**REVIEW OF LITERATURE**

- **Viruses reported on Duranta**

  During a recent survey for begomoviruses, symptoms typical of begomoviruses, including reduced leaf size, upward leaf curling and chlorosis, were observed by S. Iram et al (2005) on *D. erecta* throughout the Punjab and Northwest Frontier Province (NWFP). To detect the presence of a begomovirus, nucleic acid extracts were prepared from leaf samples showing symptoms collected from 10 distinct locations in the Punjab and NWFP. The DNA was resolved in agarose gels, transferred to nylon membranes and hybridized with an [α 32 P] dCTP-labelled full-length clone of *Cotton leaf curl Multan virus* (pCLCUV003; Mansoor et al., 2003). The pattern of hybridizing single- and double-stranded DNA bands typical of the replication of geminiviruses was observed for all samples with symptoms. None were observed with samples without symptoms, confirming the association of a begomovirus with the disease. The presence of a begomovirus was further confirmed by PCR amplification using primers CLCV1 (virion-sense primer 5′-CCGTGCTGCTGCCCCCATTGTCCGTCAC-3′; annealing within the coat protein gene) and CLCV2 (complementary-sense primer 5′-CTGCCACAACCATGGATTCCACGCACAGGG-3′; annealing in the C2 gene), designed to sequences conserved among begomoviruses from the Indian subcontinent (MSM et al., unpublished data). An amplification product of the expected size (1700 bp) was produced from all samples with symptoms, but not from samples without symptoms. For a sample originating from Faisalabad, the PCR product was cloned and end-sequenced. The sequences obtained showed the highest levels of sequence identity to *Croton yellow vein virus* (91% over a stretch of 407 nucleotides in the virion-sense; *Croton yellow vein virus* is a provisional species in the genus *Begomovirus*) and *Papaya leaf curl virus* (93% identity over a stretch of 462 nucleotides in the complementary sense). These findings suggested that the virus of *D. erecta* is either a recombinant virus or a distinct begomovirus for which authors suggested the name *Duranta* leaf curl virus.

Pigeon Berry (*Duranta repens*) is a common ornamental plant of the family Verbenaceae that is often grown as a garden hedge. In an attempt by M. Tahir et al (2006) to identify alternate hosts of *Cotton leaf curl virus* (CLCuV), leaf samples from *D. repens* showing leaf curl symptoms and apparently healthy (symptomless) plants were collected from Multan, Pakistan. Total DNA was isolated from both types of leaf samples. The presence of a begomovirus was confirmed by PCR amplification using a degenerate primer pair, designed from conserved sequences of genes for replication associated protein and coat protein of begomoviruses (Mansoor et al., 1998). An amplification product of the expected size (i.e. approx. 1.5 kb) was produced from symptomatic samples whereas there was no amplification from the symptomless leaf samples. The PCR product was cloned and sequenced. The DNA sequences obtained from *D. repens* showed the highest levels of sequence identity to croton yellow vein mosaic virus segment A, C1 gene (91% over a stretch of 548 nucleotides in the virionsense). A second genomic component DNA B (approx. 2.8
kb) was identified by PCR using a set of primers designed from published sequences. The DNA B sequences obtained from *D. repens* showed the highest level of identity with *Tomato Leaf Curl New Dehli Virus* segment B, movement protein (94% over a stretch of 400 nucleotides in the complementary-strand). This indicates that the leaf curl disease of *D. repens* is associated with a bipartite begomovirus.

**Other reported disease of Duranta**

**XU Dong-hui et al, (2002)** observed that *Duranta cv Golden Leaves* and *Morus rubra*, the garden plants in Jinjiang City are parasitized by *Cuscuta chinensis*, the parasitical rate is 68%, the withered death rate of host is 24%. The contiguous *Murraya paniculata, Lantana camara, Ixora chinensis, Hibiscus syriacus* and *Lagerstroemia indica* aren't jeopardized.

O. L. Pereira et al, (2006) observed that a black mildew caused by *Asteridiella pittieri* (Meliolales) was observed on the foliage of the ornamental species *Duranta repens* var. *aurea* (Verbenaceae) in the states of Minas Gerais and S’ao Paulo, Brazil. This was the first record of this fungus in Brazil. Although the impact of the disease on the host is minimal, infected plants become unsightly and, therefore, worthless for horticultural purposes.

*Duranta repens* leaves are one of the most important tree species for urban greening. In order to understand the damages caused by the pest disease in cultivation, **Liang Ping et al, (2007)** carried out a systematic investigation on the pest disease of *Duranta repens* cv. golden leaves. Nine species of pests and diseases were identified as follows: *Ceroplastes japonicus Green, Aphis gossyii Glover, Trialeurodes vaporarioum Westwood, Thrips flavus Schrank, Lymantria dispar* (Linnacus), *Bradylaena ravida* (Benson), *Meliola sp.*, *Capnodium sp.*, *Cascuta chinensis* Lamb and a kind of leaf spots, etc. Generally, the pests and diseases happened in less number and caused little damage. As a good greening tree species, it is worthy to further expand the planting range and area.

