IJPSR (2017), Vol. 8, Issue 5 (Research Article)

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 26 October, 2016; received in revised form, 15 December, 2016; accepted, 16 December, 2016; published 01 May, 2017

VARIATION IN RESIN DUCTS AND YIELD IN CHIR PINE POPULATION

Prerna Bhardwaj [*1], Kulwant Rai Sharma [2] and Prem Kumar Khosla [1]

School of Biological and Environmental Sciences [1], Shoolini University, Solan, Himachal Pradesh, India.
Department of Forestry [2], YS Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh, India.

Keywords:

Pinus roxburghii, Resin Yield, Resin ducts, Altitude, Latitude, Morphotypes

Correspondence to Author:
Prerna Bhardwaj

Ph.D Scholar
School of Biological and Environmental Sciences, Shoolini University, Solan, Himachal Pradesh - 173212, India.,

E-mail: prernabhardwaj135@gmail.com

ABSTRACT: *Pinus roxburghii* (F-Pinaceae) is one of the most common chir-pine found in the mid-Himalayan region. The crown of this species displays two different needle colour morphotypes (Dark- Green, Light- Green). It is a well known timber and resin yielding tree. Wood exudes oleoresin which yields rosin and turpentine oil having important role in commercial industry. So, the present study was focused on the identification of superior phenotypes possessing higher quality resin yield from two morphotypes of *P. roxburghii* of Himachal Pradesh. Trees were selected from different areas of Himachal Pradesh with varying latitude and altitude and were tapped for one month. Needle from the same trees were collected, washed and used for section cutting to determine resin ducts. The needle colour, altitude and latitude had significant influence on these parameter. Results showed that the Dharamshala latitudinal cline -32^o to 33^o N (L_3) has recorded maximum resin yield (544.439g) whereas Kullu – Mandi latitudinal cline -31^o to 32^o N (L_2) observed minimum resin yield (312.795g) and the highly significant resin ducts (4.622) was found in Dharamshala latitudinal cline -32^o to 33^o N (L_3) whereas minimum resin ducts (2.317) was observed in Solan latitudinal cline -30 ^{o} to 31^o N (L_1).

INTRODUCTION: *Pinus roxburghii* known as chir pine, is the most important species in India. It is also found in Western Ghats in temperate and sub-tropical conditions. The species also overlapps with *Pinus wallichiana* and *Cedrus deodara* in temperate reaches embodying mild snowfall. It is scattered over Kashmir to Bhutan and in the Shiwalik hills at an altitude of 450-2,400m. All coniferous trees synthesize and secrete resin that vary somewhat in content and type of resin acids [6]. Chir pine is the primary species commercially tapped for oleoresin in India.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.8(5).2213-17

Article can be accessed online on: www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.8 (5).2213-17

P. roxburghii a species of considerable economic importance in India, plays an important role in the commerical forestry. The resin, in general terms, is a liquid hydrocarbon secretion of many plants, and is mainly composed of volatile and nonvolatile terpenes and essential oils [9]. It exudes rosin and turpentine oil. Turpentine oil is a clear, transparent liquid with a pungent and bitter taste obtained from Chir pine.

The turpentine is chiefly used as a solvent in pharmaceutical preparations, perfume industry, in manufacture of synthetic pine oil, disinfectants, insecticides and denaturants. It is one of the most important basic raw materials for the synthesis of terpene chemicals which are used in a wide variety of industries such as adhesives, paper and rubber. Chir pine rosin is principally used in paper, soap, paint, varnish and polish industries.

Resin canals exude a complex of secondary metabolites (resin or pitch) as a result of injury from wind, fire, or attack by wood-boring insects. Resin canals also serve as an important diagnostic characteristic in conifers [4, 12]. The number of resin ducts and the relative position of resin canals in the needle may be used as an aid in identification [2]. The present investigation were undertaken with an aim to study the variation in resin ducts and yield in natural population of *P. roxburghii.*

MATERIALS AND METHODS: Samples of oleoresin and needles were collected from different sampling sites. Trees which were located about 100m apart from each other were selected for the study in order to avoid inbreeding. Himachal Pradesh constitutes the sampling area. It is divided into three latitudinal clines 30^0N-31^0N, 31^0N-32^0N, 32^0N-33^0N which further was divided into three altitudinal clines upto 800m, 800m-1500m, 1500m-2200m. From each altitudinal cline the oleoresin were collected from three trees representing two morphotypes Dark green, Light green. Trees were tapped for one month by using Bore hole method [14]. The method involves drilling of holes into the wood. Holes 2.5cm in diameter were drilled to a depth of 10 cm. A chemical spray of 1:1 mixture of 10 per cent 2-chloroethyl-phosphonic acid or Ethephon and 20 per cent sulphuric acid was applied with fine spray bottle. The sprouts were tightly fixed and polythene bags were attached to the sprouts with the help of tie for the collection of oleoresin. Needles from the same trees were randomly selected for the determination of resin ducts through section cutting technique [10]. Mean and standard error were calculated for each trait. The first and second order interactions were also calculated.

