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Responses of maternal siblings of *Pinus densiflora* to simulated acid rain

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We examined simultaneously the effects of family identity and simulated acid rain on germination and seedling performance of red pines for about 36 wks. Seeds collected from six randomly chosen trees at Hongneung, and were planted in blocks subjected to simulated acid rain (pH 3.0 and 5.6). Seedling characters were measured by eight wk intervals after germination. The significant effects of maternal identity were detected at all growth stages. The effect of acid rain on overall seedling performance became significant only at later stage of seedling growth. Seedlings treated with pH 3.0 rain were more vigorous than those treated with pH 5.6 rain. Variation in mean root/shoot ratio suggests a compensatory response to acid rain stress. The strong maternal effects independent of both seed mass and germination date and the relatively constant ranking of maternal families imply that maternal effects may be, at least to some extent, controlled by genetic components. In consequence, acid rain affects germination date and seedling growth of red pines, but the responses differ among maternal families and are also associated with seed mass and germination date.

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Environmental factors relating to seed production in *Pinus densiflora*.

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We examined the pattern of cone production, cone size, seed production, seed size, and seed efficiency of *Pinus densiflora*. Cones were collected from red pine trees randomly chosen at three sites (Youju(YJ), Hongneung(HN), and Kwanak(KA)) in 1998. The mean number of cones per tree differed significantly among the sites (YJ 6.0 ± 5.5 , HN 45.3 ± 5.6 , KA 40.1 ± 5.7) with an overall mean of 20.8 ± 8.6 . In particular, 15 out of 41 trees at YJ did not produce new cones, and the rest of trees also produced only a small number of cones. In addition, both the number of filled seeds and seed efficiency per cone (%) were the least at YJ among the three sites (seed number: YJ 1.86 ± 1.90 , HN 8.12 ± 6.34 , KA 9.83 ± 9.42 ; seed efficiency: YJ $1.18 \pm 0.74\%$, HN $4.73 \pm 1.17\%$, KA $4.73 \pm 1.87\%$). Red pines at KA produced the smallest seeds among the sites (YJ $12.3 \pm 3.4\text{mg}$, HN $12.3 \pm 2.5\text{mg}$, KA $10.6 \pm 3.1\text{mg}$). Both soil pH and density of red pines were not associated with any of these seed yield traits. These 1998 results are not concordant with the 1997 results, suggesting a yearly variation of seed yield traits of red pines. In consequence, seed yield traits of red pines may vary with sites and with years. The extent to which variation in seed yields of red pines is related to reproductive cycle and climatic factors will be examined in further studies.