveness in reducing crop losses caused by pests and diseases, their misuse has emerged as a significant concern. Overuse of broad-spectrum pesticides by farmers has led to pest adaptation and resistance. Pesticide resistance, characterized by a diminished response of pest populations due to prior exposure, represents an accelerated evolution. The selection pressure on the pest is initiated with repeated use of pesticides. Farmers often exhibit brand loyalty, choosing the same product year after year due to comfort with both the product and the selling dealer. Despite several registered products being available, limited choices, coupled with factors such as cost, application convenience, and speed of action, influence farmers' purchase decisions. The restricted number of pesticide classes further contributes to the ongoing and repeated use of specific chemicals or classes of chemicals shedding light on the critical link between pesticide application practices and the escalating issue of resistance in Nepal's agricultural system.

Management of Root Rot (*Rhizoctonia solani* Kühn.) of Common Bean Using Host-Resistance, Consortia of Chemicals and Biocontrol Agents in Nepal

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Rhizoctonia root rot and web blight caused by *Rhizoctonia solani* Kühn is one of the destructive diseases of beans. Experiments were conducted to evaluate the common bean landraces and genotype, bio control agents and chemical fungicides against the pathogen. Nine landraces of common bean from Jumla and one genotype from Chitwan were evaluated for resistance against the pathogen under screen house and field conditions. All landraces and genotype were found highly susceptible to the pathogen whereas the highest lesion length (3.02 cm) was measured in the Rato Male Simi followed by Rato Sano Chhirke Simi (2.40 cm) at Chitwan condition. Chemical fungicides such as SAAF (carbendazim 12%+mancozeb 63% WP), Vitavax (carboxin 37.5%+thiram 37.5% DS) and Nativo (tebuconazole 50%+trifloxystrobin 25% w/w (75 WG) and bio control agents such as *Trichoderma viride* (10⁹ cfu/ml), *Pseudomonas fluorescens* (10⁹ cfu/ml) and *Bacillus subtilis* (10⁸ cfu/ml) were evaluated as seed and soil treatment in different combinations against *R. solani*. SAAF and Vitavax were found highly effective as they completely checked the incidence of pre-emergence damping-off. Similarly, SAAF was also equally effective followed by Vitavax and Nativo in controlling post-emergence damping-off. On the other hands the highest disease incidence (26.63%) was recorded in the treatment where seeds were treated with *Pseudomonas fluorescens* formulation @ 10 g/kg of FYM slurry along with soil application with *Pseudomonas fluorescens* formulation @ 10 kg/ha with 50 kg FYM, whereas the lowest disease incidence (4.96 %) was recorded in treatment where SAAF was used as seed and soil applications. Highest grain yield (4125 kg/ha) was recorded where Nativo: Seed treatment @ 1.5 g/kg + Soil drenching @ 1.5 g/L was used. Thus, it can be concluded that the best control for pre-emergence damping-off was obtained by SAAF: Seed treatment @ 2 g/kg + Soil drenching @ 2 g/L) and Vitavax: Seed treatment @ 2 g/kg + Soil drenching @ 2 g/L) while best control of post-emergence damping-off was achieved with

ABSTRACT

combination of seed and soil treatments with SAAF: Seed treatment @ 2 g/kg + Soil drenching @ 2 g/L). There was no incidence of web blight throughout the growing period. Our findings could be useful in devising strategies for the integrated management of *R. solani* causing root rot disease in beans.

Chemical Pesticides Management in Nepal: Pesticide Quality Control

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Chemical pesticides are essential in the agriculture production for protecting crops from weeds, diseases and insect-pests. Additionally, they are important in management of animal and household pests as well as vector-borne diseases of human. A total of 138 technicians have been registered and 11,35,328 kg a.i. chemical pesticides have been imported during fiscal year 2021/22 in Nepal. Nepal consumes a relatively small amount i.e., 396 g a.i. of pesticides per hectare on an average compared to other countries. Despite this, chemical pesticides induced risks to human health and the ecosystem remain still high and reasons behind this are sub-standard as well as counterfeit products available in the market, improper handling, haphazard use and careless application. Here, we discuss many facets of managing chemical pesticides including regulatory framework, pesticides usage and necessity of pesticides formulation analysis in Nepal. The highlights regarding the urgent need of a laboratory to the analysis of pesticides formulation to ensure the efficacy and quality products used for effective pest control with the protection of human health, non-target organisms, bio-diversity and the environment. Therefore, it is crucial to have a specialized laboratory with top-notch technology and trained personnel in order to appraise and analyze the quality of chemical pesticides in the country.

Virus Testing in Seed Potato Certification in Nepal: Where We are and What Can We Do?

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Viruses are a major concern in seed potatoes globally, which need to be certified for virus-free before marketing. The seed cycle of pre-basic seed (PBS) of potatoes is not maintained appropriately in Nepal due to a lack of designated virus testing facilities, which impacts the national demand and supply of PBS. Double Antibody Sandwich Enzyme-Linked Immunosorbent Assay (DAS ELISA) is being employed to test the six major viruses (*PLRV*, *PVX*, *PVY*, *PVS*, *PVA* and *PVM*) in pre-basic seed produced by the Nepal Agriculture Research Council in Nepal. However, virus testing and indexing using ELISA is becoming persistently challenging due to lack of skilled human resources, access to antibodies, and lack of government focus. To improve high throughput detection of major concern potato viruses we established one tube-one step RT-PCR protocol for the detection of five potato viruses concurrently. We collected potato leaf samples having virus-like symptoms from different parts of the country, extracted RNA and transcribed to cDNA. We employed five primer pairs: PVAF, PVAR, PVXF, PVXR, PVYF, PVYR, PLRVF, PLRVF, PVSF, PVSF in multiplex RT-PCR for five virus RNA amplification. We detected five viruses in single or in combination in different samples. The protocol concurrently could amplify cDNAs from *Potato virus A*, *PVX*, *Potato virus Y*, *Potato leaf roll virus*, and *Potato virus S*. The current protocol could detect all or individual viruses in different combinations. This could be the first attempt to detect multiple potato viruses in a single PCR reaction in Nepal. PCR-based assays are getting due priorities than ELISA in virus testing due to the decreasing cost of the PCR reagents, wide availability of primers, increasing access to PCR facilities, higher sensitivity, specificity, and repeatability of the PCR tests compared to ELISA. The current protocol could be useful in establishing molecular marker-based rapid, reliable, and accurate virus testing facilities for strengthening seed potato certification in Nepal.

