Gum/Rubber

from different ***H. brasiliensis*** clones was naturally coagulated, subjected to different durations of maturation, processed into solid rubber and compounded into pure gum stocks and vulcanized. Coagula maturation had clone-specific effects on the processability of the raw rubber: reduced for some clones, while others was less sensitive. The cure and mechanical behaviours of the compounded stocks and vulcanizates, respectively, were not sensitive to the clonal origin of coagula and their duration of maturation. Although coagula maturation could be associated with leaching, deactivation of inherent antioxidants in *Hevea* latex, as well as cross-linking and/or oxidation of polyisoprene chains, these results show that compounding with a standard pure gum recipe compensates for the *Hevea* latex constituents affected by maturation. Hence, extended maturation of *Hevea* coagula, for economic or other reasons, would influence much more the bulk behaviour of raw rubber and have insignificant effects on the compounded stocks and vulcanizates [Soh Fri Pamela, Nkeng George E and Ehabe Eugene E, Effect of natural coagula maturation on the processability, cure and mechanical properties of unfilled vulcanizates of *Hevea* natural rubber, *J Appl Polym Sci,* 2007, **103**(4), 2359-2363].

Latex extraction from rubber tree

Insecticides/Larvicides/Fungicides/Herbicides

Larvicidal and repellent potential of *Albizia amara* and *Ocimum basilicum* against dengue vector

Mosquitoes are nuisance to human beings and spread dreadful disease like malaria, filariasis, dengue haemorrhagic fever and Japanese encephalitis, etc. *Aedes aegypti*, the yellow fever mosquito, is also a well-known vector of dengue. Plant products have been used traditionally by human communities in many parts of the world against the vectors and species of insects. Investigations were made by researchers at Department of Zoology, Bharathiar University, Coimbatore, India to evaluate the larval toxicity and smoke repellent potential of ***Albizia amara*** **Boiv.** and ***Ocimum basilicum*** **Linn.** at different concentration (2, 4, 6, 8 and 10%) against the different instar (I, II, III and IV) larvae and pupae of *Aedes aegypti*. The LC_{50} values of ***A. amara*** and ***O. basilicum*** for I instar larvae was 5.412 and 3.734, II instar 6.480 and 4.154, III instar 7.106 and 4.664, IV instar 7.515 and 5.124, respectively. The LC_{50} and LC_{90} values of pupae were 6.792, 5.449% and 16.925, 15.474%. The smoke toxicity of ***A. amara*** was more effective against *A. aegypti* than the ***O. basilicum***. Thus, these products can be used as economically viable form for personal protection against mosquito vector. Moreover, this kind of plant-derived product does not cause any ill effect to other beneficial organism [Murugan K, Murugan P and Noortheen A, Larvicidal and repellent potential of *Albizzia amara* Boivin and *Ocimum basilicum* Linn. against dengue vector, *Aedes aegypti* (Insecta:Diptera:Culicidae), *Bioresour Technol*, 2007, **98** (1), 198-201].

Ocimum basilicum

Neem formulations for root-knot nematode on roots of tomato plants

Root-knot nematodes, *Meloidogyne* spp. are the most important nematode pests in both tropical and subtropical crop production regions worldwide. *Meloidogyne incognita* and *M. javanica* are the most damaging species of field crops, vegetables and fruit trees in the warm sandy soils of Pakistan. On tomato these nematodes can cause 24-38% loss, where sequential cropping of one susceptible crop after another is practised with up to four per year. The nematodes feeding on roots cause injuries, which enable entry of other soil-borne pathogens. The high cost of application of nematicides to manage the nematodes and their possible detrimental effects on human and animal health

and the environment has promoted the search for alternatives such as botanical products. Neem (***Azadirachta indica* A. Juss.**) has been known as insecticide used by smallholder farmers, hence the objective of the study done by researchers at Pakistan and UK was whether it could be a valuable method for nematode control. Two types of neem formulations, crude and refined, were tested. The crude form was neem leaves and neem cakes and one of the neem-refined products was *Aza*. The protective and curative soil application of these formulations significantly reduced the number of egg masses and eggs per egg mass on tomato roots. Protective application of neem crude formulations (leaves and cake) did not reduce the invasion of juveniles whereas *aza* at 0.1% w/w did. Curative application of neem formulations significantly reduced the number of egg masses and eggs per egg mass as compared with the control [Javed Nazir, Gowen SR, Inam-ul-Haq M and Anwar SA, Protective and curative effect of neem (*Azadirachta indica*) formulations on the development of root-knot nematode *Meloidogyne javanica* in roots of tomato plants, *Crop Prot*, 2007, **26**(4), 530-534].

