



RESEARCH ARTICLE

# Status of smoky blight (*Botryosphaeria obtusa*), pink (*Corticium salmonicolor*) and nail head (*Nummularia discreta*) canker diseases of apple (*Malus domestica*) in Himachal Pradesh

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**ABSTRACT:** Survey results of apple growing areas in Himachal Pradesh revealed that the highest severity of Smoky Blight Canker (SBC) occurred in Shimla, Sirmaur and Kullu districts while that of Nail Head Canker (NHC) in Kinnaur and Lahaul & Spiti districts. Pink Canker (PC) was uniformly distributed in all the districts with exceptionally high intensity in Kullu. The SBC thrived better at winter (October-March) temperature of 0-15°C/summer (April-September) temperature of 15-20°C as well as high mean rainfall during summer months (April- September) in Shimla, Sirmaur and Kullu (respectively 176, 226 and 123 mm). NHC flourished at 0°C and below, supported by drought and frosty conditions during winters and low annual rainfall in summer months in Kinnaur (58.3 mm) and Lahaul & Spiti (26 mm). PC established under a wide range of temperature and rainfall conditions with tendency to be more severe in high annual mean temperature in winters and high annual mean rainfall areas of Kullu (1377 mm) followed by Shimla (1515 mm) and Sirmaur (1648 mm). On the other hand, it prevailed with comparatively lesser severities in drought prone and less rainfall areas of Kinnaur (801 mm-annual mean) and Lahaul & Spiti (443 mm-annual mean).

**Key words:** Apple, smoky blight, Pink canker, Nail head canker, Prevalence, Himachal Pradesh

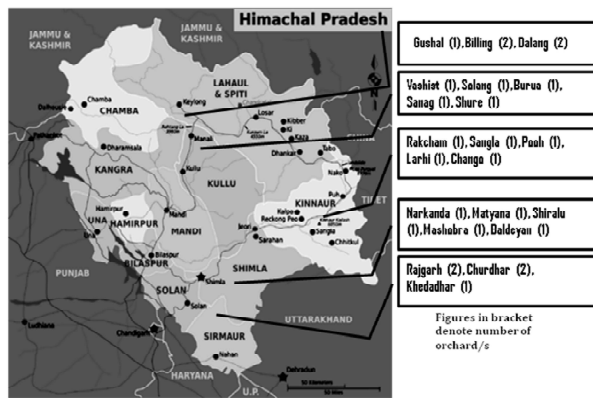
Apple (*Malus x domestica* Borkh.) cultivation commenced in Himachal Pradesh during the later part of nineteenth century. Commercial production of this fruit brought prosperity to its growers and proved to be an economic boon to the state earning it the name of "Apple state of India". At present, apple farming is practiced in 1,06,440 hectares (Anonymous, 2014) by more than 1.45 lakh families earning rich income along with livelihood to other people engaged with this industry as labourers, transporters, middlemen, retailers etc. With average productivity rate of 6.5 t/ha, Himachal Pradesh produced 738.72 thousand tonnes of apple in the year 2013-14 (Anonymous, 2014). But, yield of apple per unit area in this state is low compared to other regions of the world (44.5 t/ha in Chile, FAO, 2015). Outbreak of several diseases from time to time along with other reasons such as poor quality material, inadequate technology, improper inputs, insufficient chilling units, changing climate etc. have been the major constraints in achieving the attainable yield. Many diseases caused by fungi, bacteria, viruses etc. are responsible for immediate and long term losses. Thakur (2008) reported 30-40% total yield loss due to these diseases. Root rot during sixties causing the death of 10-15% apple trees each year (Agarwala, 1961), scab epiphytotic during late eighties onwards (Gupta, 1978; Sharma and Gupta, 1995; Gupta and Sharma, 1995) with reported losses of Rs. 1.5 crores in a single year, 1983 and *Marssonina* blotch in late nineties creating

