IJBPAS, November, 2016, 5(11): 2763-2770

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

VARIATION IN CONE CHARACTERISTICS OF *PINUS ROXBURGHII*

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Received 30th July 2016; Revised 4thSept. 2016; Accepted 24th Sept. 2016; Available online 1st Nov.2016

ABSTRACT

The present study was undertaken to assess the variation in cone characteristics of *Pinus roxburghii* sampled from different latitudinal and altitudinal clines of Himachal Pradesh. The cone parameters were measured using standard measuring techniques and expressed in metric system. The length, breadth and weight of cones exhibited significant variation among the clines. The Dharamshala latitudinal cline-32° to 33°N (L3) recorded maximum cone weight (150.132g) whereas, Kullu – Mandi latitudinal cline -31° to32°N (L2) observed minimum cone weight (131.016g). The significantly highest cone length (17.526 cm) was noticed in Dharamshala latitudinal cline -32° to 33°N (L3) while lowest cone length (15.386 cm) was observed in Kullu-Mandi latitudinal cline -31° to 32°N (L2). The Dharamshala latitudinal cline -32° to 33°N (L3) has also recorded maximum cone breadth (19.972cm) and Kullu – Mandi latitudinal cline -31° to 32°N (L2) observed minimum cone breadth (18.145cm). Among all the clines cone traits were recorded to be robust at Dharamshala cline.

Keywords: *Pinus roxburghii* Sarg, latitude, altitude, needle colour, cone length, cone breadth, cone weight.

INTRODUCTION

Pinus roxburghii, commonly known as chir pine, found in the mid Himalayan region; is named after William Roxburgh. It is a tall tree scattered over Kashmir to Bhutan and in the Shiwalik hills at altitudes of 450-2,400m. The diverse range of climatic condition in the natural distribution of chir is expected to result in high genetic variation within different populations of this species. Provenance variation with respect to

morphological, physiological and biochemical traits has been studied in chir pine Thapliyal and Dhiman, (1997).The present investigation were undertaken with an aim to evaluate the variation in cone characteristics of *P.roxburghii* sampled from different regions of Himachal Pradesh according to different latitudinal and altitudinal clines.

MATERIAL AND METHODS

The cones were collected from different sampling sites which were tallest, straightest, best shaped with well developed crowns and were free from pests and diseases. 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 cones were collected from three trees representing two morphotypes Dark green, Light green. Trees which were located about 100m apart from each other were selected for the study in order to avoid inbreeding FAO, (1985). Three cones per tree were collected at random for recording the cone weight, length andbreadth. The data recorded for different cone characteristics were subjected to statistical analysis under RBD (Factorial) as suggested by Panse and Sukhatme (1967).Mean and standard error were calculated for each trait. The first and second order interactions were also calculated.

RESULT AND DISCUSSION

Variation due to latitude, altitude and colour of needle was found in cone characters of *P.roxburghii* in different areas of Himachal Pradesh. The mean, standard error and critical difference among different parameters are presented in Tables 1, 2, 3.

Cone weight

The data on effect of latitudinal clines, altitudinal clines and colour of needle on cone weight (g) are presented in Table 1.

The latitudinal clines was found to be statistical significant. The Dharamshala latitudinal cline -32^oto33^o N (L3) has recorded maximum cone weight (150.132g) whereas, Kullu – Mandi latitudinal cline -$31^o$to 32^o N (L2) observed minimum cone weight (131.016g). Different altitude had also significant influence on cone weight. The highest cone weight (151.149g) was observed at 800-1500m altitude and lowest cone weight (126.296g) was found to be in 1500-2000m altitude. The data on colour of needles also had significant influence on cone weight. The maximum cone weight (169.819g) was recorded in dark- green trees in Dharamshala latitudinal cline -32^o to33^oN (L3) and minimum cone weight (117.639g)

was recorded in light green trees of Kullu-Mandi latitudinal cline -31°to 32° N (L2).

The second order interaction between latitudinal clines, altitudes and needle colours the interaction Z2x A2x C1 had significantly highest cone weight (192.050g). The significantly lowest value of (102.641g) was recorded in Z1x A1 x C2 which was statistically at par with Z3x A1x C2 (108.464 g), Z3x A3x C2 (109.627g), Z2x A1x C2 (118.100g). The interaction between colour of needle and altitude was observed to be statistically non-significant.

Same results have been reported by Dinesh et al., (2007)who concluded that more than 90 per cent of the variation in cone fresh weight was at the between-tree within-population and the within-tree level. Within-tree variation (39%) was smaller than between tree within-population variation (52%) for cone fresh weight. The highest coefficient of variation was recorded for cone fresh weight (15.54g) by Mukherjee et al., (2004) and revealed that the difference recorded may be in response to different intensities of natural selection pressure acting upon these traits in their natural habitat. In a leguminous species the pod, seed and germination traits were considered largely under maternal influences but were strongly controlled by micro and macro habitats, besides the age and general health of the parent trees ISIK, (1986).

