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Effect of Morphological and Environmental Factors on Oleoresin Yield in *Pinus Roxburghii* Sargent

K R Sharma[1], Rajneesh Kumar[2], Bhupender Dutt[3] and Varun Attri[4]
[1-4]Department of Forest Products, College of Forestry, Dr Y S Parmar University of Horticulture and Forestry, Nauni, HP-173230
Email: rajneeshjee@rediffmail.com

ABSTRACT
Pinus roxburghii, also known as chir pine, is commercially tapped for oleoresin in India. The oleoresin is an important forest produce of pine forests in the world and is biosynthesized as part of a defense mechanism against the major predators (mainly bark beetles and their associated pathogenic fungi). The oleoresin production of pines is not only important to oleoresin industries but it has also got immense potential to generate employment to rural people. Various methods of oleoresin tapping have been used in the past but a new method known as borehole method has been developed which is superior to other methods in improved quality and no impurities. The turpentine, rosin and other products manufactured from it will be better and fetch higher price. Therefore, the present investigation was carried out with the objective to study the effect of morphological and environment factors on oleoresin yield. The trees having the diameter of 30-35 cm were selected for tapping. The oleoresin yield exhibited positive significant correlation coefficient with cone length, number of seeds/cone and needle length. The correlation studies between oleoresin yield and environmental factors showed that the oleoresin yield exhibited positive significant correlation coefficient with maximum temperature and total evaporation and negative correlation with relative average humidity and rainfall.

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INTRODUCTION

Forests are renewable sources providing simultaneously a wide range of economic products for human beings vis-a vis a good amount of unaccounted social and environmental benefits. Pine oleoresin is commercially produced from about 20 pine species in both natural and plantation forests in many developing countries. Indian pines are the most divergent and economically important group of species, which provide valuable natural resources and contribute significantly to the local and industrial economy of our country. The crude oleoresin exudates is converted by steam distillation into its primary fractions of rosin (diterpenes) and turpentine (mono- and sesquiterpenes), which in turn are processed into chemical products such adhesives, coatings, printing inks, paper size, disinfectants, cleaners, food gums, pharmaceuticals, fragrances and flavorings . The demand for forest products and services in India is increasing with rapid economic growth and increase in population pressure. Resin Tapping is an important forest based industry having a bearing on the rural and industrial economy of our country. In Himachal Pradesh chir pine (*Pinus roxburghii* Sargent) is commercially tapped for oleoresin.

Pinus roxburghii Chir pine is a native of the inter-ranges and principal valleys of the Himalaya, beginning from Afghanistan in the west and ending in Bhutan in the east and it extends through Pakistan, India and Nepal. In India, its forests are found in Jammu and Kashmir, Haryana, Himachal Pradesh, Uttar Pradesh, parts of Sikkim, West Bengal and Arunachal Pradesh. The total area under chir forests is estimated to be 8,90,000 hectares and occurs between 450 m and 2300 m altitude. Chir pine mostly forms pure forests in its natural habitat but in upper limits, it is found in association with deodar, kail, ban oak, burans (*Rhododendron*) *etc*. and in the lower limits with sal, sain, khair, harad, bahera, amla, jamun *etc*.

In Himachal Pradesh, chir pine occurs scattered at altitude ranging from 450 m to1050 m over the outer Siwalik hills and lower Himalayas (Kangra, Hamirpur, Bilaspur and Una districts). In Chamba district, pure chir pine forests occur in the outer hills at 900 m – 1350 m altitude and in the Dalhousie range it chiefly occurs between 1200 m – 1500 m altitude. In Kullu district, chir forests are found in outer Saraj, outer Sainj and Tirthan Valley areas, along the banks of Parbatti river extending upto Manikaran and to a limited extent in Hurla and lower Beas Valleys. In Rampur Bushahar (Distt. Shimla), it occurs between 1200 m – 1950 m in Nogli, Taranda, Pandrabis and Pabar ranges. Sometimes the scattered trees may be seen up to 1650 m on the Northern and upto 1800 m on Southern aspects. In Shimla, chir pine occurs in many localities in the form of almost pure forests. In Jubal, it forms very open forests up to 1680 m. In Mandi, also there is fair extent of chir pine forests up to 1800 m. Sirmaur and Solan districts too have extensive Chir pine forests (1).