havoc by premature defoliation (Sharma and Sharma, 2012) have been of major concern to the apple growers of the state. Equally important have been parallel outbreak of cankers in 1970s in the state (Agarwala and Gupta, 1971). Cankers are characterized as localized lesions on a branch or stem which result into sloughing away of plant tissues and creation of wounds increasing in size from season to season. As many as thirteen different cankers have been reported from Himachal Pradesh (Sharma and Sharma, 2012) but a status report on the magnitude of individual canker affiliated to geographically and climatically diversified apple growing areas is still lacking. Presently, we attempted to find out the distribution patterns of three most important cankers of apple viz. Smoky blight, pink and nail head in various apple growing districts of Himachal Pradesh. Such an information may help in conjecturing the accurate appraisal of the disease and consequent economic losses. Also, the allocation trends of various cankers discerned in this survey exercise would apprise the apple growers about the canker resistant varieties to be transplanted in diversified altitudes and geographic locations of the state.

## MATERIALS AND METHODS

The apple orchards having minimum ten trees of same age (8-10 years) were surveyed in five apple growing districts of Himachal Pradesh (Fig. 1) during the autumn months (15 October-15 December) of the year 2014. In each district, 5 random locations/orchards as indicated

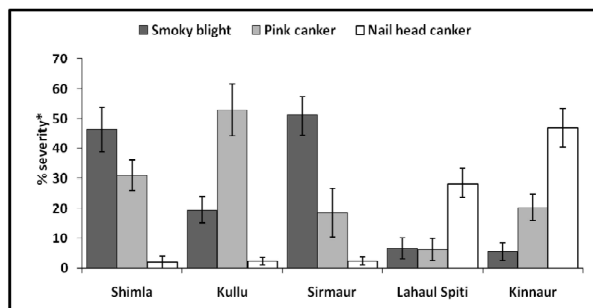
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**Fig. 1.** Locations in five apple growing districts of Himachal Pradesh surveyed for prevalence of three cankers

in the map (Fig. 1) were selected to assess the natural severity of three canker diseases viz. Smoky blight, pink canker and nail head canker. Locations of orchard to be surveyed in each district were chosen within 10 km aerial periphery of the respected headquarters of the districts of Shimla, Sirmaur, Kullu, Lahaul & Spiti and Kinnaur where weather observatory monitored by India Meteorological Department are installed. Assessment of canker severity was made on 10 trees of same age (8-10 years) in each orchard. In all, observations were recorded on 50 trees in each district. Severities of all three cankers recognised on the basis of their typical symptoms (Fig. 7) on trunks and branches were enumerated in terms of percent prevalence (or % disease area) on total biomass of trunk and branches of each tree through visual estimation. Percent severity values of each canker on individual 50 trees per district were subjected to statistical analysis of standard deviation about mean.

Weather data such as temperature, rainfall and relative humidity for five districts were obtained from India Meteorological Department, Meteorological Centre, Birla House, Cliff-end Estate, Shimla (H.P.) and graphically presented in Figs. 3, 4, 5 and 6.



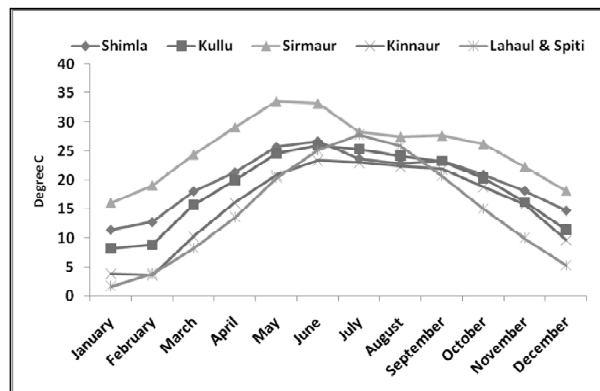
\*Mean of 5 random sites indicated in the map (Fig. 1), each site represented by 50 random trees, site mean (50 trees) of % areas of individual cankers enumerated on the basis of visual assessment, vertical bars represent standard deviation about mean

**Fig. 2.** Incidence of three canker diseases recorded in five apple growing districts of Himachal Pradesh in the autumn of the year 2014

