Technology Notes

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Dr YS Parmar University of Horticulture & Forestry, Nauni 173 230 Solan, HP, India

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Promising Disease Management Technology for Bacterial Blight of Pomegranate

Dr Jyotsana Sharma, Director
ICAR-National Research Centre on Pomegranate, Solapur

Bacterial blight caused by *Xanthomonas axonopodis* pv. *Punicae* was the major impediment in successful cultivation of pomegranate, when ICAR-NRC on Pomegranate, Solapur was established in 2005. The disease was causing huge losses (80- 100%) threatening its cultivation. The scientists of the ICAR-NRCP, Solapur then worked hard and developed a robust and **Modified IDM/IDIPM (Integrated Disease and Pest Management Schedule) for managing bacterial blight in pomegranate.** They successfully demonstrated it in the affected orchards in a network mode in different states. This instilled the confidence among the farmers and resulted in huge expansion of pomegranate area under cultivation, production, productivity and livelihood security of around 2.5 lakh farm families in India.

The Modified IDIPM Schedule and Six Steps to Manage Bacterial Blight: Six steps to manage bacterial blight was found to be most economical, eco-friendly and promising strategy to check bacterial blight 80-100% in orchards facing above 50 to 100% losses in rainy season (Kharif) crop. One organic block of pomegranate cv. Bhagawa was severely affected with bacterial blight in year 2018 with 85% blight incidence. In the year 2019 the modified IDIPM schedule was followed in the same. The schedule gave hundred percent blight free crop with good fruit quality in 2020. The detailed IDIPM Schedule and 6 steps to manage bacterial blight as detailed below:

1. Put plants on rest soon after harvest in December till February. Take main pruning and provide recommended nutrition for rest period soon after harvest.
2. Put plants on stress from March till there is natural defoliation without chemical defoliants.
3. Allow naked defoliated stems to face sun for another 20-30 days till the tip portion of the branches start drying. Due to high temperature and low moisture, the bacteria residing safely in the nodes (source of infection in next season) of the naked stems will desiccate and die.
4. Go for light pruning removing upper 10-15 cm of stems, put recommended fertilizer doses, irrigate and start the new crop.
5. Take need based sprays of insecticides, fungicides, nutrients, growth hormones and bactericides only at 7- 10 days interval.
6. All blight affected orchards in the community should follow the same schedule for promising results.

Stage Specific Schedule of Fungicide Sprays: Spray 1% Bordeaux mixture before defoliation. At First flush of leaves, do morning spray with salicylic acid formulation (0.3 %) and evening spray with streptocycline (0.5 %) + carbendazim 50WP (0.1 %). At mid of the flowering, spray streptocycline + Carbendazim 50WP. At full flowering, spray streptocycline + mancozeb 75% WP (0.2 %). As the fruit set starts, spray streptocycline + Propineb 70WP (0.3 %) or Ziram 80% WP (0.2 %). In the mid of fruit setting, spray Streptocycline +Thiophanate Methyl 70WP (0.1 %). At fruit enlargement, spray Bordeaux mixture (0.5%). After one week , spray Bronopol (0.5 %) + Mancozeb 75% WP. Repeat the sprays at one week interval with streptocycline + carbendazim 50WP followed by Bronopol + Ziram 80% WP + Azadirachtin 10000 ppm (0.3 %) then by Bordeaux mixture; Streptocycline + Mancozeb 75% WP; Captan 50WP (0.25 %) + Bronopol; streptocycline + copper hydroxide 77WP (0.2 %); Bronopol + Thiophanate Methyl 70WP; Streptocycline + Propineb 70WP ; Bordeaux mixture; Spray Bronopol + Captan 50% WP; Streptocycline + copper oxychloride 50 WP; Bordeaux mixture and Potassium dihydrogen phosphate (1.0 %) + Bronopol + Captan 50% WP . During rest period apply Bordeaux paste (10%) on pruned ends. Immediately after pruning spray, Bordeaux Mixture (1%) Spray Bordeaux Mixture (1%) at 15 days interval or alternate with Bronopol + Copper oxychloride 50WP spray.