Evaluation of Biorational Products in Management of *Cucumber Mosaic Virus* in Tomato**Ram Bahadur Khadka[@], Bimala Pant, Shrinkhala Manandhar and Suraj Baidya**National Plant Pathology Research Center, Khumaltar, Lalitpur
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Plant viruses are considered the most emerging group of plant pathogens with almost no control measures available. The incidence of *Cucumber mosaic virus* is increasingly becoming a challenge for tomato growers in mid-hill regions of Nepal, especially in high tunnel conditions in the summer rainy season. Experiments were conducted to manage the *CMV* in tomato plants in three consecutive years between 2021-2023. The experiments were conducted in split plot design where cultivation conditions (adjacent open field and net house) were the main plot factor and six to seven commonly available biorational products were subplot factors. The subplot factors were Antivirus, Lentinan, Prevental, Vircon H, dimethoate, cow urine, jholmal, and water. Each treatment was replicated three times. Seedlings were grown in plastic trays under virus free greenhouse. Application of treatments were started immediately after planting and continued until seven weeks at weekly intervals. All biorational products were applied as prescribed by the manufacturers. Jholmal was prepared locally and applied at 1:10 ratio with water. In control treatment water was sprayed. Disease incidence and severity were started recording after 21 days of transplanting in 15 days intervals. The symptoms were confirmed using *CMV*-specific immunostrips. The area under disease progressive curves were significantly lower in tomato plants grown in net house compared to open fields irrespective of the treatment. The AUDPC was not significantly different within the treatments. The results indicate the low efficacy of commonly available biorational products in *CMV* suppression. However, following clean planting techniques such as raising seedlings under a virus-free net house and row cover with an appropriate net could be applied to manage *CMV* in the summer rainy season in mid-hill regions of Nepal.

In vitro* Antagonistic Activity of *Trichoderma* species against Agriculturally Important Plant Pathogenic Fungi*Surendra B.K.^{1,*}, Jharjhari Chakma¹, Rashila Maharjan², and Satyendra Pratap Singh¹**¹Department of Mycology and Plant Pathology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi 221005, Uttar Pradesh, India²Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi 221005, Uttar Pradesh, India

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Plant pathogenic fungi pose a major threat to agriculture by significantly reducing crop yields. The use of chemical controls on plants presents environmental hazards that can be potentially harmful to humans and other animals. Therefore, the application of biological methods in plant disease control is a more effective and safer alternative. *Trichoderma* species is widely recognized as a prominent biocontrol agent, known for its cost-effectiveness, efficacy, and environment friendly nature. Therefore, present study aims at evaluating the antagonistic behavior of two *Trichoderma* species namely *T. viride* and *T. harzianum*, against six highly problematic plant pathogenic fungi viz. *Curvularia oryzae*, *Bipolaris sorokiniana*, *Phomopsis vexans*, *Fusarium oxysporum* f. sp. *lycopersici*, *Colletotrichum capsici*, and *Alternaria solani* under *in vitro* conditions. Both the *Trichoderma* species displayed significant antagonistic activity against all the tested fungal pathogens in dual cultures, resulting a 7–36% and 13–40% mycelial growth inhibition (MGI) in tested pathogens by *T. viride* and *T. harzianum*, respectively. *Trichoderma harzianum* proved to be the most effective biocontrol agent against the tested fungal pathogens, with *T. viride* following closely behind.

Study on Inoculum Doses of *Corcyra cephalonica* (Stainton, 1866) Eggs for its Efficient Mass Production in Laboratory**Ajaya Shree Ratna Bajracharya[@] and Binu Bhat**

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Rice moth, *Corcyra cephalonica* (Stainton, 1866) is a well-established factitious host for laboratory rearing of different egg parasitoids and predators. The insect is mass produced in ventilated plywood boxes with 2.5 kg of food medium in Nepal. A study was conducted to find an optimum dose of egg inoculum in order to increase production efficiency of this rearing system. Experiments were conducted in completely randomized design on crushed maize charging with 0.5, 0.33, 0.25 and 0.2 cc of egg inoculums at National Entomology Research Center during December 2022 to April 2023. Days to first adult emergence, adult emergence period, total adult and egg produced per box, body length and weight of moth, fecundity per female and 100 egg weight were recorded and analyzed using GenStat Discovery computer application. Days to first adult emergence did not differ significantly recording 54-55 days. The adult emergence period was found to increase with higher egg inoculum recording 63, 62, 49 and 42 days for 0.5, 0.33, 0.25 and 0.2 cc egg inoculums, respectively. Moth production was significantly higher in 0.33 cc (n = 1385) followed by 0.5 cc (n = 1169), 0.25 cc (n = 877) and 0.2 cc (n = 825) inoculums. Egg production was significantly the highest in 0.33 cc (n=75539) and the remaining 0.5 cc (n = 71801), 0.25 cc (n = 72815) and 0.2 cc (n = 71801) were at par. The body length and weight of moths were found to decrease with increase in inoculum size, and female moths were recorded bigger than male. The fecundity per female was the highest in 0.25 cc (n = 371), followed by 0.2 cc (n = 363), 0.33 cc (n = 271) and 0.5 cc (n = 260). The 100 eggs mass did not differ among treatments recording 35-36 mg. The inoculum dose of 0.2 cc egg appeared to be suitable for efficient mass production of *C. cephalonica*.

**Exploring Insect Parasitoids of Fall Armyworm
(*Spodoptera frugiperda* J.E. Smith) in Nepal**

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The fall armyworm (FAW) (*Spodoptera frugiperda*, J.E. Smith) (Lepidoptera: Noctuidae), poses a significant threat to maize production worldwide, including Nepal where it was first reported in 2019. It did cause panic among farmers in spite of awareness workshops, news releases, and communications conducted well ahead of its invasion in Nepal. Earlier, the Government of Nepal formed a fall armyworm Taskforce to address this problem. Previously, monitoring the spread of FAW and crop losses estimation were given priority, however, it was soon realized that long-term sustainable management of this pest was utmost important. Subsequently, the integrated pest management (IPM) was recognized to offer the effective, economical, sustainable and safety for human and environmental health, and socially acceptable solution. Biological control is a major component of IPM and its basic approach is to first identify local natural enemies of the pest before exploring into classical, augmentative or conservation biological control. Indigenous natural enemies are the frontline defenders of an invasive pest. A review as well as initial field survey was conducted to assess and document the global situation of biological control with a focus on Nepal for the exploration of insect parasitoids as a key component of IPM practices targeting FAW infestations in maize fields. Initial surveys revealed presence of an indigenous egg parasitoid, *Trichogramma chilonis* (Hymenoptera: Ichneumonidae) and a fortuitously introduced egg parasitoid *Telenomus remus* (Hymenoptera: Scelionidae) attacking the eggs of FAW. Here we present a summary of the findings from previous studies and the initial field survey on the FAW parasitoids.

