POLLEN DISPERSION IN HIMALAYAN BLUE PINE[1]

by

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Introduction

Knowledge of pollen dispersion is useful in forest genetics and tree improvement work. Pollen flow within a tree population determines its mating pattern and consequently local and geographic variation in the species. Studies carried out in the past have shown that pollen and seed travel relatively short distances and gene flow is limited enough to promote genetic differentiation (Wright, 1953, 1962; Strand, 1967; Sluder, 1969). On the other hand, though it implies that breeding unit is small in most tree species, even in those species with arealy continuous range, still isolation is slight in most tree population. Environmental and physiological factors may also influence pollen movement within and between populations.

From a practical point of view, pollen dispersion is an important consideration in seed orchard establishment in which both contamination by foreign pollen and inbreeding is avoided. Seed orchards should be established at some distance from the source of contaminating pollen. Some other factors including, size of pollen source, wind velocity and direction, etc. are also important in this regard. As far as inbreeding is concerned, self-pollination is quite significant in conifers as well as in broad-leaved species. According to Sarvas (1967), self-pollination amounts to about 26% of the total pollination in *Pinus sylvestris* in southern Finland. Inbreeding as a result of crossing of closely related clones is reduced by special positioning of clones in the seed orchard (Anon., 1968; Klein, 1973).

This study was undertaken to investigate pollen dispersion and migration in the natural stands of Himalayan blue pine (*Pinus wallichiana* A.B. Jacks. Syn. *P. griffithii*). The results of the study would be useful in planning genetic and improvement programme for this species.

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Study of Pollen Dispersion in Blue Pine

A heavily-pollinating isolated single tree or a small group of trees is the ideal source for pollen dispersion study. This is generally hard to find in blue pine. However, a small stand of this species, about 5 acres in area, was located at Bagh-i-laila which is approximately 10 miles north-west of Parachinar town in Kurram Agency. It is located on a 5000 feet high ridge and is isolated from large blocks of blue pine forests by several miles. Blue pine is dominant species in the area and trees are 40—80 years old with 50—70 feet height.

The pollen dispersion study of blue pine was conducted during May, 1974. Observed duration of anthesis was 13th May to 20th May at this place. Sampling of fall of pollen was carried out according to procedure suggested by Wright (1962). Transects were established in four directions, viz., north, south, east and west of the stand. Glass slides were coated with vaseline and fixed horizontally on 4.5 feet long wooden sticks at geometrically increasing distance of approximately 10, 20, 40, 80, 160, 320, 640, 1280, 2560, feet from the source. The slides were removed and fresh slides placed on wooden sticks after every 48 hours, thus three sets of slides were obtained within 8-days period of anthesis.

Counting of pollen per unit area was done in the laboratory. Eight spots were selected randomly on each slide and pollen were counted under the microscope at×40 magnification.

Results and Discussion

Average pollen count for three sets of slides is given in Table 1, each value being average of 24 observations. This data is represented graphically in Figure 1. They show that most of the pollen travelled relatively short distance and on the average only about 15% of the pollen was carried beyond a distance of 600 feet from the source. These values however, differ from those reported for other studies. For instance, Wright (1953, 1962) found that the pollen of most forest tree species travel short distance in quantity. More than 95% of conifer pollen was trapped within less than 200 feet. Size of the pollen was found to have a marked effect on its movement from the source. Large-sized pollen of coniferous species moved shorter distance than small-sized pollen of broad-leaved species. Topography also influenced pollen dispersion, but wind velocity did not.

Standard deviation was also determined by Wright (1962) for species, which is a measure of pollen dispersion around a mean and indicates distance within which 91% of the pollen fall. This distance varied from 55 to 238 feet in these species. With the exception of *Ulmus americana* L. in which the distance was 2200 feet. In the case of blue pine, standard deviation was calculated in similar manner for average values and was found to be 1538 feet. This is quite high as compared to the reported values for American species.

Examination of Fig. 1 shows that pollen dispersion and density is erratic beyond a distance of 160 feet from the source. This as well as high value of standard deviation may