Multilingual Mobile Application- 'Solapur': To disseminate the information on various technologies on pomegranate farming, ICAR-NRCP has developed Mobile App called 'SolapurAnar'. The app provides information on all aspects of pomegranate production and value addition. The app has been developed in six languages *viz.* English, Hindi, Marathi, Kannada, Telagu, and Gujarati. The App has more than 20,000 downloads (including upgraded version) and has rating of 4.4/5.

Impact of Pomegranate Technologies: The Centre through its outreach activities has strengthened pomegranate cultivation not only in Maharashtra but also in states like Gujarat, Odisha, Telangana, Rajasthan, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Madhya Pradesh and Himachal Pradesh. The research efforts by the scientists and awareness initiatives of ICAR-NRCP in collaboration with other ICAR-institutes and state universities successfully brought down the losses due to bacterial blight-the major constraint in pomegranate cultivation. The impact of technologies is visible in constant increase in pomegranate area under cultivation, production, productivity and export. The export revenue from fresh pomegranate in the year 2005-06 was Rs 567 million rupees, in the year 20011-12 was Rs 1473 Million Rupees and in 2018-19 it was Rs 6885 Million Rupees.

Climate Change Affecting the Host-Pathogen Interactions

Dr H.R. Gautam

Climate change has the potential to disrupt plant-microbe interactions as per the reports from different parts of the world. The major consequences of the climate change like drought reduces nutrient concentrations in plant tissues as well as microbial biomass. It can further alter plant competitive dynamics, and soil C:N:P ratios can influence plant water use efficiency and the recruitment of symbionts that ameliorate drought. There is tremendous progress in our understanding how plants respond to microbial colonization and how microbial pathogens and symbionts reprogram plant cellular processes. Climate change is having a strong impact on plant-microbe interactions. Leaf endophytes can improve plant tolerance to drought, heat, or salinity, increase tissue nutrient concentrations, and deter herbivores or pathogens. Mycorrhizal fungi acquire up to 80% of plant N and 75% of phosphorus (P) and increase water uptake from soil. Root ascomycetes can acquire soil N and protect plants under drought or heat stress. Some fungi and plant growth-promoting bacteria produce analogs of plant hormones that stimulate germination or growth. Rhizosphere bacteria, such as *Streptomyces,* can increase plant fitness under drought or disease. N-fixing bacteria boost N in leaves, roots, rhizospheres, and seeds. All these benefits can help plants resist and recover from climate-related stress.

Pathogenesis interactions at molecular level like plant resistance pathways, including pattern-triggered immunity and effector-triggered immunity, RNA interference, and defense hormone networks, are all affected by environmental factors. On the pathogen side, virulence mechanisms, such as the production of toxins and virulence proteins, as well as pathogen reproduction and survival are influenced by temperature and humidity. Climate change may increase the impact of pests by allowing their establishment in areas where they could previously not establish. Changes in temperature can result in changes in geographic ranges and facilitate overwintering.

Plant pathogens are typically distinguished by their infection strategy. While biotrophic pathogen like *Hyaloperonospora arabidopsidis*, commonly feed on living host cells, whereas necrotrophic fungal pathogen like Botrytis cinerea, derive nutrients from killed plant tissues. Many pathogens, for example the bacterial pathogen *Pseudomonas syringae* pv. *tomato* (Pst), have both a biotrophic and a subsequent necrotrophic infection stage and are thus referred to as hemi-biotrophs. Plants have developed a sophisticated defense system against pathogens that recognizes pathogen-associated molecules and subsequently activate downstream defense cascades. The mutually antagonistic phytohormones salicylic acid (SA) and jasmonic acid (JA) are crucial for the regulation of the plant immune signaling network, in which the SA pathway typically regulates defenses against biotrophic pathogens, whereas JA is effective against necrotrophic pathogens and insect herbivores.

Atmospheric CO_2 concentration can induce changes in hormone levels in many plant species. In general, SA, auxin, and gibberellin levels and signaling increase under elevated CO_2 conditions, whereas ABA and JA levels and signaling decrease, but effects vary between studies and plant species. For example, suppression of JA-related signaling by high CO_2 levels was associated with increased susceptibility of maize to *Fusarium verticillioides* and of soybean to herbivores. In tomato plants, elevated CO_2 levels induced an increase in SA levels and concomitantly a decrease in JA signaling. This was associated with enhanced resistance against yellow leaf curl virus, tobacco mosaic virus and Pst, which are typically sensitive to SA-dependent defenses, and increased susceptibility to *B. cinerea,* which is sensitive to JA-dependent defenses.