Parasitising Efficiency and Biological Traits of *Telenomus remus* on Single and Multi-layered Eggs of Fall Armyworm, *Spodoptera frugiperda*

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Fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) is an invasive polyphagous and voracious agricultural pest. This trans-boundary pest was first reported in Africa outside its native American range which later spread to Asian and Pacific regions. It has gained resistance to many of synthetic insecticides. Therefore, deployment of biological control agents is only option for sustainable and healthy crop production system. This study was conducted to determine the biological efficiency of single pre-mated female *Telenomus remus* (Hymenoptera: Scelionidae) on single and multi-layered egg of fall armyworm. *T. remus* was reared in its natural host *S. frugiperda* for which the experiment was conducted in controlled conditions at 26 ± 1 degree Celsius, 65 ± 5 % relative humidity and 14:10 h light-dark period. The female population of *T. remus* were produced from single egg mass of fall armyworm, fed with pure honey solution and allowed mating for 24 hours after their emergence. The parasitized egg mass was replaced with fresh egg mass until the female were attracted to eggs or their death. Parasitism was non-significant in both types of egg layers (92.42% in single layered and 92.91% in multi-layered egg mass). However, fecundity and abortive egg percent were significantly higher in single layered egg mass (231.1, 39.73 %) as compared in multi-layered (172.8, 34.75 %). In contrast, both the emergence and female-male ratio of offsprings were significant in multi-layered egg mass (63.71 %, 3.12) than single layered egg mass (58.65 %, 2.8). The egg layers of fall armyworm showed variations in sex ratio, fecundity, abortive eggs and emergence. The findings of this research can be useful in mass production of *T. remus* for augmentative biological control of *S. frugiperda*.

**Identification of Invasive Pest, *Thrips parvispinus* Karny, 1922
(Thysanoptera: Thripidae) in Nepal**

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Suspected invasive thrips' samples collected from the thrips infested bell pepper (sweet pepper) (*Capsicum annuum*) plants growing in Khairahani Municipality, Chitwan, Bagmati Province, Nepal were in course of thrips identification, processed preparing slides of thrips using a permanent mounting medium Canada Balsam. Investigating on the morphological characters of the glass slide mounted thrips under a compound microscope revealed the identity of thrips being *Thrips parvispinus* Karny, 1922 (tobacco thrips) (Insect: Thysanoptera: Thripidae). Similarly, the thrips voucher samples collected from the same host plants in the same locality was proceed for DNA barcoding to confirm species identity. The short gene sequences in the classified portion of the thrips genome investigated through DNA barcoding confirmed *Thrips parvispinus* Karny, 1922. This thrips, identified based on both the traditional morpho-taxonomic and gene sequencing, is reported for the first time in Nepal.

Sublethal Effects of Flonicamid on Stage Structure and Growth of *Myzus persicae* (Suzler) Population (Hemiptera: Aphididae)**Sabitri Baral^{1,*}, Resham Bahadur Thapa¹, Ratna Kumar Jha²,
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Life table based computer projection was done to predict the sublethal effects of flonicamid on stage structure and growth of *Myzus persicae* population having parental generation exposed to LC₂₅ dose of flonicamid. Based on the basic data such as the age-stage specific survival rate and fecundity obtained from age-stage two-sex life table analysis, the growth of stage-structured population of *M. persicae* was simulated using initial population structure under two scenarios for two consecutive generations and two conditions: exposed to LC₂₅ dose of flonicamid and not exposed to it. The first scenario started with a newly born nymph and the second scenario started with the youngest female. The results showed that the population growth of *M. persicae* decreased with the exposure of sublethal concentrations of flonicamid. This information provides critical insights for deciding the timing of intervention, and to design pest management strategy and programs for *M. persicae*.

Efficacy of Botanical Extracts, Microbial and Chemical Insecticides against Cowpea Aphid, *Aphis craccivora* Koch of Cowpea under Protected Cultivation

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Aphids are the polyphagous pests causing heavy loss even in protected cultivation of crops. An experiment was conducted on cowpea aphid, *Aphis craccivora* Koch (Aphididae: Hemiptera) to develop an eco-friendly cowpea aphid management strategy with efficacy testing of botanical extracts, microbial and chemical pesticides against *A. craccivora* and their effect on yield attributes of cowpea (*Vigna unguiculata* L.) under protected conditions. Botanical leaf extracts were tested for their efficacy against the third instar nymphs of *A. craccivora*. The treatments were; Neem (*Azadirachta indica* A. Juss.) 10%, Chinaberry (*Melia azedarach* L.) 10%, Tulsi (*Ocimum tenuiflorum* L.) 10%, Fermented cow urine (1:5), *Beauveria bassiana* (Bals.-Criv.) 1.15% WP @ 5 g/L water, Azadirachtin 500 ppm @ 2 ml/L, Cypermethrin 10% EC @ 2 ml/L water along with control (water spray). Chinaberry, Tulsi and Neem leaf extract, resulted in 95.64%, 92.71% and 90.68% mortality of *A. craccivora* at 48 hours after treatment. Fermented cow urine (1:10) demonstrated the highest repellency to adults of *A. craccivora*. In pot experiment, the lowest aphid count per leaf was recorded in the order of Cypermethrin (1.59) < Azadirachtin (1.99) < Neem 10% + Chinaberry 10% + Tulsi 10% + Cow urine 20% (2.025) < Chinaberry (2.1) < Neem (2.21). Chinaberry leaf extract had the highest population reduction (49.46%) followed by Neem (39.76%) on cowpea plants. Yield gain over control was obtained the highest from Cypermethrin (53.48%) followed by Chinaberry (50.63%), Neem 10%+ Chinaberry 10% + Tulsi 10% + Cow urine 20% treated plants (44.62%), respectively. Benefit: Cost ratio of Chinaberry (2.02) and Cypermethrin (2.03) were comparable and Cypermethrin spray resulted in the highest net profit followed by Chinaberry and Neem 10% + Chinaberry 10% + Tulsi 10% + Cow urine 20%. Thus, Chinaberry leaf extract (10%) can be used for eco-friendly management of *A. craccivora* in cowpea under protected conditions.