Paddy weed control

The scientists at South Korea examined four common medicinal and two leguminous plant species for their potential use in paddy weed control. The screening indicated that all species exhibited strong allelopathic activities, the strongest of which was ***Nerium oleander* Linn.** Allelopathic potentials of plant parts were ranked in the order: leaf>root>stem. The only exception was for ***Alocasia cucullata* Schott**, where the stem displayed the highest potential. In a bioassay, ***N. oleander*** and ***Helianthus tuberosus* Linn.** showed the highest suppression of germination and growth of ***Echinochloa crus-galli* Beauv.** (Barnyard grass) and

Nerium oleander

***Monochoria vaginalis* Presl** (Monochoria). Other than for ***Passiflora incarnata* Linn.**, the spontaneous growth of paddy weeds was significantly suppressed in a greenhouse at 1 tonne/ha. At 1.5 tonnes/ha, all examined species markedly reduced weed plant growth and the dry weight of weeds by 60-100% and 70-100%, respectively. In paddy fields, weed biomass was reduced by 70-80% and rice yield was increased by an average of 20% compared with the control. ***Stylosanthes guyanensis* (Aubl.)Sw.**, a leguminous plant widely used in Southeast Asia and Africa as a cattle feed, cover crop, mulch and for soil improvement, gave the greatest increase in rice yield (25.8%). These plants might be useful as natural herbicides and might also contain numerous growth inhibitors that could be used for the development of biological pesticides [Khanh TD, Hong NH, Xuan TD and Chung IM, Paddy weed control by medicinal and leguminous plants from Southeast Asia, *Crop Prot*, 2005, **24**(5), 421-431].

Side effects of botanical insecticides on coccinellid predators of the date palm scale

Apart from the Indian neem tree, several other plants belonging to family Meliaceae contain compounds with insecticidal activity, including the East African "tree of knowledge", ***Melia volkensii* Gürke**. Oil formulations of ***M. volkensii*** seed extract have been tested to control nymphs of the Desert Locust, *Schistocerca gregaria* (Forskål). It was also reported that neem insecticides classified as harmless to *Coccinella septempunctata* Linn. based on single exposure laboratory bioassays were in fact harmful when tested under more realistic, multiple exposure conditions in microcosm experiments. Several authors proposed that botanical (neem) insecticides in biological or integrated pest management schemes must be used carefully to minimise side effects on ladybirds.

Thus, bioassays were conducted by researchers in Mauritania to determine the toxicity of botanical insecticides from the tree ***M. volkensii*** to ladybird predators of the date palm scale, *Parlatoria planchardi* Targ. ***M. volkensii*** seed extract was formulated in neem oil or a mixture of neem and maize oil. Three preparations were tested on *Chilocorus bipustulatus* Linn. var. *iranensis*, an introduced species, and one on the indigenous *Pharoscymnus anchorago* F., a species already used in previous bioassays. Fourth instar larvae were exposed for 2 days to treated scale-infested date palm leaves. The botanical insecticides were toxic to *C. bipustulatus*. Median lethal application rates (LR_{50}s) were close to the recommended application rate of 1 l/ha. In contrast, *P. anchorago* showed no increased mortality at this rate. Hazard quotients (application rate divided by the LR_{50}) were generally less than 2, suggesting a low risk for both species. However, risk mitigation measures are recommended when using oil formulations because the threshold value for *C. bipustulatus*, the more susceptible of the two ladybird species, would be exceeded at higher dose rates or when conducting multiple applications. Sublethal effects included an extension of the larval stage and morphogenetic defects. These effects were again more pronounced in *C. bipustulatus* than in *P. anchorago* [Peveling Ralf and Ely Sidi Ould, Side-effects of botanical insecticides derived from Meliaceae on coccinellid predators of the date palm scale, *Crop Prot*, 2006, **25** (12), 1253-1258].

Repellent activity of essential oils against *Culex pipiens*

Many researchers reported that the phytochemicals derived from plant sources might be alternative agents for the control of mosquitoes, because they have larvicidal, pupicidal, adulticidal and repellent activity. An attempt has been made by researchers at Turkey to evaluate the repellent efficacy of essential oils extracted from 5 plant species against *Culex pipiens* Linn. (Diptera: Culicidae), usually the most common pest mosquito in urban and suburban settings in the Antalya province. All plant materials and their essential oils used in this study are already used in flavouring, pharmaceuticals, and confectionary and are considered nontoxic to humans.