**Other Ethnomedicinal properties of Duranta**

Three C-alkylated flavonoids 7-O-a-D-glucopyranosyl-3,5-dihydroxy-3’-(4-_acetoxyl-3_-methylbutyl)-6,4’- dimethoxyflavone (1), 7-O-a-D-glucopyranosyl-3,4’-dihydroxy-3’-(4-_acetoxyl-3’-methylbutyl)-5,6-dimethoxyflavone (2), 3,7,4’-trihydroxy-3’-(8’-acetoxy-7_-methyloctyl)-5,6-dimethoxyflavone (3) and a trans-clerodane type diterpenoid (-)-6b -hydroxy-5b ,8b ,9b ,10a- cleroda-3,13-dien-16,15-olid-18-oic acid (4) are reported from *Duranta repens* along with (+)-hardwickiic acid (5) and (-)-3,13-clerodadien-16,15-olid-18-oic acid (6), isolated for the first time from this species. Their structures were established on the basis of the spectral methods, especially two dimensional (2D) NMR spectroscopy (Iqbal et al. 2004).

M. Lobna et al, (2007) isolated from *Duranta repens* Linn. var. *variegate* (Verbenaceae) 24-ethylcholest-5-en-3-â-ol (â-sitosterol) 1, naringenin 2, 3,4-dihydroxy-
bphenethyl-O-áramnopyranosyl-(163)-4-O-caffeoyl-á-D-glucopyranosid (acteoside) 3, lamiide 4, á-glucopyranosyl (162) á-fructopyranoside (sucrose) 5, á-galactopyranosyl(166) á-glucopyranosyl-(162) fructopyranoside (raffinose) 6 and identified by spectral analyses. Antiviral activity against Hepatitis A virus was studied. The total ethanol extract showed 76% inhibition, while the ethylacetate/methanol fraction of celite column showed 88% inhibition of the virus by the plaque reduction assay. Compounds 2, 5, and 6 were reported for the first time from this species. Also, the petroleum ether extract was studied. Both unsaponifiable fraction and fatty acid methyl esters were subjected to GLC for identification of their constituents. The unsaponifiable fraction was found to be a mixture of hydrocarbons ranging from C15 - C27. The fatty acids methyl esters composed of 15 fatty acids in which palmitic acid represent the main component (46%).

Larvicidal activity of crude extracts from the stem and fruits, their fractions and fresh fruit juice of Duranta repens were assayed against the larvae of Culex quinquefasciatus. The highest larval mortality was found in chloroform soluble fraction of stem (LC50 = 10.75 ppm in 12 h) and ethanol extract of fruits (LC50 = 8.51 ppm 12 h) of Duranta repens against I instars larvae. Different concentrations of juice and fresh fruit juice also showed potent effects on C. quinquefasciatus and the larvae showed comparative tolerance with the increase of their age and time. The results suggest that the stem and fruits of Duranta repens are very effective natural larvicide and can be useful against Culex quinquefasciatus (Nikkon et al. 2009).

In a need to explore and utilize naturally occurring products for combating harmful agricultural and public health pests. McConnell Marie Serena et al, (2010) evaluated the insecticidal property of the methanol (ME) and water (AqE) extracts of Duranta erecta Linn. leaves against larvae of Culex quinquefascitatus (Say). The extraction was done by using methanol (ME) and water (AqE) as solvents. The preliminary phytochemical screening of the extracts showed the presence of sugars, tannins, saponins, steroids, alkaloids, phenols, flavanoids, glycosides, triterpenes and carboxylic acid. Both extracts of D. erecta have larvicidal activity. Between the extracts, ME has more than AqE.