Impact of National Ban of Highly Hazardous Pesticides on Mortality from Suicide by Pesticide in Nepal

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Intentional pesticide self-poisoning is a public health problem in agricultural communities in LMICs like Nepal. Banning highly hazardous pesticides (HHPs) is a cost-effective intervention to reduce mortality from pesticide suicide. Eight mostly HHPs were banned in Nepal in 2019 while aluminium was reformulated. The objective of the study is to monitor the impact of the ban on pesticide suicide numbers and the agriculture yields. We analyzed autopsy data from August 2021 to January 2024 from the National Forensic Science Laboratory and Nepal Police Central Forensic Science Laboratory following a two-year phase-out period. The pesticide responsible for suicide was identified from laboratory analysis. The findings were compared to data from an earlier study (HOPE GRID 2017-2019) to compare the proportion of compounds involved in pesticide suicide cases. Data on agriculture yields were collected from publications of Ministry of Agriculture and Livestock Development (July 2005 -July 2022). Simple descriptive analysis was undertaken. There were 1,764 pesticide suicides reported by toxicology laboratories, of which 51.3 % were males. The most common pesticides were phosphine gas (48.9%), organophosphorus insecticides (29.1%) and the combination of organophosphorus and cypermethrin (17.9%). In 2021-23, compared to 2017-19, a smaller proportion of cases were the banned pesticides dichlorvos (n=70/1089;6.4% and n=273/450;60%, respectively) and aluminium phosphide (n=304/1089; 27.9% and n=299/891;33%, respectively). The proportion of cases where the pesticide was not identified was missing in 19.3 % of cases, compared to 46% in 2017-19. Analysis of agricultural data indicated that the bans had no impact on agricultural yield. OP insecticides and aluminum phosphide were responsible for most pesticide suicides in Nepal. However, the number and proportion of deaths from these pesticides has declined. There has been an increase in identification of the individual compounds from the forensic science laboratories and more improved data can help guide further pesticide regulation.

Pesticide Residue Analysis of Vegetables Collected from Collection Centre of Different Districts in Nepal and its Correlation with Post-Harvest Parameters

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Pesticides have been challenging the food safety in Nepal regarding its residue in consumable vegetables. Pesticides (carbamate, organophosphate, synthetic-pyrethroid and dithiocarbamate) residues and post-harvest parameters such as Vit C, pH, total soluble solid and titratable acidity were analyzed on bitter gourd, tomato, beans, brinjal, green chilli, cowpea, cucumber, okra, summer squash and sponge gourd from Jhapa, Sarlahi, Kavre, Nuwakot, Bhaktapur, Dhading and Kailali districts using a reagent-kit method. Seventy one percent of samples were detected with synthetic pyrethroid followed by 25% of dithiocarbamate, 3% of organophosphate and 0% of carbamate. Two percent of samples found at hazardous level of organophosphate, while 50% of synthetic-pyrethroid, and 2% of samples of dithiocarbamate were detected unsafe. In bitter-gourd, Vit C had significant ($P=0.05$) correlation with dithiocarbamate followed by synthetic-pyrethroid ($P=0.05$) with titratable acidity in brinjal, -0.54 between Vit C and dithiocarbamate on cucumber and $+0.67$ between dithiocarbamate and pH in summer-squash. It was found that the vegetable with the pesticide residue has differential effect on the different parameters like pH, nutrient content and vitamin content. This study suggests further research in the validation and assessment of residue-nutrition correlation.

ABSTRACT

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Pesticide Regulations that Protect Health: Practical and Policy Experience from the Centre for Pesticide Suicide Prevention

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This talk will highlight CPSP's experience of supporting science and policy to regulate pesticides to minimize health effects, including poisonings and suicides. I will talk about the role of pesticide regulatory systems in restricting means to suicide and the conditions for regulatory success. CPSP has been working with many countries where pesticide ingestion is used as means of suicide, including Nepal. The talk will highlight the elements of the pesticide regulatory system that address pesticide poisoning and other harm to health. It will also focus on the elements of legislation and policy that promote compliance with regulations. It will draw on the study of pesticide regulations and regulatory compliance in Nepal as well as other countries. It will be of interest to practitioners and decision-makers in Nepal working in pesticide management.

Screening of Suitable Chemical Insecticide for the Management of Red Pumpkin Beetle on Laboratory Assay

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Red pumpkin beetle (*Aulacophora foveicollis* Lucas, Chrysomelidae: Coleoptera) is considered as the most destructive insect pests of cucurbitaceous crops. Generally, different conventional insecticides have been used for its management in Nepal. However, very few experiments have been conducted for the management of red pumpkin beetle in Nepal. Therefore, in this experiment we evaluated different insecticides, namely Emamectin benzoate, Chlorpyrifos, Chlorantraniliprole, Chlorfenapyr, Imidacloprid, and Azadirachtin by feeding method on both male and female with 10 and 21 replications, respectively. Data were recorded at 12-hour interval for up to 288 hours of experiment. We found a higher mortality rate with Imidacloprid and Chlorpyrifos, followed by Chlorfenapyr, for both sexes. Thus, Imidacloprid or Chlorpyrifos could be used for the management of red pumpkin beetle. However, precautionary measures should be taken before applying them, and waiting period should be maintained before harvesting.

Study on the Effect of Household Washing Agents on Pesticide Residue on Spiked Vegetable Commodity**Anil khalan^{1,*}, Dinesh Bhatta², Prakash Ghimire³ and Prayash Adhikari⁴**^{1,2,4}Agriculture and Forestry University (AFU), Chitwan Nepal³Plant Quarantine and Pesticide Management Centre (PQPMC), Lalitpur Nepal

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The absence of a comprehensive mechanism to adequately monitor pesticide residues in agricultural products could potentially expose consumers to harmful levels of pesticide-contaminated food. This research was conducted at the Rapid Bioassay for Pesticide Residue (RBPR) Lab, Kalimati, Kathmandu and National Horticulture Research Centre, Lalitpur to access the efficacy of different household washing agents in reducing pesticide residues in spiked vegetables. Tomato, cowpea, broadleaf mustard and bitter melon were spiked with different commonly used pesticides belonging to groups of organophosphates, synthetic pyrethroid and dithiocarbamate, and the change in pesticide residue after being washed with different washing agents (tap water, common salt, sodium carbonate, sodium bicarbonate, acetic acid and hot water at 80°C) were studied. Analysis revealed that washing vegetables with hot water was the most effective in reducing the pesticide residue where pesticide levels were reduced by 87, 100, and 100 % in organophosphate, synthetic pyrethroid and dithiocarbamate, respectively. In term of the effectiveness, the hot water treatment was followed by acetic acid which reduced most of the washed samples below maximum residue limit of organophosphate by 67%, dithiocarbamate and synthetic pyrethroid both by 87%. Application of tap water was the least effective in reducing the pesticide residue level in vegetable. Vegetables washed with hot water reduced Vit C by 27% and total soluble solid by 58%, and while washed with acetic acid the pH (9.3%) and titrable acidity (16.1%) changes were significant where acetic acid caused a slight acidification of vegetables after being washed. This study suggests that use of acetic acid as washing agent in vegetable gives a best result in the context of both pesticidal residue reduction and nutrient retention.