**RESULTS AND DISCUSSION**

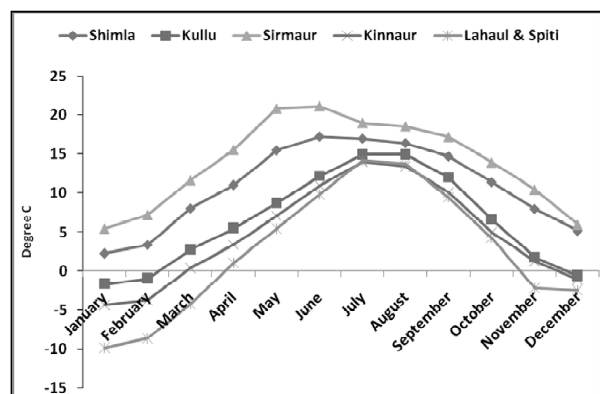
All orchards surveyed in five districts showed presence of three cankers but with distinct levels of severity. Fig. 2 shows the relative proportions of three cankers recorded in all the districts. Smoky blight canker existed to the maximum extent in districts Shimla (45%) and Sirmaur (50%), modestly in Kullu (20%) and to a significantly lower scale in the districts of Kinnaur (6%) and Lahaul & Spiti (5%). Pink canker occurred with maximum severity in Kullu (>50 %) being significantly higher to the levels existing in the districts of Shimla (30%) and Sirmaur (18%). This canker was present in district Kinnaur (18%) with severity levels at par with districts Shimla and Sirmaur. Like smoky blight, the severity of pink canker was also noted the minimum in district Lahaul & Spiti (5%) with the levels significantly the lowest among all the districts. Highest severities of nail head canker were recorded in two districts of Lahaul Spiti (28%) and Kinnaur (50%). Prevalence of this canker in other districts viz. Shimla, Sirmaur and Kullu was very less (2% in each case) and significantly lower to the districts of Lahaul & Spiti and Kinnaur.

Apple is successfully grown at an elevation of 1500-2700 metres above mean sea level in Himachal Pradesh (Awasthi, 2012). Areas surveyed in five districts Shimla,



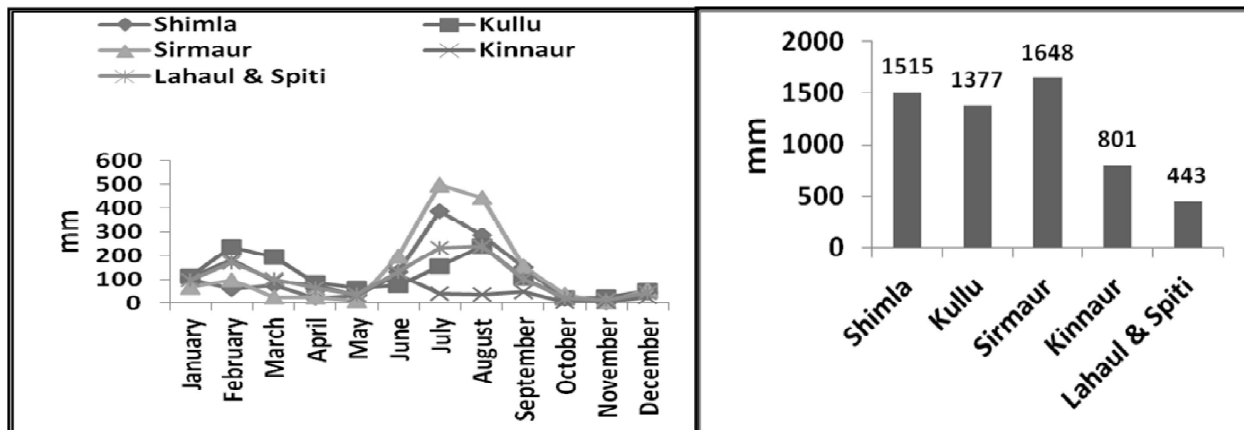
\*Each value is mean of three years 2012, 2013 and 2014