Concentrations of CO_2 in soils with active microbial communities are 10–50 times higher than the atmospheric CO_2 levels. Increases in atmospheric CO_2 concentration can alter plant photosynthetic rate, stimulate plant growth, and lead to increased carbon allocation to the belowground plant tissue, resulting in changes in the release of organic compounds in the rhizosphere. Changes in atmospheric CO_2 levels may affect the richness, composition and structure of soil microbial communities through changes in carbon allocation and root exudation, which in turn can affect the impact of the root microbiome on plant performance. Such effects may also influence growth and virulence of soil-borne plant pathogens. The incidence of sheath blight in rice caused by the necrotrophic fungus *Rhizoctonia solani* was increased under elevated CO_2. Similarly, disease incidence of Fusarium pseudograminearum was increased in wheat plants grown under elevated CO_2. By contrast, the tolerance of tomato plants to infection by the hemi-biotroph *Phytophthora parasitica* increased at elevated CO_2. In other studies, elevated CO_2 levels did not significantly influence disease incidence. In lettuce, disease caused by *Fusarium oxysporum* f.sp. *lactucae* and in soybean of the sudden death syndrome caused by *Fusarium virguliforme*, elevated CO_2 did not affect the severity of these diseases.

The plant immune system consists of a complex web of signaling modules, transcriptional networks, and hormonal crosstalk; it can be activated by at least two types of microbial signals. The first type includes broadly conserved microbe/pathogen-associated molecular patterns (PAMPs hereinafter), such as flagellin from bacteria or chitin from fungi. Recognition of PAMPs led to PAMP-triggered immunity (PTI) that is believed to be a principal component of basal defense against all microbes. However, PTI is often suppressed by evolved pathogens, mostly via virulence "effector" proteins that are delivered into the plant cell by pathogens. To counter pathogen virulence, plants have evolved an ability to recognize the second type of microbial signals (individual effector proteins) through nucleotide-binding leucine-rich repeat (NLR) immune receptors, resulting in the activation of a more violent form of immunity called effector-triggered immunity (ETI). Slightly elevated temperature than the optimal range for growth, has long been known to suppress ETI in plants and has emerged as a great concern as major crops across the globe rely on ETI for protection against many devastating plant pathogens. Increased virulence was detected in the soft-rot bacterium *Pectobacterium atrosepticum* at elevated temperature, which is associated with increased production of plant cell wall-degrading enzymes, quorum-sensing signals, and accelerated disease development. Elevated temperature also affects beneficial plant-microbe inter-actions. In most cases, it positively affects hyphal growth and plant colonization of arbuscular mycorrhizal fungi (AMF), probably due to faster plant carbon allocation to the rhizosphere where AMF lives.

Some rhizosphere bacteria and endophytes could alleviate the negative impact of temperature stress on plants and expand the ability of host plants to grow at different temperatures. An interesting example is the symbiosis between tropical panic grass *Dichanthelium lanuginosum* and the fungus *Curvularia protuberate*, which allows both organisms to grow at high soil temperatures, whereas separately, neither the plant nor the fungus can survive at this condition. Moreover, the ability of *C. protuberate* to confer heat tolerance to the host plant requires infection of the fungus by *Curvularia* thermal tolerance virus. In addition to panic grass, *C. protuberate*-mediated heat tolerance could be observed in tomato, suggesting that the underlying mechanism may be broadly applicable to help diverse plants to cope with elevated temperature. Some microbes can even help plants to cope with multiple stresses. An intriguing example is *Burkholderia phytofirmans* strain PsJN, which improves plant tolerance to heat in tomato, cold in grapevine, drought in wheat, and salt and freezing in Arabidopsis. This bacterium also has direct antifungal effects, can prime plant defense, and makes better resource mobilization in plants. The mechanism(s) by which PsJN confers multi-stress tolerance remains to be elucidated; its elucidation may be of special interest for microbe-mediated crop improvement.