Comparative Extraction of Insecticidal Plant Essential Oils Using Thermal Heating and Hydro-Distillation Methods

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Hydro-distillation, a conventional method of entomocidal essential oil (EO) extraction was compared with the traditional thermal heating (Chulho) method practiced in Karnali Province, Nepal based on the time required and amount of extraction, and the relative amount of the EO components subjected to GC coupled with MS (GC-MS) of the wooden part of Himalayan cedar, *Cedrus deodara*. Chulho method required ~3 h and yielded 35±3% of the extract in contrast to the requirement of ~4 h for hydro-distillation to acquire only 0.9±0.3% of the extract. Hydro-distillation yielded β -Himachalene (21.95%), α -Himachalene (11.87%), (*E*)- α -Atlantone (15.02%) and Italicene (5.49%). In contrast, Chulho method resulted in (*E*)- α -Atlantone (25.81%), β -Himachalene (12.05%), (*E*)- γ -Atlantone (7.02%), (*Z*)- α -Atlantone (6.19%), Deodarone (5.73%) and α -Himachalene (5.21%). The EO extracted through Chulho method had the true natural aroma with the cleaner properties (no use of solvents and the resultant residuals) which is certain to gain research attention for the extraction of entomocidal EOs.

Thematic Session III

III. Industrial Entomology and Mushroom Farming: (Apiculture, Sericulture, Lac culture and Mushroom cultivation, Insect as food and feed, pollinators)

**Perception of Non-keepers towards Bee Forage (Mustard field) for
Apis mellifera Linnaeus, 1758: A Case of Khairahani Municipality,
Chitwan**

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Beekeeping has been practiced in Nepal since time immemorial. It is one of the key enterprises with the potential to generate income and employment in the terai, high, and mountain districts of Nepal. Bees, especially *Apis mellifera* Linnaeus, 1758 are migrated from one place to another, from one district to another for forage in Nepal. Despite this fact, while carrying out these practices of bee migration for forage beekeepers suffer from many difficulties in the forage area where migrated bees are kept. The study analyzes the perception of non-keepers towards bee forage (Mustard field) in Chitwan district using a simple random sampling of 30 respondents from Khairahani Municipality Ward No. 7. The survey was conducted in the last week of November 2023. Data obtained from a semi-structured questionnaire were subjected to descriptive analysis. 53.33 percent of non-keepers in that locality know about the benefits of bees to the mustard crop. But 46.67% of non-keepers have a common understanding that bees are kept normally for honey production rather than pollination services. Most non-keepers perceived that beekeeping was the business of beekeepers for honey production rather than other services. Some of the respondents were also of the opinion that bees sucked the nectar of crops and decreased their yield in the study area. For non-keepers, developing awareness about the importance of bees in the ecosystem is essential through mass media (FM, radio, Facebook, television, etc.). This paper indicates that there should be strong and helpful coordination among non-keepers, beekeepers, and related organizations for the sustainable development of the bee sector in Chitwan district.

**An Overview of Bee Keeping in Rupandehi District,
Nepal over Seven Years****Dipak Khanal¹@, Rabin KC¹, Shankar Neupane¹ and Utkal Sapkota**¹Paklihawa Campus, Tribhuvan University, Paklihawa, Rupandehi, Nepal.

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Bee keeping is a high-value income-generating agricultural activity in Nepal. However, there is a lack of intensive information related to bee keeping. We conducted a comparative study among the beekeepers in 2014 and 2021 to assess the status of bee keeping in a gap of seven years in Rupandehi district. The result revealed a slight increase in honey production averaging 21.35 and 25.45 kg/year/hive in 2014 and 2021, respectively. The average number of beehives per beekeeper increased from 39 in 2014 to 42 in 2021. We report that primary bottlenecks to beekeeping are lack of foraging area, pesticide poisoning, pests, diseases, and lack of government subsidiary. The lack of foraging area was mainly attributed to rapid population growth and unplanned urbanization. The problem of pesticide intoxication was worst during 7 years in the study area. Governmental incentives to beekeepers, and stricter rules on pesticide application could encourage beekeepers to get involved in beekeeping. Rigorous documentation on beekeeping can help to realize the potential of honey production, and to come up with efficient mitigation measures towards problems associated with beekeeping.

**Diversity and Abundance of Insect Pollinators of
Kiwifruit in Dolakha District, Nepal****Ram Chandra Gouli[@] and Bishnu Prasad Neupane**

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Kiwifruit is a pollination-dependent dioecious vine. Insects are the primary agents for its pollination. The diversity and abundance of insect pollinators of the kiwifruit at the Temperate Fruit Rootstock Development Center, Boch, Dolakha during its full-bloom was assessed using sight-count method. One hundred flowers of ten randomly selected plants were observed at hourly intervals from 09:00-14:00 each day in the third week of May during 2019 and 2020. The major pollinator fauna were nine species from three different orders. Hymenopterans (55.6%) outnumbered to all the families followed by Dipterans (33.3%) and Lepidopterans (11.1%). Hymenopteran genus *Apis* and *Bombus* were the most dominant pollinators of kiwi-fruit. The highest number of the insect pollinators were observed during 9:00-10:00 am dawn followed by 12:00-13:00 pm noon, thereafter the pollinators' activity declined with time of the day. The pollinators' dynamics reported in this study helps to consider their ecological roles while adopting other pest-insect management strategies of kiwifruit.

Propolis: Its Sources and Uses**Prakash Neupane Jaisi¹*, Min Raj Pokhrel²*, Robert Owen³ and Khem Raj Neupane⁴**¹ Faculty of Agriculture, Agriculture and Forestry University, Chitwan, Nepal² Department of Entomology, Agriculture and Forestry University, Nepal³ Melbourne University, Victoria, Australia⁴ Gorkha Honey and Honeybee Products, Bharatpur, Chitwan, Nepal
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Propolis is bee glue made from plant resin mixed with bee wax, saliva and enzymes. Plants produce resin as a defense mechanism against pathogens, herbivores and environmental stressors containing compounds that deter feeding, inhibit microbial growth, seal wounds, and provide structural support. The collection and utilization of propolis, mainly observed in the European honeybee (*Apis mellifera* L.), extends to other bee species such as the rock bee (*A. dorsata*), dwarf honeybee (*A. florea*), and stingless bees, including *Meliponine*, all of which gather and use it for diverse purposes. The honeybees use propolis in hive, maintenance, defense against intruders, pathogen protection, virus inhibition, oral hygiene enhancement, detoxification, regulation against environmental stressors such as extreme temperature. We, humans, have been using propolis since ancient times for its therapeutic benefits, including wound treatment and disinfection. In modern times, propolis is utilized for its broad pharmacological activities, such as anti-bacterial, anti-viral, anti-inflammatory, anti-cancer, and anti-oxidant effects, while also being incorporated into skincare products and cosmetics, and is viable commercial beehive product. However, there is limited research and few reviews on the plant species that honeybees use as a source of propolis. This review paper provides a synthesis of global plant species from which bees collect resin to make propolis, along with probable plant sources of resin for propolis in Nepal.