**Fig. 3.** Maximum temperature recorded in canker infested districts of Himachal Pradesh



\*Each value is mean of three years 2012, 2013 and 2014

**Fig. 4.** Minimum Temperature recorded in canker infested districts of Himachal Pradesh\*



\*Each value is mean of three years 2012, 2013 and 2014, monthly mean (left) and annual mean (right)

Fig. 5. Rainfall patterns observed in canker infested districts of Himachal Pradesh\*

Sirmaur, Kullu, Kinnaur, Lahaul & Spiti are located within the elevation suitable for apple cultivation. Intensities of these three canker diseases which were recorded in varying proportions in different areas appears as a phenomenon influenced directly or indirectly by the elevation of the place responsible for creating weather diversity. Weather analysis of three consecutive years, 2012, 2013 and 2014 before the year of survey (autumn of 2014) is given in Figs. 3, 4, 5 and 6 respectively for the climatic components of mean maximum temperature, minimum temperature, rainfall and relative humidity.

Comparative perusal of data depicted in Fig. 2 with Figs. 3, 4 and 5 reveals that climate factors directly influenced the prevalence patterns of these three canker diseases in Himachal Pradesh. Smoky blight established more in areas of Shimla, Sirmaur and Kullu where maximum temperature ranged between 15-27°C in summers (April-September) when petal fall occurs (April-May) and minimum of 0-5°C during winters (October-March). It may be attributed to the fact that ascospores of the pathogen germinate more during petal fall stage as has been demonstrated by Arauz and Sutton (1989). They also reported that at temperature below 15°C, spores germinate very slowly and fail to cause infection. This explains why districts Shimla, Kullu and Sirmaur exhibiting maximum temperature above 20°C during petal fall months had more SBC than the districts of Kinnaur and Lahaul & Spiti with temperature below 15°C during the same period. On the contrary, the nail head canker was recorded the maximum in the districts of Lahaul & Spiti and Kinnaur. The reason may be attributed to the fact that disease infection occurs more through frost cracks as noted earlier by Cooper (1917). Frosting is a more common phenomenon in Lahaul & Spiti and Kinnaur with winter temperature ranging between -5 to -10°C in winters. It seems that higher temperature ranging above 0°C during winter months did not favour development of nail head canker as revealed by very low disease severity in the districts of Shimla, Sirmaur and even in district Kullu. The third disease, the pink canker, exhibited prevalence trend different to smoky blight and

nail head cankers. This disease exhibited its establishment the maximum in district Kullu where temperature ranged below 0°C during winter months. Slightly higher temperature range 3-5°C of districts Shimla and Sirmaur and lower temperature range below 0°C of districts Lahaul & Spiti and Kinnaur did also favoured development of this canker but significantly to a lower extent as compared to the district Kullu (Fig. 2).

On simultaneous glimpse of Figs. 2 and 5, a relationship between prevalence of the cankers under study and the patterns of rainfall in various districts of Himachal Pradesh could be deduced. Nail head canker prevailed with the highest intensity in districts of Lahaul & Spiti and Kinnaur where annual mean rainfall remained below 800 mm throughout the year. This observation is supported by earlier work of Anderson (1956) who found that drought conditions in summer enhanced the disease. On the other hand, districts Shimla and Sirmaur witnessing annual rainfall more than 1300 mm and above supported higher intensity of smoky blight canker. Holmes and Rich (1969) also found that disease will be more severe when maximum spore release takes place during rains. The pink canker showed its uniform presence in all the districts with significantly maximum intensity in Kullu. This disease seems to be adapted to lower as well as higher rainfall areas. Development of all the cankers seems to be independent of the percent relative humidity in the environment as all the districts (Shimla and Kalpa - representing respectively lower and higher altitudes) were recorded with percent R.H. significantly at par throughout the year (Fig. 6). Since rainfall patterns showed influence on establishment of cankers but not R.H., hence it can be concluded that atmospheric humidity does not affect development of cankers but it may be the duration of direct wetness on the host surface facilitating infection or rain splashes helping in release of spores from overwintering/wintering spores in soil which influence development of cankers. Verma (1988 and 1991) also observed that maximum progress and spread of infection takes place during rainy season in case of pink canker. Smoky blight is also favoured by high rainfall resulting in longer wetness on the host