RESULTS AND DISCUSSION: The latitude, altitude and color of needle showed significant effect on resin yield and resin ducts in different regions of Himachal Pradesh.

Resin ducts: The data on effect of latitudinal clines, altitudes and colour of needle on resin ducts are presented in **Table 1**.

The latitudinal clines showed significant effect on resin ducts. The maximum resin ducts (4.622) was found in Dharamshala latitudinal cline -32^o to 33^o N (L_3) whereas minimum resin ducts (2.317) was observed in Solan latitudinal cline -30^o to 31^o N (L_1**)**. Different altitudes also noticed significant effect on resin ducts. The maximum resin ducts (5.917) was recorded in trees growing between 1500-2000 m in altitude and the minimum resin ducts (1.700) was recorded in trees growing upto 800m altitude. The needle colour also had significant influence on this parameter. The maximum resin ducts (3.874) was observed in dark green trees and minimum value (2.741) was noticed in light green trees. The interaction between latitudinal cline and altitude was found to be statistically non- significant.

The second order interaction between latitudinal clines, needle colours the interaction $L_2A_1C_1$ (6.900) had significantly highest resin ducts (1.456). The significantly lowest value of (1.467) was recorded in $L_1A_3C_2$ which was statistically at par with $L_3A_2C_2$ (1.567), $L_1A_1C_2$ (1.633), $L_1A_3C_1$ (1.933), $L_3A_3C_2$ (2.000), $L_1A_2C_2$ (2.067). Resin ducts is an important character applied in classifying the Pinene and particularly in distinguishing *Pinus* species [2, 7, 13, 15, 19, 25].

Same results have been reported by Sheue [21] who discovered the variation of resin ducts in *Pinus taiwanensis* needles along an elevation gradient. The resin ducts is an important factor which influences the oleoresin yielding capacity of the tree [22].

TABLE 1: EFFECT OF LATITUDINAL CLINES, ALTITUDES AND COLOUR OF NEEDLES ON RESIN DUCTS OF *PINUS ROXBURGHII*

	1500-2000m (A_1)	**800-1500m (A_2)**	**Up to 800m (A_3)**	**Mean**
Solan latitudinal cline -30^{o}to 31^o N (L_1)	2.450	2.800	1.700	2.317
Kullu –Mandi latitudinal cline -31^{o}to 32^o N (L_2)	4.550	1.983	2.417	2.983
Dharamshala latitudinal cline -32^{o}to 33^o N (L_3)	5.917	3.383	4.567	4.622
Mean	4.306	2.722	2.894	
	SE$\pm$(d)	C.D.$_{0.05}$		

Latitudinal clines (L)	0.140	0.284
Altitudes (A)	0.140	0.284
Interaction (L x A)	0.242	0.492

	Solan latitudinal cline - 30° to 31° N (L_1)	**Kullu–Mandi latitudinal cline -31° to 32° N (L_2)**	**Dharamshala latitudinal cline -32° to 33° N (L_3)**	**Mean**
Dark green (C1)	2.911	3.411	5.300	3.874
Light green (C2)	1.722	2.556	3.944	2.741
	SE±(d)	$C.D._{0.05}$		
Colour (C)	0.114	0.232		
Interaction (C x L)	0.197	N/A		

	1500-2000m (A_1)	**800-1500m (A_2)**	**Up to 800m (A_3)**
Dark green (C1)	5.056	3.167	3.400
Light green (C2)	3.556	2.278	2.389
	SE±(d)	$C.D._{0.05}$	
Interaction (C x A)	0.197	N/A	

	Solan latitudinal cline -30°to 31° N (L_1)			**Kullu –Mandi latitudinal cline -31°to 32° N (L_2)**			**Dharamshala latitudinal cline -32°to 33° N (L_3)**		
	1500-2000m (A_1)	**800-1500m (A_2)**	**Up to 800m (A_3)**	**1500-2000m (A_1)**	**800-1500m (A_2)**	**Up to 800m (A_3)**	**1500-2000m (A_1)**	**800-1500m (A_2)**	**Up to 800m (A_3)**
Dark green (C_1)	3.267	3.533	1.933	5.000	2.400	2.833	6.900	3.567	5.433
Light green (C_2)	1.633	2.067	1.467	4.100	1.567	2.000	4.933	3.200	3.700
	SE±(d)	$C.D._{0.05}$							
Interaction (AxLxC)	0.342	0.695							

Resin yield: The experimental results of the present study have shown significant variation in resin yield with respect to latitude, altitude and colour of needle.