Effect of Queen Cell Cup Types on Graft Acceptance and Queen Bee Emergence in *Apis mellifera* L.**Anisha Poudel¹, Min Raj Pokhrel^{2*}, Govinda Pokhrel³ and Robert Owen⁴**¹College of Natural Resource Management, Puranchaur, Kaski, FoA/AFU, Nepal²Department of Entomology, AFU, Rampur, Chitwan, Nepal³Department of Agriculture, Bagmati Province, Hetauda, Makawanpur, Nepal⁴Sagar Mauri Ghar, Gaidakot, Chitwan, Nepal

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A study was conducted at the Beekeeping Development Center in Bhandara Chitwan district from April to June 2023 to assess the effectiveness of various cup materials and their impact on larval acceptance and resulting queen bee quality. The experiment was laid out in a Randomized Complete Block Design with five replications and four treatment groups: bee wax (T₁), paraffin wax (T₂), mixed bee wax and paraffin wax (T₃), and plastic cups (T₄) as queen cell cup materials. Two-day-old larvae were grafted onto 100 cups and acceptance rates were checked after 72 hours, while queen quality was assessed post-emergence. Results indicated that mean larval acceptance was significantly highest in T₁ throughout the three months (April:4.6, May:4.8, June:4.8) while T₂ exhibited the lowest acceptance rates; T₄ and T₃ showed moderate acceptance levels. Also, queen bees reared in bee wax cups displayed greater body weight (176.6mg) and length (1.94cm) in April, along with significantly higher mean emergence numbers (April:4.4, May:4.6, June:4.2), compared to T₂, T₃, and T₄. Study reveals that bees exhibit a preference for bee wax cell cups over synthetic cups for queen rearing in European honey bees during the spring season resulting in higher quality bees.

Pollination Methods for Watermelon, *Citrullus lanatus* (Thunb.) Fruit Setting and Yield

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Pollination is an essential ecosystem service to sustain food security. Human-made agroecosystems led pollinators to decline, which ultimately reduced fruit setting and the yield of watermelon production. A field experiment was conducted at Manahari Rural Municipality, Makawanpur from March to July 2023 to study the effect of pollination methods on the fruit setting and yield of two watermelon varieties. The experiment was laid out in a two-factorial randomized complete block design (RCBD) with first-factor as watermelon varieties (Saraswati and Vishala) and second-factor as pollination methods (bee pollination, hand pollination, open pollination, and control), which were replicated three times. The data regarding the foraging activity of domesticated bee pollinators (*Apis cerana* F. and *Apis mellifera* L.) in open field conditions and yield-attributing parameters from the experimental plot were recorded. In open field conditions, *Apis mellifera* L. recorded the highest abundance (5.12 bees/m²/5 min.), foraging speed on male (5.14 second/flower), and female flower (6.17 second/flower) while *Apis cerana* F. recorded the highest foraging rate (9.31 flowers per bee per minute). The foraging activity was more active in the morning hours (8–10 am) as compared to midday (12–2 pm) and evening hours (4-6 pm) for both bee species. From the experimental plot, variety Saraswati recorded the highest number of fruits per plant (2.52), fruit girth (14.45 cm), fruit weight (1.82 kg), seeds per fruit (122.53), and yield per plant (4.91 kg), while the highest fruit length (18.58 cm) and 1000 seed weight (49.37 g) was recorded in Vishala variety. The highest fruit set (74.51%), number of fruits per plant (3.15), healthy fruit (84.83%), fruit girth (15.81 cm), fruit weight (2.21 kg), seeds per fruit (141.04), and yield per plant (6.98 kg) were recorded in bee-pollinated plots. The result suggests that the use of *A. mellifera* bees in the pollination of watermelon is useful to increase fruit set, production, and productivity.

Harnessing the Benefits of Bee Colony Migration for Honey Production in Nepal

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Migratory beekeeping is a modern concept of commercial beekeeping in which bee colony are transported from one nectar-exhausted area to another nectar-rich area that improves the yield of honey and increase crop yield through pollination. Nepal has a wide range of climatic conditions and a vast floral diversity, which allows migratory beekeeping by which the strength of the colonies get improved. Honeybees are kept in hives by the farmers from terai to mountain (70 to 4,200 msl) and honey collected from domesticated as well as wild honeybee species in Nepal. The diverse climatic conditions and abundance of flora are privilege to native honeybees like *Apis laboriosa* Smith, *Apis dorsata* Fab., *Apis florea* Fab., and *Apis cerana* Fab., as well as imported species, *Apis mellifera* Lin. Suitability of *A. mellifera* in terai and lower hills, and predominance of native honeybee *A. cerana* has entered in commercialization for honey production for more than two decades. Though migratory beekeeping creates a mutualistic environment between beekeeper and farmer, Nepal has confronted with a number of obstacles in bee management, bee floral management and colony migration since they are very sensitive to bee forage availability. Among many constraints facing, one of the important management decisions for the beekeeper is to choose where Jsufficient forage source is and how many hives should be placed in one location for optimal foraging performance. This paper foresees the ecological advantages of honey flora availability viewing carrying capacity, status of honey production from bee colony migration and challenges in beekeeping and honey marketing in Nepal.

Major Pests of Oyster Mushrooms in Nepal and Their Management Practices

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Oyster mushrooms is one of the commonly used mushrooms in Nepal. The mushroom is challenged by various pests ultimately diminishing farmers' income. Therefore, this study focuses on identifying key pests affecting oyster mushrooms in Nepal and explores farmers' strategies to mitigate these challenges. A study was conducted from June to July 2023 in Kathmandu Valley with a total sample size of 100 individuals including 80 farmers and 20 stakeholders. Data collection primarily involved direct interviews with farmers, agricultural officers, and researchers, through simple random methods. From the survey, it was found that the major pests of oyster mushrooms were mushroom flies, green mold, mites, wild mushrooms, however bacterial blotch was found to be minor one. As management practice farmers followed cultural and chemical methods where cultural practices such as sterilization of substrate, sanitation, proper ventilation, and temperature are the most effective methods for the management of pests. For non-chemical or alternate methods, farmers use neem oil, lime treatment, and salt treatment. Stakeholders were familiar with the pest green mold, mushroom flies, and mites. Stakeholders face challenges of proper information and techniques for the management of Oyster mushroom pests. Integration of non-chemical methods to manage oyster mushroom pests is recommended for safe and quality mushroom production.