Tapping of resin in India was started in 1896, although the preliminary experiments were conducted from 1890-1895 to try and utilize the extensive pine forests of Kumon (2). Later on it was taken up in Himachal Pradesh and Jammu & Kashmir, but till today only *Pinus roxburghii* is being tapped commercially, though *Pinus kesiya* is also being tapped to some extent. The total annual resin production from the main resin producing states *i.e.* Jammu and Kashmir, Uttaranchal and Himachal Pradesh is about 60,000 tonnes (3). Himachal Pradesh alone produces 40 per cent of the total resin in India (4).

India is the second largest resin producer in Asia after China. Earlier, India used to export resin, but now consumes all its production internally through its small and large scale industries. With the diversified use of the resin products in various industries, the demand for the same is increasing day-by-day in the country while the production has fallen down considerably from 74,000 tones in 1975-76 to 35,000 tones in 1985-86 and further to 28,000-30,000 tons in 1990-91. During 1994-95 the oleoresin production in India was about 25,000-30,000 tones only (5). The major causes of this decline is the tremendous pressure, unscientific method of tapping and frequent fire in the chirpine forests causing heavy mortality of the trees. So it becomes imperative to search for an alternative. Earlier resin tapping was done with French cup and lip method. This method leads to the deterioration of the wood because of repeated deep cut on the same face of the tree and may lead to breakage of trees due to strong wind. To overcome this problem a new method of oleoresin extraction called 'Rill method' had been developed. But this method also failed to solve the problem, because a new rill was made after four days or at a weekly interval. The excessive use of chemical in this method was the major problem, which not only deteriorates or dries the trees but also deteriorates the quality of oleoresin component.

Borehole technique for resin tapping has been described by Hodges (6). The extraction process in this method involves drilling holes into the wood to open the resin ducts and collect the oleoresin in closed containers. Prolonged resin flow from boreholes for a period of several months is a key feature of this system. Oleoresin production capacity from borehole treatment is the function of volume of resinous wood tissue affected concentration of performed oleoresin in the tissue, exudation pressure potential, flow conductance and induced oleoresin secretion rate. Borehole wounds cause little damage to the tree bark and cambium tissue. Hole are covered by new cambium and bark growth. Since the holes are near the ground level there is no damage to the merchantable part of the tree. This technique can prove to be very effective in conservation and management of pine resources in India. The oleoresin extracted by this method is superior and free from the impurities, so the quality of turpentine, rosin and other products manufactured from it will be better and fetch higher market price.

The oleoresin yield is affected by various morphological and environmental factors such as cone length, cone weight, cone breadth, number of seed /cone, needle length, needle breadth, temperature, humidity, sunshine hours, evaporation *etc*. Keeping in view the importance of these factors the present study was carried out.

MATERIAL AND METHODS

The present investigation was carried out in Chirpine stand at Dr Y S Parmar University of horticulture and Forestry, Nauni-Solan of Himachal Pradesh in the year 2016-17. The oleoresin was extracted by using the borehole method (Fig. 1).

The trees having the diameter of 30-35 cm at breast height were selected. The diameter and height of the trees were measured with the help of tree caliper and Ravi multimeter, respectively. The needle and cone length were measured with the help of simple scale and, needle & cone breadth with the help of digital verner caliper. The number of seeds/ cone was counted manually. The resin yield and cone weight was measured with the help of digital weighing balance. The agro meteorological data were procured from the observatory of Dr Y S Parmar University of horticulture and Forestry, Nauni-Solan. Simple correlation coefficient (Karl Pearson's) between two characters was worked out by using the Panse and Sukhatme (7) formula.

RESULTS AND DISCUSSION

Simple correlation coefficients between oleoresin yield and morphological characteristics are presented in Table 1. Out of 21 correlation combinations eleven was positive and significant at 1% level of significance. The correlation coefficients between rests of the combinations were found to be non-significant. The oleoresin yield exhibited positive significant correlation coefficient with cone length (0.460), number of seeds/cone (0.464) and needle length (0.357). The positive significant correlation coefficient was also observed between cone length & cone weight (0.806), cone breadth & cone weight (0.688), number of seed /cone & cone weight (0.651), Cone Length & cone breadth (0.743), number of seeds /cone & cone length (0.737), needle length & cone length (0.374), number of seeds/ cone & cone breadth (0.669) and needle length & number of seeds/cone (0.357). The results are in agreement with Egorenkov (8), who suggested that the needle and cone characteristics might be a useful indicator of resin yield in breeding programme. A similar study was conducted by Kumar *et al*. (9) in *Pinus wallichiana* and Lekha (10) in *Pinus roxburghii*.