The crude ethanol extracts (stem and fruits), their fractions and two triterpenes, β-Amyrin and 12-Oleanene 3β, 21β-diol, isolated as a mixture from the chloroform soluble fraction of an ethanolic extract of Duranta repens stem, were evaluated for antibacterial, antifungal activities by the disc diffusion method and cytotoxicity by brine shrimp lethality bioassay. The structures of the two compounds were confirmed by IR, 1H-NMR, 13C-NMR and LC-MS spectral data. The chloroform soluble fraction of stem and ethanol extract of fruits possess potent antishigellosis activity and also exhibited moderate activity against some pathogenic bacteria and fungi but the isolated compound 1 (mixture of β-Amyrin and 12-Oleanene 3β, 21β- diol) showed mild to moderate inhibitory activity to microbial growth. The minimum inhibitory concentrations (MICs) of the extracts (stem and fruits), their fractions and compound 1 were found to be in the range of 32–128 μg/ml. The chloroform soluble fractions of stem and ethanol extract of fruit showed significant cytotoxicity with LC50 value of 0.94 μg/ml and 0.49 μg/ml, respectively against brine shrimp larvae (Nikkon et al. 2008).
Plant-mediated synthesis of silver nanoparticles is an increasing commercial demand in medicine due to its inhibitory activity on microbes. The emergence of multidrug resistant organisms raises the problem of untreated bacterial infections. To overcome the problem of antibiotic resistance, use of silver nanoparticles synthesized from plants could be an alternative for therapeutic purpose. However, metallic nanoparticles are traditionally synthesized by wet chemical techniques, where the chemicals used are quite often toxic and flammable. An attempt was made to biosynthesize a simple and eco-friendly biosynthesis of silver nanoparticles using Duranta repens leaf extract as the reducing agent. Characterization using UV-Vis spectrophotometry and transmission electron microscopy (TEM) was performed. TEM showed the formation of silver nanoparticles with an average size of 30–80 nm. The antimicrobial efficacy of the synthesized silver nanoparticles (Ag NPs) against common human bacterial pathogens was investigated using Agar well diffusion technique on Mueller-Hinton agar media. The zone of inhibition of the growth of bacteria is compared with the standard antibiotics. A significant zone of inhibition was obtained against human pathogens (Patil et al. 2012).

Antifungal activity of Duranta erecta L. against some phytopathogenic fungi: Aspergillus niger, A. flavus, A. fumigatus and Penicillium sp. For this purpose, methanolic extract of leaf, stem and root were prepared and tested by “Disc Diffusion Method”. The methanol extract was subjected to preliminary phytochemical analysis. Alkaloids, saponins, and polyphenols (tannins and flavonoids) were detected as phytoconstituents of the methanol extract. As a result of antifungal activity it was found that the extract of leaf generally revealed antifungal activity against all Aspergillus spp. but activity was highest against A. fumigatus (20±0.67 mm). Stem extract showed less activity against all test fungi but no activity against A. flavus. Root extract did not show any antifungal activity except A. fumigatus with less activity (9±0.98) (Sharma et al. 2012).

The antibacterial properties of methanol leaf extract of Duranta plumieri was determined against Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus, Klebsiella pneumoniae, Proteus mirabilis and Bacillus subtilis as test organisms using the agar disc diffusion method. The minimum inhibitory concentrations were determined using the microbroth dilution method. The methanol extract was subjected to preliminary phytochemical analysis. Free radical scavenging activity of the methanol extract at different concentrations was determined with 2, 2-diphenyl-1-picrylhydrazyl (DPPH). E. coli, S. aureus, K. pneumoniae, B. subtilis and P. mirabilis were susceptible to D. plumieri extract with minimum inhibition concentrations of 48 mg/ml, 192 mg/ml, 192 mg/ml, 12 mg/ml and 96 mg/ml respectively. The extract had no activity against P. aeruginosa. Alkaloids, glycosides, saponins, steroids and polyphenols (tannins and flavonoids) were detected as phytoconstituents of the methanol extract (Adu et al. 2011).

The antioxidant and antibacterial activities of methanol extracts of five species from Verbenaceae were evaluated and their polyphenols were quantified. Two methods i.e., FRAP
and DPPH were used to estimate the total antioxidant capacity of the plants materials. Antibacterial activity was measured on serotyped bacteria (4) and pathogenic bacteria (13) using the solid agar dishes diffusion method. Polyphenolic quantification was measured using Folin-Ciocalteu, ammonium citrate iron and AlCl3 reagents, respectively. As a whole Duranta erecta L. gave a better antioxidant activity (FRAP: 15.03 m mol EAA/g and IC50: 7.88 m mol EAA/g) and best antimicrobial activity, (22.33 mm) at a concentration of 25 μg/mL. This result was obtained on Gram-positive bacteria such as Staphylococcus epidermidis (Bangou et al. 2012).

Induction of resistance against plant diseases by seed treatment is simple, cost effective and an efficient strategy for disease management. Aqueous extracts of three plants namely, Duranta repens, Polyalthia longifolia and Parthenium hysterophorus were evaluated for induction of resistance against sorghum downy mildew at 2.5% and 5% concentrations by seed sprouts. Seeds were dipped for 3 h, followed by decanting and incubation to obtain sprouts. The sprouts obtained after 42 h incubation were inoculated by dipping in conidial suspension, planted in pots and raised in greenhouse conditions to observe systemic disease incidence. Duranta repens extract at 2.5% and 5% concentrations provided protection of 50.9% and 85% respectively, as against 38.5% protection provided by positive control. Biochemical analysis showed enhanced levels of defence enzymes PAL and POX in plant extract-treated seedlings. Evaluation of 6 solvent fractions of D. repens revealed disease protection by almost all fractions, indicating synergistic effect by various biochemicals. The method is helpful to attain goal of sustainable agriculture with biological and ecological safety. The novel method developed in the present investigation of using weight of seedlings as indicator of health index is effective and more convenient as compared to measurement of root and shoot lengths (manjunatha et al. 2013).