Water can greatly impact many aspects of plant and microbe biology. Plants react to water deficit by regulating the level of the phytohormone ABA. ABA increase triggers a signaling cascade, resulting in large-scale transcriptional reprogramming and physiological changes, including closure of stomata to reduce transpiration. Thus, during drought stress, ABA-induced stomatal closure may reduce bacterial entry through stomata. However, increased ABA can lead to suppression of SA signaling pathway in the mesophyll cells inside the leaf, thus compromising post-invasion, SA-mediated resistance.

In contrast to host immune suppression, high humidity generally favors pathogen virulence. High humidity is critical for promoting post-invasion bacterial virulence and/or survival inside the plant. Water-soaked lesions are a common early symptom of foliar diseases; they are formed due to abnormal accumulation of liquid inside the leaf apoplast. Water soaking creates a disease-favorable micro-environment that could potentially increase the flow of nutrients to bacteria, diluting plant-derived defense molecules and/or facilitating bacterial spread beyond initial infection sites. *P. syringae* uses the type III secretion system to deliver two "water-soaking" effector proteins, AvrE and HopM1, into the plant cell to cause water soaking as an integral part of bacterial pathogenesis. Notably, the ability of AvrE and HopM1 to cause water soaking requires high atmospheric humidity, as low air humidity might promote evaporation of excess apoplastic water through open stomata, countering the virulence function of AvrE and HopM1. Moisture also affects root disease development. Bacterial wilt in ginger plants caused by soil-borne *Ralstonia* *solanacearum* is more severe when the soil moisture is high. Expression of two wall-associated kinase (WAK) genes, WAK16 and WAK3-2, is high under low soil moisture. High soil moisture dampens WAK16 and WAK3-2 expression and weakens plant immunity toward *R. solanacearum*, suggesting WAK16 and WAK3-2 may play important roles in sensing soil moisture and mediate cell wall-based plant immunity against root pathogens. Scientists using data from a global field survey and a nine-year field experiment have found that warmer temperatures increase the relative abundance of soil-borne potential fungal plant pathogens.

As such, understanding how environmental conditions influence plant-microbe interactions is crucial in predicting disease outbreaks, engineering effective symbiotic and biocontrol agents, and designing "dream" crop plants with increased resilience to current and future climate change.

Strategic management of yellow rust of wheat in India

Dr Prem Lal Kashyap, Dr Sudheer Kumar and Dr Gyanendra Pratap Singh

ICAR-Indian Institute of Wheat and Barley Research, Karnal, India

Wheat is an indicator of the economic health of India and presently contributes approximately 14% to the world wheat basket and holds the global share of 11% area under wheat cultivation. As a result of consistent and integrated efforts made by farmers and researchers at national level during the last several decades recorded an all time high wheat production of 107.18 million tones during 2019-20 as no major epidemic of yellow rust occurred from past several years. At present, wheat rust research in India has become a systematic, coordinated and model system of disease management and every year intelligent and strategic planning safeguard about 10 million tons of wheat produce from rust invasion. The nobel laureate Dr. Norman Borlaug said that rust never sleeps. The continuous evolution of new virulent races make the existing ruling varieties susceptible, for instance, one of the mega wheat variety (i.e. PBW343), become susceptible because of the emergence of *Yr9* virulence in *P. striiformis* f. sp. *tritici* resulted phase out of PBW343 from cultivation. Such cases of shits in the virulence patterns of yellow rust fungus continuously alert researchers and farmers about the threat pose to national food security. With the phase out of variety PBW 343, proportion of race 78S84 declined, whereas increase in 46S119 proportion was observed. At present, 67S64, 110S119, 110S84, 47S103 and 238S119 races of stripe rust are prevailing in the region. Therefore, in order to contain yellow rust disease from becoming an epidemic and move towards rest of the North Western Plain Zone (NWPZ) and Northern Hill Zone (NHZ) of India, an integrated strategic model has been developed which includes regular monitoring of rust races, skillful deployment of wheat varieties with diverse rust resistances, their adoption and need based application of fungicides. Every year strategy planning meeting has been conducted on "Evolving strategies for enhancing wheat production with special reference to management of wheat rust" in the month of September, where, Secretary, Department of agriculture, cooperation & farmers welfare, Director, ICAR- Indian Institute of Wheat and Barley Research; Director, Agriculture and Director research of SAUs of Uttar Pradesh, Uttrakhand, Bihar, Madhya Pradesh, Haryana, Himachal Pradesh and Punjab discuss regarding the strategic plan framed and its implementation for combating yellow rust in upcoming wheat season. As a consequences, a constant monitoring programme in all villages through farmer-participatory scouting along with local KVK specialists, State Agricultural machinery become a continuous activity to keep vigil about the course of spread in each district and its immediate reporting to the respective Director of Agriculture in each of the above state and ICAR-IIWBR, Karnal from last several years.