Essential oils extracted from the seeds of anise (***Pimpinella anisum* Linn.**), dried fruits of eucalyptus (***Eucalyptus camaldulensis* Dehnhardt**), dried foliage of mint (***Mentha piperita* Linn. emend. Huds.**) and basil (***Ocimum basilicum* Linn.**) and fresh foliage of laurel (***Laurus nobilis* Linn.**) were tested for their repellency against the adult females of *Culex pipiens*. All essential oils showed repellency in varying degrees, eucalyptus, basil and anise being the most active [Erler F, Ulug I and Yalcinkaya B, Repellent activity of five essential oils against *Culex pipiens*, *Fitoterapia*, 2006, **77** (7-8), 491-494].

Resveratrol controls microbial flora of fruits

Resveratrol is known as a grapevine secondary metabolite with fungicide activity. The scientists at Spain and Italy jointly investigated the effects of its exogenous application on harvested grapes. The results showed the reduction of microbial flora growth and consequently, prolonged shelf-life, without affecting the nutritional quality of the fruit. Resveratrol treatment also resulted in being effective on fruit that normally does not accumulate such metabolites as, for example, tomatoes, apples, avocado pears and peppers. All treated fruits maintained their post-harvest quality and health longer than the untreated ones. This study demonstrates the potential use of resveratrol as a natural pesticide to reduce post-harvest fungi development on a broad spectrum of fruit types [Jimenez JB, Orea JM, Montero C, Gonzalez Urena A, Navas E, Slowing K, Gomez-Serranillos MP, Carretero E and De Martinis D, Resveratrol treatment controls microbial flora, prolongs shelf life, and preserves nutritional quality of fruit, *J Agric Food Chem*, 2005, **53**(5), 1526-1530].

Fruit baits for *Eudocima phalonia* control

The adult fruit-piercing moth, *Eudocima* (*fullonia*) *phalonia* (L.) Comb. (Lepidoptera: Noctuidae) is a major pest of citrus and numerous other commercial fruit crops. Application of insecticides is undesirable particularly at harvest time in fruit crops. To develop a 'lure and kill' method to control *E. phalonia*, a series of experiments was carried out in field cages and in laboratory to elucidate which fruit baits attract the maximum numbers of adult moths by researchers at Agricultural Experiment Station, College of Natural and Applied Sciences, University of Guam, Mangilao, Guam, USA. *E. phalonia* was significantly attracted to feed more on fruit puree with Agar and Phytogel than on fruit puree with Agarose. Of the 15 fruit baits tested, moths preferred to feed on banana baits more than on any other, followed by guava and orange, which were significantly more attractive than kiwi, apple, pineapple, pear, papaya, mango, grapefruit, tomato or green grape. Star fruit, plum and sour sop fruit baits were the least attractive and were no more attractive than water control treatments. This study identifies valuable attractants which may be used as part of a lure and kill strategy for this important pest and also form a foundation upon which future bioassay-driven fractionation and chemical structure elucidation can be developed [Reddy GVP, Cruz ZT and Muniappan R, Attraction of fruit-piercing moth *Eudocima phalonia* (Lepidoptera: Noctuidae) to different fruit baits, *Crop Prot*, 2007, **26** (4), 664-667].

Aromatic plant-derived larvicide for mosquito control

Interest in the control of *Aedes aegypti* and *Anopheles dirus* lies in the fact that they act as vectors of dengue and dengue hemorrhagic fever and malaria, respectively, which are serious public health problems in Thailand and many developing countries. Recently, essential oils derived from plants have received much interest as potential bioactive agents against mosquito vectors. Thus, five aromatic plants, ***Carum carvi* Linn.** (caraway), ***Apium graveolens* Linn.** (celery), ***Foeniculum vulgare* Mill.** (fennel), ***Zanthoxylum limonella* Alston** (mullilam) and ***Curcuma zedoaria* Rosc.** (zedoary) were selected for investigating larvicidal potential against mosquito vectors by researchers in Thailand. The selection of plants used in this study focused on those belonging to similar or associated plant families reported to have potential against mosquitoes. In addition the herbs used as vegetables and spices in traditional medicine were mainly considered in the search for effective and safe materials. Two laboratory-reared mosquito species, *A. dirus* and *A. aegypti* were used for the experiment. All of the volatile oils exerted significant larvicidal activity against the two mosquito species after 24 hours exposure. Essential oil from mullilam was most effective against the larvae of *A. aegypti*, while *A. dirus* larvae showed the highest susceptibility to zedoary oil [Pitasawat B, Champakaew D, Choochote W, Jitpakdi A, Chaithong U, Kanjanapothi D, Rattanachanpichai E, Tippawangkosol P, Riyong D, Tuetun B and Chaiyasit D, Aromatic plant-derived essential oil: An alternative larvicide for mosquito control, *Fitoterapia*, 2007, **78**(3), 205-210].