Status, Prospects and Importance of Hornet Farming in Nepal**Bikash Bhusal[@], Ram Prasad Mainali, Mukunda Bhattarai and
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Hornet is a wild insect which is found in many district of Nepal. Due to its increasing nutritive and economic value, it has been rearing commercially in Gorkha and Gulmi district of Nepal as an edible insect. To understand hornet rearing and its socio-economic and ecological significance, a survey was conducted in Shahid Laxhan Rural Municipality of Gorkha district using 15 hornet rearing households. According to survey result, farmers bought initially building hive from forest and transfer on tree or pole, which later within 3-4 months develop into commercial sized hive with market value Rs. 10,000 to 15,000 per hive. Due to increasing market potential, most of the young people were interested having this farming. However, there was higher risk on hornet farming as some people died due to hornet biting every year in Nepal even though there was no evidence recorded in Gorkha district. Harvesting currently entails the unintentional destruction of entire colonies, including their queens. Domestication coupled with conservation practices could present a good income source for farmers and create employment opportunities. Consequently, governmental intervention is crucial to ensure the sustainable development and safety of this emerging sector.

Evaluating the Efficacy of Organic Essential Oils as Alternative Varroa Mite Control Agents in Sustainable Beekeeping

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Varroa destructor mites are known to be one of the primary threats to honeybee colonies worldwide. These mites feed on the blood of honeybees, weaken the bees immune system, and transmit viruses and diseases. This parasitic mite infestation can cause significant damage to the bee colonies, leading to decreased honey production, weakened colony growth, and even death. To identify the effective alternative methods for controlling this notorious mite, five treatments including four different types of organic essential oils, such as thyme, peppermint, artemisia and commercial mixture having major ingredients of mentha oil, eucalyptus oil and camphor oil (trade name Sancho) and no treatment (control) were used in the experiment. The experiment involved four replications of 20 hives, where each hive was treated with either @3ml per hive of organic essential oil or @0.5ml per hive of sancho or no treatment. The treatment was administered three times at weekly intervals. Dead mites were counted using sticky paper, while the sugar shake method was used to count live mites in adult bees at one-week intervals. Among the essential oils tested, thyme oil proved to be the most effective in reducing mite populations. Sancho and peppermint oils were the next best options, while artemisia oil did not perform well. Sancho oil was the most effective essential oil, likely due to its affordability and easy availability. Botanical acaricides were found to be cost-effective for commercial beekeeping due to their low residual effect and minimal impact on beneficial insects. The results suggest that the soft acaricides are very effective in controlling varroa mites. It is recommended that further research be conducted to determine the appropriate dosages, concentrations, and intervals for treatment application to ensure sustainable beekeeping practices.

Thematic Session IV

Digital Tools in Plant Health Management System

**Current Scenario and Important Stakeholders:
Digital Intervention in Nepal-Agriculture Sector****Madhu Manjari[@], Mahesh H.M., Malvika Chaudhary and Vinod Pandit**

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Digital interventions for agriculture are well recognised by the Government of Nepal through the 22 billion investments in the Digital Nepal Framework which is directed towards achieving a digital Nepal overcoming current hurdles like poor digital literacy. An integrated National Information and Communication Technologies (ICT) policy has been drafted to improve access to information technology across the layers of society, which would significantly reduce the digital gap in many sectors including agriculture. Out of the many barriers, the percentage of women using the internet is lower than that of men. Other roadblocks like the internet penetration rate estimated to be only 54.88 percent in Nepal (World Bank, 2022) is accounted for due to limited telecom network and electricity. To overcome these barriers, along with infrastructure investments, comprehensive training on digital tools is essential. Localised digital tools making information accessible would be required as drivers. Additionally, reducing gender disparities in education and resources is crucial for creating a more inclusive digital landscape. Nepal has shown great potential and scope through multisectoral interventions in developing sustainable solutions to crop health problems. However, the deficit can be achieved exponentially by supporting the evidence-based decision-making of extension advisors, researchers, and farmers, by harnessing information and knowledge through the use of digital tools. Organizations like CABI play a vital role in this effort, offering digital tools to enhance agricultural practices and promote gender-equitable advisories. With its experience and expertise, CABI has developed a suite of digital tools under the PlantwisePlus program. These decision-support digital tools can be used by various stakeholders involved in agriculture production systems to build their capacities in making informed decisions. The digital learning courses enhance the knowledge of agricultural service providers and other relevant stakeholders in plant health issues. Digitalization in the extension of scientific information and synergetic collaborations between government agencies, private sectors, NGOs, and international organizations are essential to maximize the impact of digital initiatives. CABI digital tools have been disseminated amongst various

ABSTRACT

stakeholders supporting the mandates of sustainable practices for securing food security as well as food safety. This collaborative approach fosters sustainable agricultural solutions and contributes to narrowing the digital divide, fostering inclusive growth in Nepal's digital journey.

ABSTRACT

*IPPS_2024_Oral_259_Th4_002***PlantVillage Application: Empowering Farmers Worldwide with AI-driven Agricultural Solutions****Peter McCloskey¹, Prabha K C² and David Hughes^{1,@}**¹PlantVillage²PlantVillage Nepal, Kathmandu, Nepal

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"PlantVillage" application leverages artificial intelligence (AI) tools offering virtual assistance by identifying and addressing plant health issues. The application utilizes Google's TensorFlow technology which recognizes plant leaves and patterns indicative of disease and pest symptoms. It harnesses AI in maize, potato, sweet potato, coffee, beans, and banana, effectively detecting threats like fall armyworm, blight, banana wilt and bunchy top. The application incorporates the unique functionalities for collecting diseased/damaged plant images through the "Other Crops" section. It allows farmers globally to submit images of affected plants and receive tailored management advice from domain experts. This application has gained popularity in African countries especially for cassava disease detection. In Nepal, it has been used to detect blight disease in potato, fall armyworm in maize, Fusarium wilt in banana and seek advice on pests and diseases affecting the crops. This study highlights the role of PlantVillage application in bringing transformative innovation in agriculture.