If the yellow rust is noticed in the wheat crop, a team of scientists from ICAR-IIWBR and SAUs and agricultural department visit farmers fields and take a sample for race analysis and advise the farmers are to spray the crop with triazole group of fungicides (such as Propiconazole, Tebuconazole and Triadimefon) @ 0.1% to check the further spread. Besides this, mobiles phones and internet services are regularly used for information sharing on wheat crop health and suggestions for proper management. Special emphasis on the strategic sowing of newly released high yielding yellow rust varieties in yellow rust prone areas of Himalayan foot hills have been given to decline the yellow rust progression in NWPZ. At present, a galaxy of varieties like DBW 303, DBW 222, DBW 187, WH 1270, HD 3226, PBW 723, HPBW 01, WB 2, HD 3086, DBW 621-50, PDW 314 (d), and WHD 943 (d) for timely sown and HD 3298, PBW 752, PBW 757(VLS), DBW 173, DBW 90, WH1124, DBW 71, HD 3059, PBW 590, WH 1021, and DBW 16 for late sown conditions have been recommended for NWPZ. The farmers of NHZ can grow varieties such as HS 562, HPW 349, HS 507, VL 907, and VL 804 for timely sown and HS 562, HPW 349, HS 507, VL 907, VL 804 etc. for

Yellow rust disease symptoms in wheat field

late sown conditions. Besides this, regular monitoring of wheat health via weather forecasts every fortnight from December to March has been made. In spite of favourable weather, proactive survey and surveillance, advisories and timely issuance of wheat crop health newsletters on monthly interval have acted as strong pillars in successful management of yellow rust in India from past several decades. In nutshell, a combined strategy including regular disease surveys, strengthening research capacity, development of new rust resistant varieties, strategic deployment of resistant varieties and ensuring their adoption among farmers, open rust information sharing platform along with need based use of fungicides have led to effective management of yellow rust disease and boost wheat production in India.

Holistic approaches for management of anthracnose and spike shedding disease of black pepper

Mohammed Faisal P, Biju CN[1], Ankegowda SJ, Balaji Rajkumar, Akshitha HJ and Jeevalatha A[1]

ICAR-Indian Institute of Spices Research Regional Station, Appangala, Madikeri, Karnataka
[1]ICAR- Indian Institute of Spices Research, Marikunnu Post, Kozhikode

Black pepper (*Piper nigrum*) also known as “King of Spices” is one of the most important commercial spice crop grown in different parts of the country for its culinary and pharmaceutical importance. Cultivation of black pepper encounters numerous production constraints of which diseases caused by *Phytophthora* spp. and *Colletotrichum* spp. are of greater importance especially in high rainfall regions where the disease incidence is recorded to almost 100%. Integration of various cultural practices and timely adoption of recommended fungicides were found to be promising in managing the diseases effectively and economically. Among the various diseases, anthracnose/fugal pollu incited by *Colletotrichum* spp. is a persistent problem in higher elevations which is further aggravated under misty conditions. The pathogen infects all the aerial plant parts in which the symptoms are manifested on the leaves, spikes, runner shoots as well as berries. On the leaves, the symptoms are manifested as dark black or brown spots surrounded by a yellow halo which later turn into a shot-holes. Symptoms on the leaves also often confuses with the leaf blight/rot symptoms caused by *Phytophthora* spp. However, the presence of yellow halo is the characteristic symptom which differentiates the diseases. On the runners and younger shoots the symptoms are manifested as linear dark brown/black lesions. On the spike, blackening of petiole occurs under severe conditions leading to spike shedding thereby causing heavy loss to the growers.