The data on effect of latitudinal clines, altitudes and colour of needle on resin yield are presented in **Table 2**.

Effect of latitude on resin yield was statistically significant. The Dharamshala latitudinal cline -32° to 33° N (L_3) has recorded maximum resin yield (544.439g) whereas Kullu–Mandi latitudinal cline -31° to 32° N (L_2) observed minimum resin yield (312.795g). Different altitudes noticed significant effect on resin yield. The maximum resin yield (543.339g) was recorded in trees growing between 1500-2000m in altitude and the minimum resin yield (335.539g) was recorded in trees growing between 800-1500m altitudes.

The colour of needle has observed significant influence on resin yield. The maximum resin yield (716.456g) was found in dark green needle color trees growing between 1500-2000 m in altitude which was statistically at par with upto 800m A_3x C_1 (582.889g) and minimum value of resin yield (218.167g) was found in light green trees growing upto 800 m in altitude which was statistically at par with A_2xC_2 (277.189g).

Many researchers reported that the yield of oleoresin is affected by number of factors such as diameter, tree crown, growth rate, inherited capacity of individual, environmental factors, time of tapping, stimulants, width of blaze and diameter and depth of boreholes [11, 24,] number of resin canals [18], atmospheric temperature [1].

Resin ducts of needles and resin yield of stem varies along with latitudinal and altitudinal clines and colour of needle strongly and statistically effects these parameters. These results were similar with the findings of many researchers [20]. Resin production is also affected by genotype and environmental interaction [23].

TABLE 2: EFFECT OF LATITUDINAL CLINES, ALTITUDES AND COLOUR OF NEEDLES ON RESIN YIELD OF *PINUS ROXBURGHII*

	1500-2000m (A_1)	800-1500m (A_2)	Up to 800m (A_3)	Mean
Solan latitudinal cline -30°to 31° N (L_1)	528.200	373.533	364.783	422.172
Kullu –Mandi latitudinal cline -31°to 32° N (L_2)	473.600	208.433	256.350	312.795
Dharamshala latitudinal cline -32°to 33° N (L_3)	628.217	424.650	580.450	544.439
Mean	543.339	335.539	400.528	
	SE±(d)	$C.D._{0.05}$		
Latitudinal clines (L)	48.884	99.372		
Altitudes (A)	48.884	99.372		
Interaction (L x A)	84.670	N/A		

	Solan latitudinal cline -30°to 31° N (L_1)	Kullu–Mandi latitudinal cline -31°to 32° N (L_2)	Dharamshala latitudinal cline -32°to 33° N (L_3)	Mean
Dark green (C_1)	558.000	388.089	747.145	564.411
Light green (C_2)	286.345	237.500	341.733	288.526
	SE±(d)	$C.D._{0.05}$		
Colour (C)	39.914	81.137		
Interaction (C x L)	69.133	140.533		

	1500-2000m (A_1)	800-1500m (A_2)	Up to 800m (A_3)
Dark green (C_1)	716.456	393.889	582.889
Light green (C_2)	370.222	277.189	218.167
	SE±(d)	$C.D._{0.05}$	
Interaction (C x A)	69.133	140.533	

	Solan latitudinal cline -30°to 31° N (L_1)			Kullu –Mandi latitudinal cline -31°to 32° N (L_2)			Dharamshala latitudinal cline -32°to 33° N (L_3)		
	1500-2000m (A_1)	800-1500m (A_2)	Up to 800m (A_3)	1500-2000m (A_1)	800-1500m (A_2)	Up to 800m (A_3)	1500-2000m (A_1)	800-1500m (A_2)	Up to 800m (A_3)
Dark green (C_1)	726.600	432.167	515.233	518.167	253.400	392.700	904.600	496.100	840.733
Light green (C_2)	329.800	314.900	214.333	429.033	163.467	120.000	351.833	353.200	320.167
	SE±(d)	$C.D._{0.05}$							
Interaction (AxLxC)	119.741	N/A							

CONCLUSION: Resin is an economical and industrial important product and chir pine is the principal source for its tapping. So, before resin tapping it is important to select best chir pine trees. In the studied traits, resin yield and resin ducts varies with latitude and altitude which indicates that these traits are influenced by environmental effects. According to the results of SED and CD obtained through OPSTAT software suggests that the dark green trees growing in 1500-2000m altitude and 32º-33º N latitude are good resin yielders and can be selected for resin tapping.