AgLearn: An Online Learning Platform for Empowering Agro Advisory Service Providers**Kiran Bamanu^{1@} and Prakash Kumar Dangi²**¹DreamWork Solution, Bharatpur, Chitwan²Directorate of Agriculture Development, Koshi Province, Biratnagar

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AgLearn (Agriculture Learning and Training Management System) is an online learning platform developed under the Directorate of Agriculture Development (DoAD), Koshi Province, in 2020 AD, serves as a vibrant tool for empowering extension officers in Nepal. Built on the Drupal Framework and hosted at aglearn.p1.gov.np, the platform registered 24 trainers and 735 trainees. In response to the agricultural challenges faced, particularly the outbreak of fall armyworm in maize during 2020 AD. AgLearn swiftly responded by launching a comprehensive course on fall armyworm insect pest management. Conducted by six plant protection experts across six different titles, the course spanned a month and attracted 226 trainees. Remarkably, 94.25% of participants received certificates after achieving an 80% pass mark in the quiz sessions. Another significant initiative on AgLearn was the creation of a course focusing on paddy disease and insect pest identification and management, launched on 3rd September, 2020. Led by 11 expert trainers, the month-long course garnered participation from 201 trainees, with an impressive 97.02% receiving certificates upon meeting the 80% pass mark in the quiz sessions. These endeavours underscore AgLearn's pivotal role in equipping extension officers with plant protection related information dissemination equipped with the necessary knowledge and skills to address agricultural issues in Nepal.

Perception of Smallholder Farmers on Digital Agriculture Services in Nepal

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The study offers a comprehensive review of the digital agricultural services landscape in Nepal, focusing on applications and adoption such as Krishi Guru, GeoKrishi, and Smart Krishi Nepal. These platforms leverage digital technology to reshape traditional farming practices, addressing critical challenges through features like weather forecasting, market analysis, IPM recommendations, and supply chain optimization. The integration of these services aims to empower farmers with real-time information, enhancing productivity and sustainability of the crops. Despite the proliferation of digital services, the study identifies gaps, including limited local language support, hindering accessibility for a significant farming population. The research study emphasizes the need for a more holistic approach, recognizing the scarcity of applications providing comprehensive digital agricultural services. As Nepal embraces digital transformation in agriculture, this study serves as a foundational exploration, informing policymakers and stakeholders about existing challenges and encouraging collaborative efforts to enhance inclusivity, effectiveness, and sustainability in digital agricultural services transforming agriculture productivity through digital agricultural services and their impact for sustainability in Nepal.

PPMS Software: An Approach for Plant Disease and Pests Management in Karnali Province, Nepal**Manshi Jaiswal^{1@} and Parshuram Rawat²**¹DreamWork Solution, Bharatpur, Chitwan²Integrated Agriculture Laboratory, Karnali Province, Birendranagar, Surkhet

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PPMS (Plant Pest Management System) is an online software system initiative developed under the Integrated Agriculture Laboratory, Karnali Province, Nepal for the provincial plant disease and pest database and pesticide monitoring as well as management in 2023 AD. The software, specifically tailored to address the challenges of the plant disease and pest management in the region. This system comprises modules dedicated to maintaining comprehensive databases of diseases, insect pests, weeds, crop disorders, and plant clinic records, thus enabling efficient monitoring and management of crop health issues. Furthermore, the software incorporates tools for pesticide monitoring and management to ensure the judicious linkage and effective use of pesticides in agricultural practices. Initially, during development, software system has incorporated 13 plant diseases and 10 insect pests with the flexibility and scalability of further database management. By facilitating data-driven decision-making, this system aims to enhance the capacity of extension officers and agricultural practitioners in Karnali Province to mitigate the impacts of plant diseases and pests, ultimately contributing to improved agricultural productivity and food security in the region.

AI-powered Tomato Disease Diagnosis and Treatment Assistant**Yagya Raj Pandeya^{1, 2, @}, Samin Karki¹, Ishan Dongol¹ and Nitesh Rajbanshi¹**¹Artificial Intelligence Program, Department of Computer Science and Engineering,
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Traditional farmers of Nepal often struggle with diagnosing and treating crop diseases due to limited access to agricultural expertise. To address this challenge, we developed a user-friendly mobile application that leverages deep learning for tomato leaf disease detection and remedy suggestion. The app features a simple interface where farmers can capture images of affected leaves using their smartphones. Our system, powered by the You Only Look Once (YOLO) object detection method, analyzes the image to identify the specific disease. This information is then translated into the Nepali language and displayed within the app, along with recommended remedies guided by domain experts. To ensure effectiveness, we trained the system using a dataset encompassing various tomato leaf diseases and employed data augmentation techniques to prevent overfitting. The proposed method achieved a mean average precision of 0.76 and offers an efficient mobile interface for interacting. This mobile application has the potential to empower farmers by providing immediate access to disease diagnosis and treatment information, ultimately improving their crop yield and agricultural practices

Tele Plant Doctor: Contributing towards the Digital Village Initiative**Arun G C**

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The global agrifood system faces unprecedented challenges due to the burgeoning world population, escalating food demand, and the impacts of climate change and socio-economic factors. Timely and accurate diagnosis of crop diseases and pests is imperative to ensure food security, food safety, and sustainability. While molecular-based methods offer high accuracy, they are hindered by complexity, time consumption, and resource intensiveness (both financial and skilled human resource). Recent advancements in artificial intelligence (AI), particularly cloud-based image processing algorithms, present a promising solution for real-time diagnosis, revolutionizing farming practices. This application explores the integration of AI, machine learning (ML), and deep learning (DL) techniques to develop the Tele Plant Doctor application for disease detection in potato and tomato plants. Leveraging AI and image processing capabilities, Tele Plant Doctor provides a user-friendly platform for farmers to detect diseases promptly. The application employs TensorFlow Keras for ML framework, Generative Pretrained Transformer 4 Turbo Vision Preview API for leaf detection, and custom ML models for leaf classification. To optimize models for mobile deployment, TensorFlow quantization techniques are utilized, along with React Native for frontend development and Python for backend infrastructure. Training the model involved a dataset sourced from various repositories, augmented with image augmentation techniques. The dataset comprised 23,000 images representing 10 specific diseases and pests affecting potato and tomato plants, alongside healthy leaves. This application represents a significant advancement in timely plant disease and pest diagnosis, facilitating collaboration among plant protection professionals across extension, research, and educational domains at local, provincial, federal, and international levels. However, AI-powered plant disease diagnosis faces challenges related to data quality and quantity, as well as the variability of symptoms based on environmental factors and plant varieties. Despite these limitations, with appropriate training and sufficient high-quality data inputs, these challenges can be mitigated, enhancing the accuracy and effectiveness of disease diagnosis in agricultural systems. This endeavor underscores the transformative potential of AI in addressing critical issues in global agriculture, paving the way for sustainable and resilient farming practices.