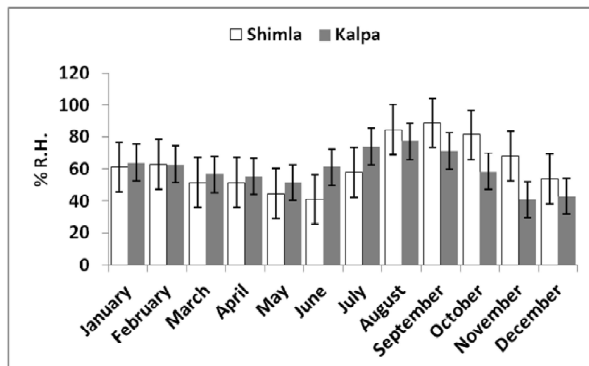


Fig. 6. Percent relative humidity noted in two canker infested districts of Himachal Pradesh.

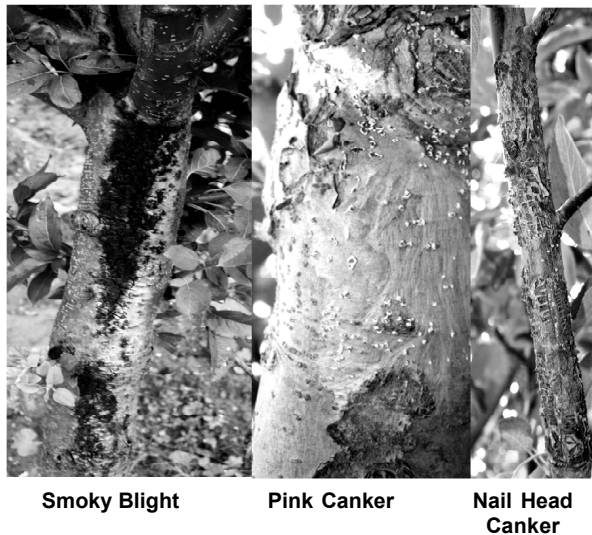


Fig. 7. Symptoms of three cankers surveyed in Himachal Pradesh during autumn of 2014.

surface as substantiated by its high severities in districts Shimla (1515 mm-annual mean rainfall), Sirmour (1648 mm - annual mean rainfall) and Kullu (1377 mm - annual mean rainfall) while nail head canker prefers to develop on dry host surface possible in low rainfall districts of Lahaul & Spiti (443 mm - annual mean rainfall) and Kinnaur (801 mm - annual mean rainfall).

So far, there has been no authentic record showing losses provoked due to outbreak of apple cankers both as single or multiple occurrence. Also, previous few years have witnessed reduction of apple cultivation in the state due to manifestation of several abiotic and biotic constraints surfacing as a result of climate change happening under the influence of global warming. In addition to the direct impact of climate change on apple productivity, it has also aggravated infestation of some diseases and pests resulting in more losses in yield (Sharma, 2012). Overall decrease of about 2-3% in apple yield has been reported in Shimla, Kullu and Lahaul & Spiti districts in mid 2000s and the maximum decline of about 4% was witnessed in marginal farms (Bhagat *et al.*, 2009). A strong comprehension has emerged among apple farmers of Himachal Pradesh

that canker complex has caused mass destruction of trees and orchards making them reluctant to grow apple. After intensification of apple cultivation in the state in the middle of 20<sup>th</sup> century, outbreaks of fungal diseases were successfully encountered by investigating their epidemiology and scientific management by the plant pathologists (Gupta and Sharma, 2005). In the same bid present study has been conducted to throw light on the epidemiology of some important cankers in Himachal Pradesh. The information thus generated may help in devising the effective control strategy using chemicals or deploying resistant cultivars.

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