Table 1: Effect of latitudinal clines, altitudes and colour of needles on cone weight (g) of *Pinus roxburghii* Sargent

	1500-2000m(A1)	800-1500m(A2)	Up to 800m(A3)	Mean
Solan latitudinal cline -30°to 31° N (L1)	119.461	152.900	138.737	137.033
Kullu–Mandi latitudinal cline -31°to 32° N (L2)	127.472	143.412	122.165	131.016
Dharamshala latitudinal cline -32°to 33° N (L3)	131.953	157.135	161.308	150.132
Mean	126.296	151.149	140.737	
	SE+(d)	C.D.$_{0.05}$		
Latitudinal cline (L)	6.896	14.017		
Altitudes (A)	6.896	14.017		
Interaction (L x A)	11.944	N/A		

	Solan latitudinal cline -30°to 31° N (L1)	Kullu–Mandi latitudinal cline -31°to 32° N (L2)	Dharamshala latitudinal cline -32°to 33° N (L3)	Mean
Dark green (C1)	146.319	144.394	169.819	153.511
Light green (C2)	127.746	117.639	130.445	125.277
	SE+(d)	C.D.$_{0.05}$		
Colour (C)	5.630	11.445		
Interaction (C x L)	9.752	N/A		

	1500-2000m(A1)	800-1500m(A2)	Up to 800m(A3)
Dark green (C1)	142.856	171.005	146.671
Light green (C2)	109.735	131.293	134.802
	SE+(d)	C.D.$_{0.05}$	
Interaction (C x A)	9.752	N/A	

	Solan latitudinal cline -30°to 31° N (L1)			Kullu–Mandi latitudinal cline - 31°to 32° N (L2)			Dharamshala latitudinal cline -32°to 33° N (L3)		
	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)	1500-2000m(A1)	800-1500m (A2)	Up to 800m (A3)	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)
Dark green (C1)	136.281	168.967	133.710	146.480	151.999	134.703	145.807	192.050	171.600
Light green (C2)	102.641	136.833	143.763	108.464	134.826	109.627	118.100	122.219	151.017
	SE±(d)	C.D.$_{0.05}$							
Interaction (AxLxC)	N/A	16.891							

Cone length

The data on effect of latitudinal clines, altitudes and colour of needles on cone length (cm) are presented in Table 2.

All the three latitudinal clines differed significantly in cone length. Dharamshala latitudinal cline -32°to 33° N (L3) noticed significantly highest cone length (17.526 cm) and Kullu - Mandi latitudinal cline -31°to 32° N (L2) observed lowest cone length (15.386 cm). Altitudes recorded significant effect on cone length. The 800-1500 m altitude had significantly maximum cone length (16.938 cm) while altitude upto 800 m recorded minimum cone length (15.892 cm).

Needle colour had also noticed significant effect on cone length. The trees having dark-green needle colour had significantly more cone length (17.321 cm) as compared to trees having light green needle colour (15.431 cm).

Both first and second order interactions among these parameters were found to be statistically non-significant for this parameter.

These findings were similar to the findings of Gil et al., (2002) who noticed positive relationship between cone length and altitude in their natural population of *Pinus. canariensis.* Mxingfei Ji et al.,(2011) also noted that the magnitudes of morphological traits (Cone length, cone breadth, seed length and seed breadth) of cone exceeded 50% significant variation, indicating that these phenotypic variables mainly depended on the climatic or geographic variation rather than the genetic differentiation.

Table 2: Effect of latitudinal clines, altitudes and colour of needles on cone length (cm) of *Pinus roxburghii* Sargent

	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)	Mean
Solan latitudinal cline -30°to 31° N (L1)	16.167	16.483	16.000	16.217
Kullu–Mandi latitudinal cline -31°to 32° N (L2)	15.823	16.247	14.088	15.386
Dharamshala latitudinal cline -32°to 33° N (L3)	16.907	18.083	17.587	17.526

Mean	16.299	16.938	15.892	
	SE+(d)	$C.D._{0.05}$		
Latitudinal cline (L)	0.384	0.781		
Altitudes (A)	0.384	0.781		
Interaction (L x A)	0.665	N/A		

	Solan latitudinal cline -30°to 31° N (L1)	Kullu–Mandi latitudinal cline -31°to 32° N (L2)	Dharamshala latitudinal cline -32°to 33° N (L3)	Mean
Dark green (C1)	17.300	16.304	18.358	17.321
Light green (C2)	15.133	14.468	16.693	15.431
	SE+(d)	$C.D._{0.05}$		
Colour (C)	0.314	0.637		
Interaction(CxL)	0.543	N/A		

	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)
Dark green (C1)	17.271	18.254	16.437
Light green (C2)	15.327	15.621	15.347
	SE+(d)	$C.D._{0.05}$	
Interaction(CxA)	0.543	N/A	

	Solan latitudinal cline -30°to 31° N (L1)			Kullu–Mandi latitudinal cline - 31°to 32° N (L2)			Dharamshala latitudinal cline -32°to 33° N (L3)		
	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)
Dark green (C1)	17.467	18.467	15.967	16.807	16.863	15.243	17.540	19.433	18.100
Light green (C2)	14.867	14.500	16.033	14.840	15.630	12.933	16.273	16.733	17.073
	SE+(d)	$C.D._{0.05}$							
Interaction (AxLxC)	0.941	N/A							

Cone breadth

The data on effect of latitudinal clines, altitudes and colour of needle on cone breadth (cm) are presented in Table 3.