Management

An integrated approach for the management of the disease was found promising in the demonstration plots in Kodagu region of Karnataka. The disease incidence was drastically reduced to below 20 % in the two demonstration plots at Hattihole and Makkandur villages of Kodagu district. In black pepper, shade lopping of the standards or opening the shade is a regular practice adopted during late summer (May) which facilitates light penetration during the monsoon season. If the plantations are located in misty hill areas, early shade regulation during January/February is adopted followed by basin irrigation through hose pipe/drip irrigation which is proved to reduce the incidence of anthracnose and spike shedding. Two rounds of Bordeaux mixture spray (1%) during (May/June-August/September) reduces the incidence drastically. If the symptoms appear after September, one round application carbendazim-mancozeb (0.2%) reduces the disease incidence and check its further progression.

Tip drying symtoms on the leaves

Microsclerotia on the runner shoot

Symptoms on the spike as blackening

Symptoms on young leaves surrounded by yellow halo

Seed Biopriming: A Technology for Judicious Use of Biological Control Agents

Dr. Narender K. Bharat

In modern day agriculture, beneficial microbes include biological control agents (BCAs) are being encouraged to be widely explored for their biological control and growth promotional activities. As these provide efficient and eco-friendly alternatives to chemical pesticides and fertilizers.

Scientist have advocated various modes of application of BCAs in the crops such as, seed treatment, seed biopriming, soil treatment, seedling root dip treatment and foliar application. The availability of these beneficial microbes is limited and also being a living entity these are liable to reduce their efficacy i.e. the colony forming units (cfu) with time of storage. It is therefore important to select an efficient and judicious technology for their use in agricultural and horticultural crops. Among all the methods listed above, seed biopriming is considered to be the most efficient and productive technology for using BCAs and it supposed to utilize bioagents judiciously for crop production.

Seed biopriming, a sub-category of seed priming, involves inoculation of seed with beneficial microorganisms along with hydrating agent i.e. water. It is primarily a method of conditioning seeds with a priming agent i.e. BCA, which triggers the defense related mechanisms in the seed embryo even before germination and imparts the growing seedlings with an enhanced defense against abiotic and biotic challenges. Further, the method is quite economic as a significantly low amount of the bioagent is required for priming purpose. If we compare the quantity of the a BCA formulation required under various methods of their application in the field, the amount of BCA formulation needed per hectare of land is approximately 5-7 kg for soil application, 3-5 kg for foliar spray application, 500g to 1 kg for seed treatment and only 50-100 g for seed priming. In addition, the biological aspects of disease control and the physiological facets of seed hydration involved in biopriming allow increased colonization, proliferation and establishment of biocontrol agents on the seed surface. Consequently, biopriming enhances nutrient and water uptake, boosts seedling vigour as well as induces systemic resistance to biotic and abiotic stresses. In other methods of seed treatment with bioagents and soil application the microbes are required to be present on the seed or in the soil at the time of sowing for their efficacy, but in case of seed priming the benefits i.e. triggered defense mechanism have already occurred in the elongating embryo inside the seed and there is no need of the bioagent to be present on the seed at the time of sowing. Seed biopriming with BCAs has strong effects on plant defense mechanism against many types of pathogens including fungal and bacterial pathogens. The bioprimed seedlings or plants ameliorate their metabolic pathways thereby augmenting accretion of organic solutes like sugars, polyhydric alcohols, proline, betaines, polyamines, quaternary ammonium compounds and secondary metabolites, such as, polyphenols, alkaloids and flavonoids.

Seed biopriming with potent BCAs, therefore, is a very efficient, economic and easy to use seed treatment technology and should be promoted for its use in production of agricultural and horticultural crop production.