Simple correlation coefficients between environmental factors *viz*., maximum temperature (Max T (°C)), minimum temperature (Min T (°C)), average relative humidity (Av. RH (%)), total sunshine hours/month (Total SS Hrs), total rainfall (Total RF (mm)), total evaporation (Total EVP (mm)), and wind velocity (WS) and oleoresin yield are presented in Table 2. Out of 28 correlation combinations four was positive and significant at 1% level of significance and four correlation coefficients were negatively significant at 1% level of significance. The correlation coefficients between rests of the combinations were found to be non-significant.

Oleoresin yield exhibited positive significant correlation coefficient with maximum temperature (0.630) and total evaporation (0.464). The positive significant correlation coefficient was also observed between total rainfall & average relative humidity (0.589) and total evaporation & wind velocity (0.585). The oleoresin yield had significant and negative correlation with relative average humidity (-0.521) and negative significant correlation coefficient was also observed between total sunshine hours/month & average relative humidity (-0.671), total rainfall & total sun shine hours (-0.656) and wind velocity & average relative humidity (-0.0.639). Highly significant and positive correlation coefficient has been observed between the oleoresin yield and temperature. The increase in yield is due to the effect of temperature, as it reduces the viscosity, thus enhancing the flow of oleoresin. The experimental results revealed that relative average humidity was not significantly correlated with oleoresin yield. However, the low humidity with high temperature increases the oleoresin yield. The results are in accordance with the findings of Deshmukh and Payal (11), Lohani (12) and Kumar *et al*. (9). The correlation coefficient between oleoresin yield and rainfall was non-significant. This might be due to that rainfall lower down the temperature thereby decreasing the oleoresin yield.

Table 1 Simple Correlation between oleoresin yield and cone & needle characteristics

Parameters	Yield	Cone Weight	Cone Length	Cone Breadth	Number of seeds/Cone	Needle Length	Needle Breadth
Yield	1						
Cone Weight	0.284	1					
Cone Length	0.460*	0.806*	1				
Cone Breadth	0.282	0.688*	0.743*	1			
Number of seeds/Cone	0.401*	0.651*	0.737*	0.669*	1		
Needle Length	0.357*	0.246	0.374*	0.139	0.357*	1	
Needle Breadth	0.172	0.006	0.008	-0.054	0.077	-.330	1

*Correlation is significant at the 0.01 level

Table 2 Simple correlation coefficient between environmental factors and oleoresin yield

	Oleoresin Yield	Max T (°C)	Min T (°C)	Av. RH (%)	Total SS Hrs (Hrs)	Total RF (mm)	Total EVP (mm)	WS
Oleoresin Yield	1							
Max T (°C)	0.630*	1						
Min T (°C)	0.069	0.184	1					
Av. RH (%)	-0.521*	-0.244	-0.100	1				
Total SS Hrs (Hrs)	0.194	0.006	-0.011	-0.671*	1			
Total RF (mm)	-0.055	-0.009	-0.022	0.589*	-0.656*	1		
Total EVP (mm)	0.464*	0.391	-0.140	-0.408	0.041	-0.155	1	
WS	0.384	0.134	0.023	-0.639*	0.134	-0.324	0.585*	1

*Correlation is significant at the 0.01 level

CONCLUSION

It has been concluded that the oleoresin yield strongly correlated with the morphological as well as environment factors. Highly significant and positive correlation coefficients were observed between oleoresin yield vs. cone length, oleoresin yield vs. number of seeds/cone and oleoresin yield vs. needle length. The correlation studies between oleoresin yield and environmental factors showed that the oleoresin yield exhibited positive significant correlation coefficient with maximum temperature and total evaporation and negative correlation with relative average humidity and rainfall.

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