ACKNOWLEDGMENT: The authors are thankful to Shoolini University of Management Sciences and Biotechnology and Dr. YS Parmar University of Horticulture and Forestry, Solan for providing facilities and guidance.

CONFLICT OF INTEREST: No

REFERENCES:

1. Anonymous: Indian Forest Utilization 1972: 826-848.
2. Boratyñska K, Bobowicz M: Ramond taxonomy based on needle characters. Plant Systematics and Evolution 2001; 277: 183-194.
3. Harlow WM: The identification of the pines of the United States, native and introduced, by needles structure. New York States College of Forestry Technical Publication 1931.
4. Fahn A: Secretory tissues in plants. Academic Press, New York 1979.
5. Farjon A: World check list and bibliography of conifers. Royal Botanic Gardens, Kew, Richmond, UK 1998.
6. Frankis MP: Generic inter-relationships in Pinaceae. Notes Royal. Botanic. Garden. Edinburgh 1989; 45: 527–548.

7. Fu L, N Li, Mill RR, Wu ZY and Raven PH: Flora of China, Cycadaceae through Fagaceae. Science Press, Beijing and Missouri Botanical Garden Press, St. Louis 1999; 4: 11-52.
8. Hodges AW: Management strategies for a borehole resin production system in slash pine. Dissertation submitted to Univeristy of Florida, Gainesville, FI 1995.
9. Holmbom T, Reunanen M, Fardim P: Composition of callus resin of Norway spruce, Scots pine, European Larch and Douglas fir 2008; 62: 417- 422.
10. Johansen DA: Plant Microtechnique. McGraw-Hill Book Co. New York 1940.
11. Kedarnath S: Evolving high oleoresin yielding strains of chir pine (*Pinus roxburghii*) through breeding. Sympine Technical papers Vigyan Bhavan, New Delhi 1971; 1-5.
12. Langenheim JH: Plant resins Chemistry, Evolution, Ecology and Ethnobotany. Timber Press Portland, Cambridge 2003.
13. Law YW, Cheng WC, Fu LK, Chu CD, Chao CS: Flora Reipublicae Popularis Sinicae. Tomus 7, Gymnospermae. Science Press, Beijing 1978; 204-281.
14. Lekha C, Sharma R: Borehole method of oleoresin tapping in chir pine (*Pinus roxburghii*): Forest Chemical Review 2005; 115(3): 11-17.
15. Li HL, H Keng., Pinaceae. In Editorial Committee of the Flora of Taiwan, Flora of Taiwan. Pteridophyta and Gymnospermae, 2nd edn. Taipei 1994; 1: 567-581.
16. Lin JX, Hu YS and Wang FH: Wood and bark anatomy of *Nothotsuga* (Pinaceae): Annals of the Missouri Botanical Garden 1995; 82: 603–609.
17. Lin JX, Liang EY, Farjon A: The occurrence of vertical resin canals in *Keteleeria*, with reference to its systematic position in Pinaceae. The journal of the Linnean Society 2000; 134: 567–574.
18. Prokazin EP: Forms of *Pinus sylvestris* with a high resin yield: Lesn. Hoz 1958; 2: 19-21.
19. Richardson DM., Ecology and Biogeography of *Pinus*, Cambridge University press 1998.
20. Sharma R, Murtem G, Lekha C: Effect of morphological and environmental parameters on oleoresin yield in chir pine (*Pinus roxburghii* Sargent). The Indian Forester 2013; 139 (6): 525-529.
21. Sheue, CR., Yang YP, and Kuo-Huang LL: Structural variation of the needles of *Pinus taiwanensis* Hay along an elevational gradient. Taiwan Journal of Forest Science 2000; 15**:** 337-349.
22. Sikarwar R, Rajawat BS, Sharma KR: Studies on relationship between stomatal density and oleoresin yield in chir pine (*Pinus roxburghii*). International journal of advanced research 2014; 2 (3): 751-758.
23. Spanos K, Gaitanis D: Resin production in natural Aleppo pine stands in northern Evia, Greece. Web Ecology 2010; 10: 38–43.
24. Verma VP, Pant SP: Effect of width of blaze and stimulant in resin tapping on the growth of chir pine (*Pinus roxburghii* Sargent.). The Indian Forester 1978; 104: 36-41.
25. Wu H, Hu ZH: Comparative anatomy of resin ducts of the Pinaceae: Trees 1997; 11**:** 135–143.

How to cite this article:
Bhardwaj P, Sharma KR and Khosla PK: Variation in resin ducts and yield in chir pine population. Int J Pharm Sci Res 2017; 8(5): 2213-17.doi: 10.13040/IJPSR.0975-8232.8(5).2213-17.