INTRODUCTION
Horticultural crops play a huge role in India’s economy by supplementing the income of the rural people. These crops form a significant part of total agricultural produce and have become key drivers of economic development in many of the states in the country. In the past one decade, there is a change in cropping pattern indicating a shift towards the cultivation of fruit and commercial crops (Mittal, 2007). Horticultural crops contribute 15.7 per cent to Agriculture GDP (Anonymous, 2010a). Cultivation of these crops is labour intensive and thus generates lot of employment opportunities in rural sector. Exports from horticulture contribute about 8 per cent in total agricultural exports from India and hence call for increase in quality production and marketing efforts. Among temperate horticulture crops, apple (Malus × domestica Borkh.) is the most important fruit crop of India. About 99 percent of India’s apple production area occurs mostly in the North-Western hill regions. This area comes under sub-temperate and temperate climate, ideally suited for the production of apple along with other pome and stone fruits. The states of Jammu and Kashmir (J&K), Himachal Pradesh (HP) and Uttarakhand are main apple producing states of India. North-Eastern hills also to some extent produce good quality apples. In India, apples, pears followed by stone fruits (cherry, plum, peach/nectarine, apricot), are cultivated on an area of 2,74,000ha, 23,000ha and 43,600ha respectively (FAO, 2008). In HP apple is the major fruit accounting for more than 40% of total area under fruits and about 88% of total fruit production from the state (Anonymous, 2010b). Commercially, apple is the most important of all the fresh fruits grown in HP, J&K and Uttarakhand. Any losses occurring would affect the economy and livelihood of some growers for whom apple is the only cash crop.

A wide range of pathogens such as fungi, bacteria, virus, viroid and phytoplasma are reported on apple from the world. Some of the economically important viruses and viroids known to cause diseases in apple and other pome and stone fruits are Apple mosaic virus (ApMV), Apple stem grooving virus (ASGV), Apple stem pitting virus (ASPV), Apple chlorotic leaf spot virus (ACLSV), Prunus necrotic ring spot virus (PNRSV), Plum pox virus (PPV), Apple scar skin viroid (ASSVd), Pear blister canker viroid (PBCVd), Apple dimple fruit viroid (ADFVd), Peach latent mosaic viroid and Hop stunt viroid. Laimer (2006) reported that losses due to viruses were second only to fungi. However, in India fungi (scab, ring rot, brown rot, cankers,
rusts, powdery mildew), bacteria (blister spots, crown galls, hairy roots, fire blight), phytoplasma (apple proliferation, decline) and insects (wooly apple aphid) are the only known economically important pathogens on apple. The lack of accurate global figures for crop losses due to viruses makes viral and virus like diseases the least worked upon in India thus, leading to neglect in temperate fruit virus characterization and management.

Bacterial and fungal diseases can be managed by the use of chemicals while plant sacrificing or eradication is the only way to control virus diseases. Viral diseases cause lower yields and reduced quality of plant products leading to economic losses. In perennial crops damage is more profound in comparison to annuals. Viruses may remain latent, spreading throughout the orchards and inflicting damages, sometimes without being in growers’ knowledge. Latent infestations are known to produce small to moderate losses in fruit production (Cembali et al., 2003).

During the initial surveys of apple orchards of HP and J&K virus like symptoms of puckering, curling, mosaic, shot holes, chlorosis were found on some of the apple trees indicating towards the presence of virus infection. Preliminary detection by ELISA showed widespread infection of ACLSV in apple orchards. Due to mixed plantation of fruit trees ACLSV was also detected in other pome and stone fruits. Apple chlorotic leaf spot virus was first reported in Malus spp. from the U.S.A. by Mink and Shay in 1959 (Brunt et al., 1996a). It is the type species of the genus Trichovirus, family Betaflexiviridae (Carstens, 2010). ACLSV has filamentous particles approximately 600-700 nm in length that contain a polyadenylated, single-stranded, plus-sense RNA and multiple copies of a single coat protein (CP) of 21 KDa (Yoshikawa and Takahashi, 1988). The importance of ACLSV is due to its worldwide occurrence and its large host range on pome and stone fruits which are of great economic value. ACLSV infection rate of up to 80-100% in many commercial apple cultivars causing yield losses of the order of 30-40% have been reported (Zhi et al., 2002; Wu et al., 1998; Cembali et al., 2003). The complete nucleotide sequences of ACLSV isolates from apple (Sato et al., 1993a), cherry (German et al., 1997), peach (Marini et al., 2008) and plum (German et al., 1990; Jelkmann, 1996) have been determined.

ACLSV is latent in most apple cultivars, but in sensitive cultivars malformation and reduction in leaf size and chlorotic rings or line patterns have been recorded. The severity of symptoms elicited by ACLSV depends largely on plant species and virus
strains (Németh, 1986a). Infections in stone fruits are also normally latent but severe
graft incompatibilities in some Prunus combinations in nurseries have been observed
(Desvignes and Boye, 1989; Ulubas and Ertunc, 2005). Virulent ACLSV strains
cause symptoms (“butteratura” or “viruela”) on apricot fruits (Liberti et al., 2005),
dark green sunken mottle, severe leaf and fruit deformation known as “butteratura”
in peach (Sutic et al., 1999b), bark split and pseudopox in some plum cultivars
(Dunez et al., 1972). The virus is reported to be transmitted by mechanical
inoculations, grafting and unclean horticultural practices (Brunt et al., 1996a).
Among biotic agents plant viruses are also an important bottleneck in quality and
quantity of yield obtained from temperate fruit crops like apple. The major problem
is at the level of selecting disease free planting material for raising healthy orchards.
The problem is compounded by the fact that a thorough screening and quarantine for
viruses in these crops has been overlooked in Indian scenario. ACLSV along with
ASPV, ASGV, ApMV and PNRSV are the quarantine viruses in Europe and
Australia. There is sporadic information and limited reports based on
symptomatology, transmission and serological detection for some viruses (Bhargava
and Bist, 1957; Dhingra, 1972; Bhardwaj et al., 1994). Keeping in view the
economic importance of apple, the lead obtained and the little information available
on the viruses infecting apples particularly ACLSV the study with following
objectives was proposed:

Objectives
1. Surveys of pome and stone fruit growing areas in HP and J&K
2. Molecular characterization of the genome of ACLSV
3. Assessment of diversity in the genome of ACLSV infecting pome and stone fruit
4. Development of diagnostic tool through heterologous expression of coat protein.