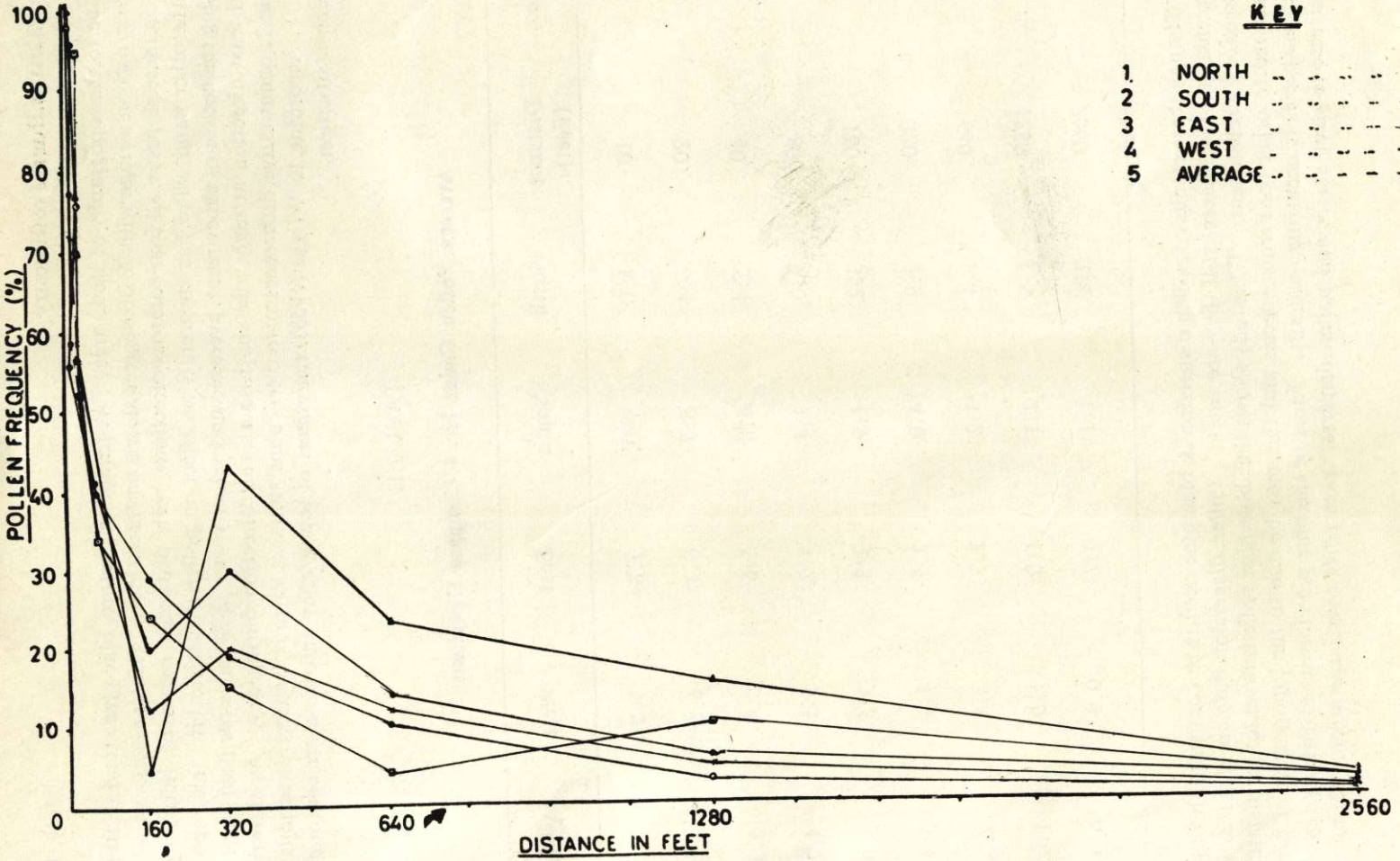

FIG 1. POLLEN FREQUENCY AT VARYING DISTANCES FROM BLUE PINE STAND.

be due to the topography of study area. As mentioned before, blue pjne stand of Bagh-i-Laila grows on a ridge with 20-30 degrees slopes on three sides. The transects were laid out on these slopes in all four compass directions, with distances measured horizontally. On the other hand, wind has apparently no effect on pollen dispersion in this species. During the course of experiment, average wind velocity was 22-24 miles per hour in north-south east direction at night and south-south east direction during day. As shown in Table 1, quantitative differences of pollen count amongst various transect directions are slight. According to Wright (1953), the effects of topography and wind are confounded in such a situation.

TABLE 1

Average Pollen Count for 4 Compass Directions

Sl.No.	Distance (Feet)	North	South	East	West	Average
1.	10	8.0	9.0	7.8	7.7	8.1
2.	20	6.4	5.7	6.3	6.5	6.2
3.	40	5.4	4.8	5.6	5.4	5.3
4.	80	4.0	3.4	4.2	5.1	4.2
5.	160	3.2	1.9	3.3	3.5	3.0
6.	320	2.9	4.0	2.5	4.1	3.4
7.	640	1.4	3.2	2.3	2.4	2.3
8.	1280	1.5	2.1	1.0	1.0	1.4
9.	2560	0.8	1.1	0.7	0.9	0.9

Though these results of pollen dispersion in blue pine need to be confirmed through experiments at other places, still they are useful. Pollen dispersion data are required in seed orchard establishment. This study shows that blue pine pollen travel longer distance as compared to other coniferous species and this may be due to the topography of area where this species is occurring naturally. Most of the blue pine forests in Pakistan grow on moderate to steep slopes and pollen dispersal takes place over large areas. Distance

between seed orchard and source of contaminating pollen will have to be more than two miles (10 × standard deviation) to reduce contamination to less than one per cent.

Gene flow as a result of pollen dispersion affects isolation and population size in forest trees. In those species (e.g. blue pine) where pollen dispersion distance is large, one would expect little differentiation or race formation. However, potential genetic effect of long distance pollen dispersal may be reduced due to other factors. Flowering time varies with elevation and may serve as a barrier to gene flow (Strand, 1967: Sluder, 1969). This may be especially true in case of blue pine growing on mountain slopes. Dogra (1972) has suggested reproductive barrier between blue pine stands at lower and higher elevations. It may actually be due to difference in time of ripening of pollen at two attitudes and not due to incompatibility *per se* (Vidakovic, 1972). These considerations also suggest that the isolation distance between seed orchard and source of contaminating pollen may not be as large as that suggested above as these two may be growing at different elevations.

Distance is the principal barrier for pollen and gene flow in isolated stands of blue pine in north-western and western parts of Pakistan. Their habitat is generally xeric to highly xeric. Both factors would promote recial differentiation in the species through natural selection. Morphological and anatomical studies carried out so far suggest the presence of genetical variation at ecotype or sub-species level in blue pine (Rehman and Siddiqui, 1974). Additional studies are under way to define the extent of variation in the species.

Summary and Conclusion

The results of this study indicate that pollen from a small isolated stand of blue pine at Bagh-i-laila travel short distance under natural conditions. However, the value of standard deviation e.g. distance within which 91% pollen fall, is larger than that reported for other coniferous species. Genetical implications of long distance pollen travel should however, be considered in conjunction with environmental and physiological factors under which blue pine stands grow with in its natural range. Elevation is as much important as pollen dispersion distance in determining isolation and racial differentiation in the species populations. These factors should also be taken into consideration in seed orchard establishment of blue pine.

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