Anthracnose and perennial canker: -an emerging threat to apple orchards in Himachal Pradesh

Dr DP Bhandari, Dr HR Gautam, Dr Ashok Kumar and Mr Vinit Kumar

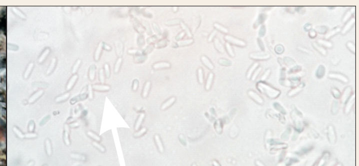
KVK Sharbo, Kinnaur

There are thirteen different types of canker reported to infect apple cultivation in Himachal Pradesh so far but two new pathogens viz., anthracnose (*Neofabraea malicortis*) and perennial canker (*N. perennas*) have now emerged as major canker fungi infecting both spur and standard varieties of apple in H.P. Overall incidence of anthracnose (45.7%) and perennial canker (64.8%) have been reported from all three blocks of district Kinnaur and many report of such symptoms of oozing cell sap have also been reported from other districts of Himachal Pradesh. Disease manifest in as small circular to elliptical reddish-purple spot on limbs, branches and stem (Fig. a), which later turn orange to brown in colour. Fungus produces enormous amount of conidia in gelatinous oozethat comes out of infected branch/ stem (Fig. b). Tissue beneath infected twigs, branch or stem disintegrate forming strings of fiber and develop canker with cracked edges. As the canker progresses callusing with series of concentric rings can be seen. Orchards under stress condition and poorly managed are more prone to be attacked by these fungi. Fungus survives in form of dormant mycelium initially in the infected twigs and forms acervulii/apothecia during harsh climatic condition (Fig. c). Conidia are allantoid (comma) shaped in *N. malicortis* whereas elongated and straight in *N. perennas* formed in acervulii which later disperse from one place to another through windand rains splashes (Fig d & e). Reports of its prevalence throughout Himachal impels to do a comprehensive study on fungal etiology, epidemiology and further management tacticsthat need to be develop for effective

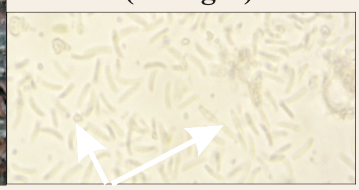
a. Circular reddish purple spot on twig/ branch

b. Oozing of fungal spore in gelatinous material

c. Formation of Acervuliion stem



d. Conidia of *N. perennas* (Straight)



e. Conidia of N. malicortis (Comma)

and suitable decision support system. Though standard operating procedures such as removal of fully infected branch or stem, proper scarification and application of Chaubattia paste (Red lead: copper carbonate: linseed oil 1:1:1.25) /Bordeaux paste/white paint (1lt + Bavistin10g/lt paint)developed for other canker fungi may serve as effective tool to keep disease under check. Spray of Blitox (0.3%) after harvest could manage its spread and minimizes chances of infection.

Chitosan: An Eco-friendly Alternative in Plant Disease Management

Dr Kumud Jarial and Dr RS Jarial

YSPUHF, College of Horticulture and Forestry Neri, Hamirpur (HP)

Injudicious use of chemical pesticides for disease management impacting environment as well as human health and increasing pesticide resistance amongst plant pathogens calls for the alteration in management practices. Use of natural compounds such as plant extracts with their active principles and animal derived compounds like chitosanwhich have been studied for their various antifungal, antibacterial and antioxidant properties seems to be a promising approach. Chitosan is a linear polysaccharide that can be obtained from the deacetylation of chitin, a long-chain polymer of N-acetyl-glucosamine present and easily extracted from fungal cell wall and crustacean shells. It has proved to be very interesting for controlling plant diseases. In fact, it has been shown both to possess a broad-spectrum antimicrobial activity against several phytopathogenic organisms and to induce numerous biological responses in plants. One of the most studied proprieties of chitosan is its high antimicrobial activity against a wide variety of microorganisms such as fungi, bacteria and viruses. It has reported to inhibit many fungi *in vitro* like *Botrytis cinerea, Alternaria alternata, Colletotrichum gleosporoides and Rhizopus stolonifer* at different pathogen development stages such as mycelial growth, sporulation, spore viability and germination, and on the production of fungal virulence factors. The antifungal activity has also been demonstrated *in vivo* in different patho-systems systems, such as in pear against *A. kikuchiana* and *Physalophora piricola*, in grapevine and strawberry against *B. cinerea*, in dragon fruit against *C. gleosporoides* and in rice, against *Rhizoctonia. solani*. Chitosan also prevents the growth of several pathogenic bacteria including *Xanthomonas* spp., *Pseudomonas syringae, Agrobacterium tumefaciens* and *Erwinia carotovora*. However, the antimicrobial effectiveness of chitosan seems to be higher against fungi than bacteria.Besides these activities, chitosan is able to inactivate the replication of viruses and viroids thus limiting their spread, even though relatively few research studies on its antiviral activity have been reported.It has also been found to be effective against seedborne pathogens when applied as seed treatment. It can form physical barriers (film) around the seed surface, and can increase the effect of other antimicrobial compounds that could be added to the seed treatments. The chitosan used as soil amendment has shown to give many benefits to different plant species by reducing the pathogen attack and infection.A soil amendment with chitosan can also reduce nematode parameters like number of galls, egg masses, females/root system and number of juveniles in the soil. In addition to these antimicrobial properties, chitosan, also behaves like a general elicitor, inducing a non-host resistance, and prime the plants for systemic acquired resistance. Chitosan behaves as a resistance elicitor inducing both local and systemic plant defence responses even when applied to the seeds. Chitosan also has the positive effect of enriching biodiversity in the rhizosphere.