Both the clines (latitudinal and altitudinal) had significant influence on cone breadth. The Dharamshala latitudinal cline -32°to 33° N (L3) has recorded maximum cone breadth (19.972cm) whereas Kullu – Mandi latitudinal cline -31°to 32° N (L2) observed minimum cone breadth (18.145 cm). A significantly highest cone breadth (20.548cm) was noticed in 800-1500 m altitudes and minimum (18.002 cm) was observed in 1500-2000m. The needle colour had significant effect on cone breadth. The maximum cone breadth (20.392cm) was found in dark- green trees and minimum cone breadth (17.741 cm) was found in light green trees .

The second order interaction between latitudinal clines, altitudes and needle colours the interaction Z1x A2x C1 had significantly highest cone breadth (21.553cm) which was statistically at par with Z2x A2x C2 (19.533), Z2x A3x C2(19.553cm), Z2x A1x

C2(19.567cm), Z1x A1x C1(20.167cm), Z1x A3x C2(20.460cm), Z2x A3x C1(20.767cm),Z2x A2x C1 (21.477cm). The significantly lowest value of (16.553cm) was recorded in Z1x A1 x C2 which was statistically at par with Z3x A3x C2 (18.290cm), Z1x A3x C1 (18.327 cm), Z1x A2x C2 (18.600cm), Z3x A2x C1 (18.613cm).

Similar findings have been reported by Mukherjee et al., (2004) who revealed that the cone width was positively correlated (r =0.35) with latitude.

Table 3: Effect of latitudinal clines, altitudes and colour of needles on cone breadth (cm) of *Pinus roxburghii* Sargent

	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)	Mean
Solan latitudinal cline -30°to 31° N (L1)	18.360	20.077	19.393	19.277
Kullu–Mandi latitudinal cline -31°to 32° N (L2)	18.315	18.687	17.433	18.145
Dharamshala latitudinal cline -32°to 33° N (L3)	19.250	20.505	20.160	19.972
Mean	18.642	19.756	18.996	
	SE±(d)	$C.D._{0.05}$		
Latitudinal cline (L)	0.419	0.851		
Altitudes (A)	0.419	0.851		
Interaction (L x A)	0.725	N/A		

	Solan latitudinal cline -30°to 31° N (L1)	Kullu–Mandi latitudinal cline -31°to 32° N (L2)	Dharamshala latitudinal cline -32°to 33° N (L3)	Mean
Dark green (C1)	20.016	18.549	20.392	19.652
Light green (C2)	18.538	17.741	19.551	18.610
	SE±(d)	$C.D._{0.05}$		
Colour (C)	0.342	0.695		
Interaction (C x L)	0.592	N/A		

	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)
Dark green (C1)	19.281	20.548	19.128
Light green (C2)	18.002	18.964	18.863
	SE±(d)	$C.D._{0.05}$	
Interaction (C x A)	0.592	N/A	

	Solan latitudinal cline -30°to 31° N (L1)			Kullu–Mandi latitudinal cline -31°to 32° N (L2)			Dharamshala latitudinal cline -32°to 33° N (L3)		
	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)	1500-2000m (A1)	800-1500m (A2)	Up to 800m (A3)
Dark green (C1)	20.167	21.553	18.327	18.743	18.613	18.290	18.933	21.477	20.767
Light green (C2)	16.553	18.600	20.460	17.887	18.760	16.577	19.567	19.533	19.553
	SE±(d)	$C.D._{0.05}$							
Interaction (AxLxC)	1.026	2.085							

Cone characters had been studied by various authors in conifers and had found a lot of variation between different morphological traits of cone (Matziris, 1988, Mahadevan et al., 1999, Singh and Choudhary, 1993).Variation in *P. roxburghii* cone morphology with respect to latitude and altitude individually could be due to the fact that this species grows in different climatic conditions and selection pressure affects the structure of population. Such variations in relation to habitat have also been reported in *Pinus bungea* (Wang et al., 1998), *Acacia nilotica* (Bagchi et al., 1990), *Dalbergia sisoo* (Gera et al., 2000).

CONCLUSION

On the basis of statistical analysis, it may be concluded that the morphological traits of cone i.e weight, length and breadth varies with respect to latitudinal, altitudinal clines and colour of needles indicating that these traits are under high environment and genetic control. So, it is recommended that cones having maximum length, breadth and weight can be collected from dark-green morphotypes growing in 800-1500m altitude and 32º-33º N latitude.

ACHNOWLEGMENT

This study was carried out in Shoolini University of Management Sciences and Biotechnology and Dr YS Parmar University of Horticulture and Forestry, Solan (H.P) and authors are thankful for providing facilities and valuable guidance.

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