Insecticidal activity of *Vitex mollis* H. B. & K.

Organic extracts from the leaves of ***Vitex mollis* H. H. & K.** were assessed by scientists at Mexico for their toxic effect on fall armyworm neonate larvae (*Spodoptera frugiperda*), an important insect pest of corn. The extracts showed insecticidal and insect growth regulatory activity, being $CHCl_3$-MeOH (1:1) extract the most active with LC_{50} 13.63 ppm and 100% larval mortality at 75 ppm. Additionally, the extracts also found to be toxic in the *Artemia salina* test. The results obtained have provided evidence to the potential use of ***V. mollis*** as insecticide. Bioassay-directed fractioning of the most active crude extracts to isolate and identify responsible compounds of the insecticidal activity and their possible mechanism of action was also taken up by them for further study [Rodríguez-López V, Figueroa-Suárez MZ, Rodríguez T and Aranda E, Insecticidal activity of *Vitex mollis*, *Fitoterapia*, 2007, **78**(1), 37-39].

Suppression of root-knot nematodes on tomato by cyanobacterial powder

Root-knot nematodes (*Meloidogyne* spp.) are among the most damaging nematodes in agriculture, causing an estimated US$100 billion loss/ year worldwide. In recent years biological control of plant-parasitic nematodes has become one of the most significant and intensive research areas. Several types of organism, including fungi, bacteria, viruses, nematodes, insects, mites and some invertebrates, have been found to parasitize or prey upon nematodes. Application of microorganisms antagonistic to *Meloidogyne* spp., or compounds produced by the microbes, could provide additional opportunity for managing the damage caused by root-knot nematodes. Very recently one of the biological control practices attempted is the study of cyanobacteria that parasitize plant-parasitic nematodes. Hence, experiments were carried out by researchers at School of Agricultural Biotechnology, Seoul National University, Seoul, Republic of Korea to investigate the nematicidal potential of a cyanobacterium, *Oscillatoria chlorina*, against the root-knot nematode, *Meloidogyne arenaria* (Neal) Chitwood on tomato plants (***Lycopersicon esculentum* Linn.**) grown in pots filled with 500 cm^3 of field soil infested with 12-s stage juveniles (J_2)/ cm^3 soil. Incorporation of freeze-dried cyanobacterial powder into potted field soil at the rate of 0.2, 0.4, 0.6, 0.8 and 1.0% (w/w) for 5 days prior to tomato planting, reduced root galling, final population of *M. arenaria* and increased vegetative growth of tomato plants and root-mass production, compared with untreated control ($P \geq 0.05$). The beneficial effect of adding cyanobacterial powder into infested potted field soil increased exponentially with concentration up to 0.8 per cent. Root galling and nematode population decreased by 68.9% and 97.6%, respectively at the highest dose (1%) of cyanobacterial powder compared with the untreated control. Addition of cyanobacterial powder into infested potted field soil at 5 days before planting was the most effective followed by 2 days before and at the time of tomato planting. It is concluded that application rate and timing are important factors in the control of root-knot nematodes with *O. chlorina* [Khan Z, Kim YH, Kim SG and Kim HW, Observations on the suppression of root-knot nematode (*Meloidogyne arenaria*) on tomato by incorporation of cyanobacterial powder (*Oscillatoria chlorina*) into potting field soil, *Bioresour Technol*, 2007, **98** (1), 69-73].

Toxicity of sucrose octanoate to egg, nymphal and adult *Bemisia tabaci*

The sweet potato whitefly, *Bemisia tabaci* (Gennadius), B biotype, presents a unique problem for vegetable growers by serving as a vector of plant viruses and by inducing physiological disorders of leaves and fruits. An action threshold of a single whitefly is necessary because of the threat of disease in many areas and growers rely heavily on a single class of insecticides (neonicotinoids) for whitefly control. Additional control methods are needed to manage this pest in commercial vegetables. Extracts of wild tobacco contain natural sugar esters that have previously been shown effective in controlling many soft-bodied insects. Toxicity of sugar esters to whitefly eggs has not been reported previously hence the scientists at USA have developed a novel tomato leaf bioassay system to assess a synthetic sugar ester derivative, sucrose octanoate, for insecticidal activity against the eggs, nymphs and adults of *B. tabaci*. The LC_{50} values for sucrose octanoate against adults, second instars and fourth instars of the whitefly were 880, 686 and 1,571 ppm, respectively. The LC_{50} against whitefly eggs was higher (11,446 ppm) but indicated that some eggs mortality occurred at the recommended application rate of 0.8-1.2% [3,200-4,800 ppm (AI)]. The tomato leaf bioassay produced reliable and repeatable results for whitefly toxicity studies and predicted that effective nymph and adult whitefly control can be achieved with sucrose octanoate at application rates ≤1% [4,000 ppm (AI)]. Field efficacy studies are warranted to determine whether this biorational pesticide has application in commercial tomato production [McKenzie CL, Weathersbee III AA and Puterka GJ, Toxicity of sucrose octanoate to egg, nymphal, and adult *Bemisia tabaci* (Hemiptera: Aleyrodidae) using a novel plant-based bioassay, *J Econ Entomol*, 2005, **98**(4), 1242-1247].