Chitosan and its derivatives have emerged as the best eco-friendly bio-pesticides for their unique plant pathogen controlling properties, safety to human and mammals and non-toxicity to other beneficial microbes. In 2015, the US Environmental Protection Agency (EPA) also concluded that there was no risk to the environment because chitosan has not shown toxicity in mammals and it is a natural biopolymer. Other studies also indicate that there has been no report on environmental degradation due to the use of chitosan. For achieving the goal of sustainable agriculture, chitosan will become a popular plant protectant in near future.However, its application in the field, including formulation aspects, is one of the least studied issues and it needs further testing and validation.

FARMING HERO

An orchardist successfully demonstrated Ultra High Density plantation of apple in tribal area

Dr Ashok Kumar & Dr Arun Kumar

KVK, Sharbo, Kinnaur

Mr. Gewa Shanker, a progressive orchardist of Village Urni, District Kinnaur (HP), has established Ultra High Density Block of Latest cultivars of apple on rootstock orchard in 510 m2 area in April, 2020on M9 Rootstock and planted 400 plants of King Roat and 100 plants of Dark Baron Gala asfeathered plants imported from Zanzi and Griba Nursery, Italy. With an objective, to set an example of harvesting maximum crop ofapple from minimum area of land, he has established this Ultra High Density Orchard at an elevation 6500 feet amsl and in the first year of planation he has received sample fruits from the established feather plants. The scientists of Dr YS Parmar University posted at KVK, Sharbo (Kinnaur) provided him all the technological help regarding orchard management and plant protection. Experts from the University and other institutions have also visited his demonstration site from time to time. Mostly, the applegrowers of this area receive no fruits during the first year of plantation but he has obtained 50 Kgof produce from the first year planted feathered trees. He has a very good experience in the field of horticulture and attended various training programmes/workshops conducted by the University Research stations and other line departments. Apart from these he always motivates all the farmers of village to go for such system of planation to increase the productivity to uplift the farmer's economy. Dr YS Parmar University of Horticulture & Forestry, Nauni has also recognized his achievements on its foundation day on 01.12.2020 and honoured with a "Progressive Farmer Award".

Contact: Mr. Gewa Shanker Village & PO Urni, Teh. Nichar, Distt. Kinnaur (HP). Mobile: 8988047750

NEWS DESK

New Governing Body of Himalayan Phytopathological Society Elected

A General House Meeting of the Himalayan Phytopathological Society, UHF, Nauni was held at Heaven's Retreat Resort, Dharon ki Dhar (Solan) on 22.11. 2020. The meeting was presided over by Dr HR Gautam, Professor and Head. Dr NP Dohroo, Professor and Head (Retired) was appointed as the Returning Officer for conducting the election for the Governing Body of the Himalayan Phytopathological Society for the year 2021 & 2022. The following office bearers of the Governing Body were elected unanimously:

President	**Dr Harender Raj Gautam**
Secretary	**Dr Narender Kumar Bharat**
Joint Secretaries	**Dr Bhupesh Kumar Gupta** **Dr Meenu Gupta**
Treasurer	**Dr Dharmesh Gupta**
Executive Members	**Dr ManicaTomar** **Dr Arti Shukla** **Dr RS Jarial**

The house also decided to start the following awards:

1. Best Thesis Award (Ph.D.)
2. Fellow of Society
3. Young Scientist Award (Age limit 40 yr)
4. Innovative Farmer Award
5. Life Time Achievement Award