Effects of kaolin-based particle film on spruce budworm

The scientists at Canada conducted studies on the influence of a kaolin-based particle film (Surround™ WP Crop Protectant) on spruce budworm (*Choristoneura fumiferana* (Clem) oviposition. Three concentrations (15, 30 and 60 g/l spray carrier) were applied to white spruce [***Picea glauca* (Moench) Voss**]. When presented with different paired choices of oviposition surfaces, spruce budworms laid very few egg masses overall and showed no significant ($P<0.05$) preference between kaolin-coated and untreated foliage. During no-choice tests, spruce budworms were significantly ($P<0.05$) less inclined to oviposit on the 60 g kaolin/litre treated foliage than on the controls, but no kaolin treatment completely inhibited spruce budworm oviposition. Egg mass size and percentage hatch were unaffected by the kaolin treatments and overall the percentage of egg masses laid on foliage was inversely proportional to treatment concentration. It is unlikely that kaolin-based particle film would be practical for wide use in natural forests without significant adaptations to current pesticide application equipment and methods. However, the technique might be feasible in selected urban settings [Cadogan BL and Scharbach RD, Effects of kaolin-based particle film on spruce budworm, *Choristoneura fumiferana* (Lepidoptera: Tortricidae) oviposition in the laboratory, *Pest Manag Sci,* 2005, **61**(12), 1215-1219].

Bioactivity of bryophyte extracts as fungicide

Plant extracts can be used as crude extracts, alternative sources of known fungicides, new leads for fungicides and resistance inducers for an integrated pest management strategy. They are the point of interest in discovery of organic pesticides. Though several phytochemical constituents and medicinal uses of bryophytes are known, their potentials in the course of crop protection remained yet little or unexplored. The scientists at Germany and Ethiopia evaluated the potential of extracts from 17 bryophytes as source of antifungal agents under *in vitro* and *in vivo* circumstances. Results showed that bryophyte extracts from ***Bazzania trilobata***, ***Diplophyllum albicans***, ***Sphagnum quinquefarium***, ***Dicranodontium denudatum*** and ***Hylocomium splendens*** with high level of inhibition (>50%) of the mycelial growth of *Botrytis cinerea* and *Alternaria solani*. Extracts of ***B. trilobata*** and ***D. albicans*** significantly reduced disease severity of *Phytophthora infestans* on tomatoes. Thus the extracts from bryophytes can be used as natural sources for alternative pest managment tools [Mekuria T, Steiner U, Hindorf H, Frahm JP and Dehne HW, Bioactivity of bryophyte extracts against *Botrytis cinerea*, *Alternaria solani* and *Phytophthora infestans, J Applied Bot Food Qual*, 2005, **79**(2), 89-93].

Chitosan for control of post-harvest diseases of tomato fruit

The effects of chitosan on grey mould and blue mould caused by *Botrytis cinerea* and *Penicillium expansum* in tomato fruit stored at 25ºC, and 2ºC, respectively, were investigated by the scientists at China. Results revealed that chitosan provides an effective control of both diseases of tomato fruit stored at 25ºC and 2ºC. Chitosan strongly inhibited spore germination, germ tube elongation and mycelial growth of *B. cinerea* and *P. expansum in vitro*, and damaged the plasma membranes of spores of both pathogens. Chitosan treatment induced a significant increase in the activities of polyphenoloxidase, peroxidase and enhanced the content of phenolic compounds in tomato fruit. These findings suggest that the effects of chitosan on grey mould and blue mould in tomato fruit may be associated with the direct fungitoxic property against the pathogens and the elicitation of biochemical defense responses in fruit [Liu Jia, Tian Shiping, Meng Xianghong and Xu Yong, Effects of chitosan on control of postharvest diseases and physiological responses of tomato fruit, *Postharvest Biol Technol*, 2007, **44**(3), 300-306].